[redacted]

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computers and people

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WEATHER-WATCHING BUOY

TEACHING COMPUTER SCIENCE

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(*Editorial Note:* The following paper written by Dr. Geisler has been adopted as a position paper by the California Educational Computing Consortium. Their membership includes representation from over 100 institutions of higher learning in California.)

BACKGROUND

There is need for general awareness of and sophistication in the applications of computing technology to the processes and problems of society. It is obvious that in the last quarter of this century the computer will play an increasingly important role in every aspect of America's life and will have a direct and important impact upon the life of every citizen. It is no overstatement to say that the impact of the computer (including digital communications) upon civilization will equal that of the wheel and printing press and far exceed that of such innovations as the internal combustion engine and the harnessing of atomic energy. Consequently, the great importance of computing should be reflected in the college and university curriculum and computing awareness and skills should be recognized as essential to a successful college experience.

THE PROBLEMS

Unlike many of these other advances in civilization, however, computing technology has had a revolutionary impact on society almost overnight. In addition, it requires a high level of technical competence in order to manage, and an equal degree of sophistication in its applications, limitations, uses, and social significance in order to control.

The ultimate benefits to society to be derived through the harnessing of "computer power" in nearly every aspect of life can, at present, only be imagined; but it is certain to be great. Spread relatively evenly throughout society these benefits will go far toward providing a good and rewarding life for all. But the future of computing is not merely a matter of economic and material progress.

The degree to which computing technology may potentially be employed to manage society is only barely perceived by the vast majority of American students leaving college today. Yet increasingly the prospects of a "managed" society are not only possible but real in light of the extremely high level of technical competence obtained by a few and the general ignorance of the subject matter characteristic of the population at large.

THE OBJECTIVES

In order to insure that the benefits of computing technology are spread evenly throughout the society and controlled to insure that they accrue to the benefit of society and are applied in a manner consistent with traditional democratic principles, California higher education should be reviewed to insure that it is relevant to the world in which students will live. The curriculum should be designed to insure that college graduates are capable of playing a significant role in achieving the above goals. This implies the incorporation of computing technology in appropriate college and university curricula regardless of the expense.

THE PROPOSAL

With these objectives in mind the California Educational Computing Consortium strongly recommended that one or more interdisciplinary courses with the above objectives be developed on every college campus. These courses should be viewed as part of the general education program available to all students which should insure a minimum level of student competence in the general subject matter of computing. The course or courses could be offered in a variety of academic disciplines and the faculty should be drawn from a variety of applications areas. Such a course or courses might be entitled, "The Impact of Computers on Academic Disciplines," "Computers and Society," "Introduction to Information Science," "Computers and Communication," "The Information Processing Revolution," etc.

THE PROPOSED GENERAL EDUCATION COMPUTER SOPHISTICATION COURSES

Differences in faculty qualities naturally lead to differing teaching strategies. The following topics are suggested as an outline of course content, but the order of presentation, degree of emphasis, etc., should reflect the teaching strategies selected by the faculty as appropriate to a particular student clientele. However, the syllabus should include the following topics as adapted to the academic interests of individual students.

I. An introduction to information processing and the rudiments of information science.

A. The attributes of data and information. / B. The concept of coding information. / C. The concept of formatting data. / D. The concept of machine readability. / E. The concept of unit record management and manipulation. / F. The concept of digital communication.

II. The elements of computer technology including some elements of computer science which outline computer capabilities and their limitations.

A. The concept of computer memory. / B. The concept of computer control. / C. The concept of computer logic. / D. The relationship between the computer mainframe and the various input and output peripheral devices.

III. Sufficient programming awareness to be able to interface with a skilled computer programmer and a systems analyst.

A. The concepts of computer programming, program algorithm, and some experience in their development. / B. Discussion of the alternative programming languages and their applications language. / C. At least an elementary knowledge of a programming language which would involve the statement of an objective, the development of an algorithm, the coding and formatting of information in machine readable form.

IV. Demonstration of the variety of computer applications appropriate to the various academic major disciplines and to general education. Ultimately all students should be capable of applying computer technology to problems within their academic disciplines and their prospective range of social responsibility upon graduation.

A. Use of appropriate on-line computer program library routines. / B. Management of appropriate on-line data bases, i.e., the ability to store, retrieve, update, and manipulate data appropriate to their academic disciplines. / C. New possibilities opened by computer (communications) networks, such as nationally shared databases (libraries), impact of mass production combining television and computer terminal techniques, widespread sharing of programs, etc.

V. Relationship of computers to other information components.

A. Television / B. Phonovision / C. Display, transmission and utilization of processed information.

VI. Summary[1] of the above materials to generate awareness of the expanding social significance of computers.

A. The sociological implications of large-scale real-time social data bases. / B. The political and social implications of the social scientist's increasingly accurate ability to predict political, economic, etc., behavior based upon the accumulated machine readable data analyzed in conjunction with on-going survey research. / C. The constitutional and legal implications of large scale social and economic data bases for the democratic citizen's traditional right to privacy. / D. The potential of information dissemination to the individual as a citizen and a consumer as a source of immediate information on governments, on industry, and all other aspects of society with which he must deal. / E. The relationship of communications technology to society.

[1]This summary or parts of it could just as well be employed as an introduction to the subject matter and to underscore its importance. □

California Educational Computing Consortium

Grace C. Hertlein
Art Editor, Computers and People
Member, Board of Directors, CECC

The California Educational Computing Consortium is a group of educators interested in the application of computing technology to the problems of higher education. Its members include faculty from the California University System, the State University System, private colleges and universities, and the community colleges of California. CECC membership includes over 100 institutions of higher education.

The foregoing position paper in this issue of "Computers and People" was adopted by CECC at its March meeting. It is anticipated that this adoption will act as a thrust in fostering additional courses in Computers and Society within the State of California.

During the academic year 1973-74, Dr. Geisler, the author of the paper, was directly responsible for the planning, coordination and implementation of a series of varied seminars throughout the State of California on many different aspects of computer use, including testing, simulation, psychology, geography, interdisciplinary graphics, art, etc. The week-end seminars were open to any faculty from the CSUC system. They were attended in great numbers, often necessitating repeat seminars, due to heavy registration and participation.

To date, thirteen Special Interest Groups have been formed:

- Computer-Assisted Instruction
- Teaching Computer Science
- Management of Computer Services
- Teleprocessing and Time Sharing
- Educational Management Systems
- Computer Graphics
- Computers and Society
- Computers in Social Science Methodology
- Computers in the Business Curriculum
- Behavioral Objectives in Academic Instruction
- Computer-Aided Test Generators
- Student Users of Instructional Computing
- Computer Applications in the Physics and Chemistry Curriculum

Additional collaboration and sharing of ideas has taken place with another related group, CEDPA (California Educational Data Processing Association), through mutual projects, seminars, and conferences.

For more information on one or more of the Special Interest Groups of CECC, please write Dr. Geisler's office. □

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computers and people

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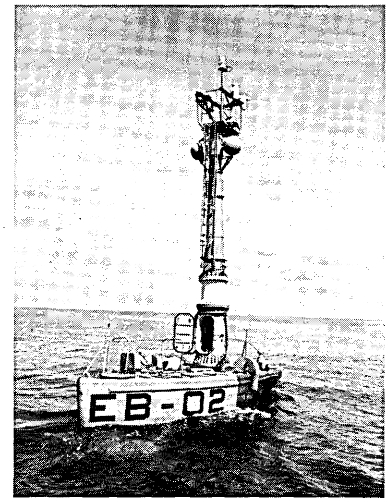
The magazine of the design, applications, and implications of information processing systems — and the pursuit of truth in input, output, and processing, for the benefit of people.



Front Cover Picture

A weather-watching buoy made by Lockheed is at its operating station 300 miles west of the coast of the State of Washington. A ROLM 1601 computer on board transmits weather information to shore-based receivers. See page 34.

Departments

Key

[A] — Article
[C] — Monthly Column
[E] — Editorial
[F] — Forum

NOTICE

*D ON YOUR ADDRESS IMPRINT MEANS THAT YOUR SUBSCRIPTION INCLUDES THE COMPUTER DIRECTORY. *N MEANS THAT YOUR PRESENT SUBSCRIPTION DOES NOT INCLUDE THE COMPUTER DIRECTORY.

NETWORKING

From time to time a new concept that is important, interesting, and *operational* comes to the forefront of thinking in the field of computers and data processing.

Such a concept is "networking," as explained in a new and important book: *Networks for Research and Education: Sharing of Computer Information and Resources Nationwide.* The book is edited by Martin Greenberger, Julius Aronofsky, James L. McKenney, and William F. Massy, and is published (1974) by MIT Press, Cambridge, Mass., 02142, hardbound, 418 pp. It contains the discussion, analysis, and certain papers, of three seminars on computer networking conducted by EDUCOM in 1972 and 1973 with the support of the National Science Foundation. Among the papers and authors are "The Potential of Networking for Research and Education" by J. C. R. Licklider, and "The New England Regional Computer Project" by Thomas E. Kurtz.

What is "networking"?

Here is a quotation from the preface:

[Beginning of quotation]

A medical researcher sits at an on-line terminal in Honolulu searching an index to the world's medical literature stored on a computer in Bethesda, Maryland, over 5000 miles away. His request passes across a radio network of the University of Hawaii. Arriving at a centrally placed message-processing minicomputer, it is operated on, then turned over to the Hawaiian telephone company's network for transmittal across the Pacific Ocean via an international satellite. In the continental United States, the request is operated on once more by a message processor of a nationwide research network, then converted and routed to a commercial time-sharing network that moves it along to the medical information system in Bethesda.

By mail the request would have taken several days. By computer communication network it takes less than five seconds. The response to the request, a set of literature citations, starts printing out at the terminal back in Honolulu within fifteen seconds from the time the request was dispatched.

Fancy? Exaggeration? No, essentially fact.

When? In five years? Not at all. Right now.

Perhaps the illustration is a bit dramatic. Perhaps it is enough to note that everyday domestic usage of the on-line medical information system through the commercial time-sharing network has been doubling every six months. . . . The point is that interest in information and computer networks is at an all-time high. The possibilities they offer in research and education inspire hope and confidence; among them, new and better computing and information services, greater efficiency in operations, broader markets, widespread access to facilities, and extensive resource sharing. But the road to these benefits is not well-paved. Many knotty problems and questions have to be answered – or even asked.

[End of quotation]

The National Science Foundation over the past few years has supported the development of about thirty regional networks among colleges and universities. This book presents the content of three working seminars, at which some 150 participants presented papers and discussed ideas relative to networking. The book naturally is a gold mine of knowledge, reports, ideas, and suggestions in the general field of computer networks used for research and education.

Among the conclusions of this joint report by the participants in the seminars and the able editors who considered and put together the main "conclusions and recommendations" are these:

1. Computer networking must be acknowledged as an important new mode for obtaining information and computation. It is a real alternative that needs to be given serious attention in current planning and decision making.
2. The major problems to be overcome in applying networks to research and education are political, organizational, and economic in nature, rather than technological.
3. Networking does not in itself offer a solution to current deficiencies. What it does offer is a promising vehicle with which to bring about important changes in user practices, institutional procedures, and governmental policy that can lead to effective solutions.

Following these conclusions are six major recommendations (see pages 23 to 33), mostly dealing with ways in which to proceed.

For as usual, the technological possibility now at hand is acting as a powerful incentive to make it a technological reality.

For networking to come into existence as a help to research and education is one kind of future event. But the use of networking for control over privacy, and for dealing with crime, however crime may be defined, is another kind of future event. The same technologically – far apart socially.

Networking is a subject with which the oncoming echelons of computer scientists and information engineers will be much concerned.

This book is undoubtedly a very useful guide to the subject, and a storehouse of ideas.

Edmund C. Berkeley

Edmund C. Berkeley
Editor

MULTI-ACCESS FORUM

DATA ENCRYPTING:

COMMENT ON STRASSBURGER'S CRITICISM

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Vienna, Va. 22180

Major Strassburger criticizes data encrypting ("Computers and People," May, page 7) on the grounds that if the computer is penetrated, the encrypting algorithm can be found, and the data files deciphered. Therefore cryptographic methods of data security are of limited value.

Although I hesitate to take issue with someone from Fort Meade, one of the main centers of cryptographic expertise in the Western world, I should point out that if the data can be deciphered from knowledge of the encrypting algorithm, the data security staff hasn't been doing its job. There is a method, now in use in various computer installations including that of the National Institutes of Health, which uses the "keytext" approach to the encrypting of data. Even with knowledge of the algorithm, cleartext cannot be obtained without knowledge of the keytext employed by the user — and that keytext need not be, and should not be, kept in the computer or anywhere else except in the user's head.

While it is theoretically possible to break a keytext cipher with the aid of a computer, in practice it will not be accomplished.

For a thorough explanation of keytext ciphers, see David Kahn's classic "The Code-Breakers". Use of a computer to attempt to break keytext ciphers was pioneered by Dr. Carl Hammer of Univac in relation to the famous "Beale Cyphers"; but in spite of much sophisticated work, the computer has not been able to decipher the message and locate Beale's buried treasure.

UNFAIRNESS:

UNFAIR COMPETITIVE PRACTICES THROUGH THE JOINT VENTURE BETWEEN HONEYWELL, INC. and DARTMOUTH COLLEGE

J. L. Dreyer, Executive Vice President
Association of Data Processing Service Organizations, Inc.
210 Summit Avenue
Montvale, N.J. 07645

ADAPSO has sent telegrams to both Honeywell, Inc., and Dartmouth College, that express its concern that both organizations may be in serious violation of Federal and State Anti-trust laws and Federal tax laws.

We understand that Dartmouth College, through utilization of its tax exempt status, governmental grants and charitable gifts, has developed a computer software system for use and distribution in conjunction with computer equipment manufactured and sold by Honeywell, Inc.

We understand that Dartmouth had established a subsidiary, DTSS, Inc., which is in direct competition with computer service firms in the private sector. The subsidiary is believed to be responsible for the distribution and maintenance of the Dartmouth-Honeywell software system and related services and products. It has entered into a joint marketing program (or joint venture) with Honeywell for this purpose.

Based upon the foregoing information, ADAPSO believes that both organizations are engaging in serious violations of Federal and State Anti-trust laws and Federal tax laws and are competing unfairly with the private service companies, in reliance upon public and private grants and gifts and Dartmouth's tax exempt status.

We have specifically requested of both parties that they discontinue all joint arrangements for the marketing of Honeywell computers and Dartmouth software; that Dartmouth completely sever all commercial activities engaged in through DTSS and Honeywell, including their use of Dartmouth College facilities, personnel, resources and privileged status and the technical systems developed by the college.

INFORMATION SERVICES:

DISCIPLINE-BASED INFORMATION SERVICES SHOULD BE SUPPORTED ON AN INCREASED SCALE, NOT CUT

American Chemical Society
1155 Sixteenth St., N.W.
Washington, D.C. 20036

The American Chemical Society has testified before a House Subcommittee that overall long-term harmful effects can be expected from the action of the Office of Management and Budget in deleting all support for modernizing informational systems of various scientific disciplines from the proposed Fiscal Year 1975 Budget for the National Science Foundation's Office of Science Information Services.

The learned scientific societies long have maintained continuous information systems that document scientific research in their particular disciplines. By means of these informational systems, basic to

THE PURPOSE OF FORUM

- To give you, our readers, an opportunity to discuss ideas that seem to you important.
- To express criticism or comments on what you find published in our magazine
- To help computer people and other people discuss significant problems related to computers, data processing, and their applications and implications, including information engineering, professional behavior, and the pursuit of truth in input, output, and processing.

Your participation is cordially invited.

research in academe, industry, and government, duplication of effort can be avoided and advances communicated. However, the scientific societies — nonprofit organizations — do not have the resources to develop systems to meet modern needs of an efficient government, a rigorous industry, and an effective educational system.

The support of the Federal Government exclusively for informational systems of mission-based projects, even though these services are highly successful, is short-sighted, since the discipline-based systems provide stable, long-term, international continuity, while the mission-based systems generally have a limited lifetime.

The ACS has requested the reinstatement of support of discipline-based information systems into the Fiscal Year 1975 Budget of the National Science Foundation. The ACS recommended that the annual budget of the NSF Office of Science Information Service grow to three to five percent of NSF funds over the next several years.

The urgency and magnitude of current world problems, such as the need for increased productivity, environmental management, and prudent husbandry of the limited reserves of critical natural resources, are severely straining our ability to utilize effectively the available scientific and technical knowledge in obtaining practical solutions to these problems.

"If there is no sustained support for the development of privately-operated, discipline-based information services, these services cannot develop processing capabilities and information-supply mechanisms comparable to those being developed, implemented and operated within the federal mission-based agencies. Therefore, the market for discipline-oriented information services will continue to decrease. The loss of income already being felt by the discipline-oriented services is resulting in tremendous pressure on them to change their coverage policies. In the absence of well-conceived modernization, these pressures can be met only by reduced coverage which, in turn, can only lead to permanent deleterious effects on long-term continuity of information access for the community as a whole. Careful study has shown that once continuity of coverage is broken, it is nearly impossible to re-establish."

INDEPENDENT USER GROUP:

THE COMPUTER INDUSTRY ASSOCIATION OFFERS $50,000 TO START AN INDEPENDENT USER GROUP AND CORRECT NATIONAL IMBALANCE IN THE COMPUTER INDUSTRY

Jack Biddle, Executive Director
Computer Industry Association
16255 Ventura Boulevard
Encino, Calif. 91316

The Computer Industry Association has called for the formation of an organization of computer users beholden to no single manufacturer, and has offered to grant $50,000 for start-up costs.

The Association seeks free and open competition in the computer and telecommunications industry which is dominated by IBM and Bell System monopolies.

No user group sufficiently independent of a single manufacturer now exists. No user group can afford to take a stand against its patron manufacturer — even when the stand would be in the user's own best interests.

We believe that an informed and sophisticated user is healthy for this industry — for himself, ourselves and the nation. And we're putting up money to show we mean it.

The money would be available to a user group provided matching grants were also made available from two other organizations for a total $150,000 in start-up funds.

The Computer Industry Association began with $50,000 two years ago. "Since then we have learned that we can have an impact on the direction of our industry and that the Association can make a difference. We believe that an independent users' group will provide users the same result."

In almost every industry, the user plays an active role in determining what suppliers develop, market and sell to him. In the computer industry, however, the supplier is dominant. The establishment of a strong, unaffiliated user group will be a positive step toward restoring the balance of power in what today is the most important industry in America.

There are three areas where users' voices must be heard loud and clear — data privacy and security, standards, and interconnection with the nation's telecommunication system. In all three areas, suppliers have dictated hardware and software size, shape and price structure to users.

The Association has called for the establishment of a strong neutral industry body to guide efforts of producers and users in seeking sound solutions to problems in the areas of privacy, standards, and interconnection before the U.S. Government steps in to do it for us. The industry body, similar to the Federal Accounting Standards Board, should consist of manufacturers and of users including the Government.

The Computer Industry Association represents 36 companies that generate gross annual revenues of $1.5 billion.

CONSPIRACY:

CONSPIRACY CLAIMED IN THE KILLING OF THE REVEREND MARTIN LUTHER KING

Editorial Note: Below we print three United Press International dispatches published May 25, May 26, and May 27, in *The South Middlesex News,* Framingham, Mass. Not one word about these developments was, so far as we know, printed in *The New York Times,* whose policy is "all the news that's fit to print".

Memphis, Tenn. (UPI) — (published May 25) — Two professional gunmen hired by four "wealthy, socially prominent Americans" killed Dr. Martin Luther King, Jr., an attorney for James Earl Ray said Friday. The two purportedly want immunity from prosecution so they can testify against the men who paid them.

Ray's attorney, Robert Livingston, of Memphis, said he has been contacted by an intermediary for the gunmen who say they were hired to murder the civil rights leader and Nobel Peace prize winner as he stood on the balcony of a Memphis motel on April 4, 1968.

"The gunmen did it strictly for money," Livingston said. "They had no feelings one way or the other for Dr. King.

"The motives of the four wealthy, socially prominent Americans who paid to have Dr. King killed sprang out of hate," he said, "although they could probably rationalize what they did as consistent with national security."

Memphis, Tenn. (UPI) — (published May 26) — U.S. Attorney Thomas Turley, Jr. discounted Saturday an attorney's claim that two professional gunmen hired by four wealthy men were responsible for the assassination of Dr. Martin Luther King, Jr.

Robert Livingston, who represents convicted assassin James Earl Ray, said Friday he had been contacted by an intermediary for two men who claimed they killed the civil rights leader and said that Ray is innocent.

The lawyer said the gunmen are seeking immunity from prosecution in order to testify against the four "wealthy, socially prominent Americans who paid to have Dr. King killed."

"Mr. Livingston may have been denied such experiences," Turley said, "but this office is contacted regularly by intermediaries of unidentified persons said to be willing and claimed to be able to solve, in exchange for immunity, crimes ranging from the so-called 'donation of constantine' to the murder of cock robin.

"And we have no intention," Turley said, "of running such rabbit tracks in the Ray case or any other.

"If Mr. Ray, his latest lawyer, or both have any such evidence, we will be pleased to receive and pursue it," Turley said. "Meanwhile, we are not going to be made pawns in a publicity game, nor inveigled into chasing easily fabricated, self-serving rumors."

King was killed April 4, 1968, as he stood on the balcony of the Lorraine Motel near downtown Memphis. Ray was linked to the crime by fingerprints found on a rifle left in front of a rundown rooming house from which authorities said the fatal shot was fired.

Memphis, Tenn. (UPI) — (published May 27) — An intermediary for an alleged hired gunman who killed Martin Luther King, Jr. may meet with the district attorney general before mid-summer, an attorney for confessed assassin James Earl Ray claimed Sunday.

"The chances are good we'll have the man with the information and others who have come forward with information that would clear James Earl Ray meet with District Attorney General Hugh Stanton by mid-summer," said Robert I. Livingston, a Memphis lawyer.

Livingston said the intermediary for the "trigger man" and two other professional gunmen promised a quarter-million dollars by four "wealthy, socially prominent Americans" to kill the civil rights leader contacted him again over the weekend while several other informers also "came forward with information."

Livingston said the intermediary is seeking immunity for the three gunmen, one of whom allegedly shot King in the neck April 4, 1968. The lawyer said the three gunmen were to split a reported $250,000 for the job and set Ray up as a "fall guy". The gunmen received only $100,000, the lawyer said.

Shelby County Attorney General Hugh Stanton affirmed that Livingston had approached him concerning the intermediary's contact, but insisted direct confrontation by the middleman must be made to his office.

"We will be glad to sit down and talk to either the intermediary or the other men," Stanton said, "but from the information we now have there is no way we can contact them — they must contact us."

Ray, a 1967 Missouri prison escapee serving a 99-year term for the King slaying at the state prison at Nashville, said in an interview he was fixing a low car tire when the Nobel Peace Prize winner was shot in the neck April 4, 1968.

Ray, who eluded authorities for 65 days after the assassination and was finally arrested in London, confessed to the slaying March 10, 1969.

Ray was linked to the crime by fingerprints found on a rifle left in front of a rooming house from which authorities said the fatal shot was fired. But now Ray is seeking a special hearing of evidence in federal court to prove he was allegedly coerced by his former defense attorney, Percy Foreman, to the guilty plea.

The state of Tennessee has appealed to the U.S. Supreme Court a 6th U.S. Circuit Court of Appeals decision this year that Ray deserves the evidenciary hearing which could lead to a new trial for Ray.

U.S. Attorney Thomas Turley, Jr. said he would gladly receive useful information in the King assassination, but that his office did not intend to chase shadows.

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ΔϒΔΘΠΦ ΘΔϒΔΣ ΔΘ≡.

SYSTEM SOFTWARE DECIPHERING

1. Software System Cracking: A View from a Victim

Raymond E. Boche
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"WHEN YOU CAN'T WIN, YOU START NEGOTIATING."

This note introduces the following paper written by one of our intermittently outstanding "students" at California Polytechnic State University, San Luis Obispo. For the reader to share my interest in Charles Carlin's comments requires an explanation of their context.

Use of a Distant Time Sharing System

Less than two years ago, our campus began to use a timesharing system located on another campus. The hardware is a CDC 3170 configuration, and our access is via seven ASR33 teletype terminals. The software is the proprietary product of International Timesharing Corporation, a firm operating similar systems commercially.

The System was "Cracked"

I have reason to believe that a group of our students, working from a terminal and with no documentation available, gained complete access to the system. By complete, I mean that they obtained copies of the entire operating system source code including all passwords and internal security keys. If you have a terminal and a telephone in your office, I believe that some of these students starting with no more than a single readily attainable user password can sit down at the terminal and print all other password accounts and any and all data files and programs stored in the system; modify anything stored in the system including segments of the operating system itself; and for a grand climax, cause the system to substitute their terminal for the operator's console — reallocate system resources — and return control without the operator having realized that anything is amiss! A reader with an industrial environment in mind may wonder: If "they" were doing "that," why didn't you stop "them"? Once they had cracked the passwords — How? When you can't win, you start negotiating.

Raymond E. Boche is Professor and Computer Center Director, California Polytechnic State Univ., San Luis Obispo, Calif. He has previously been Asst. Professor of Industrial Engineering and Computer Science at Texas Tech Univ., and Supervisor, Computer Operations, at Lockheed Missiles and Space Co. He has published numerous articles, papers, and reports. He has a Ph.D. in Industrial Engineering from Texas Tech Univ.; and a M.S. in mathematics from San Jose State College.

I doubt if any one student was dominant enough to be called "the brains of the outfit," but Charley Carlin was at least an important ringleader. I'm not sure how or when they started. Finding Charley and his cohorts in the ready room at all hours of the day and night is no surprise. They are usually working in (or on) assembler languages and trading esoteric tidbits of information of no interest to anyone else. They busy themselves with the typical mundane tasks of dumping the OS (operating system), disassembling our user accounting routine, and all the other "normal" activities so familiar to university computer center directors. When they turned to the timesharing system, I noticed a lot of symbolic dumps, an extraordinarily sophisticated CDC 3170 disassembler running on the campus IBM 360/40, and a sharp increase in paper tape consumption. They discovered some system bugs, and they began to suggest specific fixes — fixes that illustrated a knowledge of the system unavailable to the systems maintenance staff at the Timesharing Center.

... But with Integrity and Concern

This group of students (with one notable exception) evidenced particularly high integrity and concern for their fellow students. Their efforts took a lot of terminal time. They were careful to use our leased terminals to save wear and tear on the ones we own, and they stayed off our terminals during peak periods and swooped down again during holidays and quarter breaks. To save the time on our terminals for other students (and maintain a lower profile), they traveled to use idle terminals at at least seven other campuses. Their knowledge spread, and students at other campuses began to help. The systems staff began intercepting messages containing system information floating between campuses. Suspicions rose and so did our disk storage. The staff did some snooping and spotted multiple copies of systems source sprinkled throughout our legitimate files. A quick purging lasted about a week. Then the paper tape copies had been reloaded and passed through a cryptographic scrambler to defy detection. My dialog with the group increased in frequency and intensity with a plea (an order would have been foolish) to stop! It was too late to stop; the job was done. To the best of my knowledge, they have never misused or injured this system or its commercial counterpart (although others with some of their information may have done so). I doubt if line charges to commercial systems stopped them because among our more than 600 electronics students, they could surely have located a willing accomplice with no particularly pious attitude toward long distance rates.

As I examine my own attitudes toward their "success," what strikes me most is what I see as a tremendous waste of talent and creative potential. What could they have built had they channeled the same organization and energies into the creation of a new system? Charley admittedly gained a lot of detailed knowledge and some concepts about a system whose obsolescence he may have accelerated. Although the level of technology is in no way comparable, I am somehow reminded of my own considerable pride in the late fifties when I knew every nut and bolt size, torque and clearance recommendation for all 1936 through 1940 Ford cars. I may have sensed a few concepts and generalizations from that detail, but whatever satisfaction it provided at the time, I do not seem to use or remember much of that anymore.

Why Did They Bother to Crack It?

So they have cracked a supposedly secure system with an enormous effort, great dedication, tremendous organization, and no real gain! The question remains, "Why did they bother?" Will they go on to another system where there is an economic payoff? I don't believe that Charley will, but he has demonstrated that he certainly could! The fact that he could makes the many curious comments and attitudes expressed in his paper of great interest.

No Confidence in Locks as Barriers

Perhaps Charley is correct and the way to design a perfect lock is to tell everyone interested all about all the contents of the tumbler; perhaps I have just lost confidence in locks as barriers to entry and view them as symbolic "do not enter" signs with built-in delays. The lock is a barrier to the idly curious and incompetently malicious. The dedicated violator with a purpose must be caught during his efforts to evade the lock's entry delays, or as a result of his actions after entry. Security is adequate to prevent anyone attempting to use the computer on a realistic application, from inadvertently damaging the system. The continuous investment in resources to improve the "locks" is, in my judgment, a foolish "cat-and-mouse game," even in a university environment where cats abound. □

2. Concepts in Software Cracking

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"IT IS MY BELIEF THAT THOSE DESIRING KNOWLEDGE SHOULD BE ABLE TO OBTAIN WHATEVER THEY NEED TO CONTINUE AND REINFORCE THEIR LEARNING."

Prior to entering my studies in the field of computer science, I was a master locksmith opening for hire any system that people in the field of safes to padlocks could offer. This knowledge has given me an insight into the cracking of security systems, and software security is a natural extension of my interests.

I have started to scratch the surface weaknesses of software now in use. So far, I have had the opportunity to investigate very few systems in depth. They could be a poor sample of what is in store for the would-be security system cracker. At this point, I should dispel all doubt as to the connotation of the phrase "system cracker". I do not at any time in my discussion consider system cracking as system crashing. Anyone who is a system crasher is into a philosophy that I do not want to attempt to analyze or even investigate. The system crasher is a disruptor. Any action that causes a monitor program or operating system to cease to function and to require operator intervention is easily detected and the disruptor will be apprehended. The challenge of being a system crasher seems to be minimal, for when the system crashes, the climax has occurred and that is all there is. However, the problem of system cracking is much more far reaching. The system crasher knocks the system down and nothing then happens until the system is restarted. The system cracker, however, does not take the system down with him when he is working properly. Sometimes the efforts of a system cracker can knock the monitor program down. This is usually a mistake resulting from inexperience on the part of the system cracker or from a lack of documentation.

The Security of an Operating System

This paper is not intended to be an inside guide to the "supervisor mode" or a way to run the monitor from the inside out, but is a glimpse of the

Charles A. Carlin, a student at California Polytechnic State Univ., San Luis Obispo, Calif., was a master locksmith at the age of 12, the youngest in the nation. He worked in the back of his father's shop until he was 16, and then ran his own shop until he left for college at 19. He is a senior majoring in mathematics, and recently was hired part-time to teach some programming courses for the School of Engineering.

security of an operating system currently in use. It is definitely intended for someone who has at least a small amount of insight into what an operating system is and how one works. This paper is in no way intended for any type of interpretation by those who would be system crashers. In the investigation of operating systems what is desired is not to crash an operating system, but to attempt to gain status beyond that of a normal user by exploiting ineffective security measures on the part of the writers of the systems. Any knowledge gained from this investigation has been used as a tool for further investigations and learning in the security field. Anyone genuinely interested in the security field, and with an honest heart, would be gladly shown the intricacies of the systems that have been encountered. It is my belief that those desiring knowledge should be able to obtain whatever they need to continue and reinforce their learning. It is in this frame of mind that knowledge gained in the study of the operating systems available and their secure and insecure natures and features should be passed on. It is hoped that those who deal in operating system security would have a conscience with a high degree of honor in their studies. Without such, the field as a place to study could be wrecked for all.

The Huge Problem of System Security

Strides must be made to maintain the integrity of data security and of system security at a maximum. Not a month goes by without news reports of someone breaking some security system and stealing or embezzling a large sum of money or merchandise. According to statistics, the average computer theft is approximately 1.1 million dollars,[1] and in the case of the Equity Funding computer fraud, the theft was over 2 billion dollars. With the stock exchange in New York considering replacement of couriers with a large computer network, it should be apparent that if the security of this computer system was not extremely effective, the entire economy of the nation could be affected and possibly controlled. The statistics may not be accurate; we may never know how many computer embezzlers have effectively covered all their tracks and not been caught. This is frightening indeed, since the trend is toward massive data banks. As these data banks are modified, if they are the sole means of storage, the data that has been lost may never be regained.

Concepts for Analyzing Weaknesses in Systems: The Black Box

In the examination of a system's security to analyze its strengths and weaknesses, a logical process is followed. To trace the procedures that enable such an analysis, certain parallels can be made to elements of the thought process and how they are used to make distinctions and enable classification of the observed behavior or outputs of a given system. The inputs to a system are whatever the user does to cause a change in the state of the system, initially described as a "black box". The outputs are determined by the nature of the inputs to the system. If the inputs are Fortran source code to the Fortran compiler, the compiler is then the black box and the expected outputs are the final object module representing the input code. The behavior of the compiler is very well documented, and any anomalous input, such as a doubly defined statement label, will cause a corresponding anomaly in the output in the form of an object module that will not execute. The compiler as a system will only accept certain types and formats of input data and may not execute at all if the inputs contain many anomalies. To extend this to the operating system, we find that there are quite a variety of inputs that can be processed by a given system. Each of the inputs will cause some action to be taken by the operating system, and the system will have a corresponding reply, if one exists.

Many inputs are well defined and give a correspondingly well defined type of output. If the inputs were a set of dials, and the outputs were a set of gauges, one could move any of the dials and watch the corresponding output on the gauges. Note that in the interconnections of the black box there is not a one-to-one correspondence between the dials and the gauges; some of the inputs and outputs could have a one-to-one correspondence, but sometimes changing an input may appear to have no effect on the output gauges. As one analyzes the system and the outputs, certain conclusions can be reached. These insights into the operation of the black box enable judgments to be made about the way the inputs made have affected the system at hand. How are these judgments arrived at?

"The coding and recoding of inputs — how incoming inputs are sorted and organized — turns out to be the important secret of the black box that lies athwart the communication channel."[2] The way one perceives the outputs of the system is very closely related to the types of decisions one makes, if any, in readjusting the inputs to the system. One interprets the behavior of the system by parallels with his past experiences to categorize and weigh the values of the inputs and of the outputs. The ability to modify the inputs to achieve redundancies and to see anomalies in the outputs is likewise a function of the ability to perceive similarities between one set of observations and a subsequent set of observations, by past experiences with similar systems, and the ability to draw parallels. The application of these principles to the black box at hand makes the interpretation of the gauges a subject of insight, previous knowledge, reasoning ability, pattern recognition, and possibly a degree of luck.

Variation

"A man cannot step twice into the same river; neither can he twice conduct the same experiment."[3] In the examination of the black box one should notice that the same inputs may not always cause the exact same outputs, because the system is in a different state if it is in a different time frame. This difference can be so close that the results for the purposes of some observations are exactly alike. However, to avoid drawing faulty conclusions one must be conscious of the changes that can be happening unnoticed, and include some parameter in the context of the observation in an attempt to make the system a deterministic one.

The Recognition of Patterns

Changes are made in the inputs in a sequence that allows the observer to note the changes in the outputs and make observations about the behavior of the system. If the sequence of the observations allows patterns to be recognized, then the observer is on the way to making predictions about the behavior of the system. If a pattern cannot be recognized then the number of variables or the level at which the distinctions of variation of inputs or outputs are measured must be changed. The modification of these parameters should enable the observer to find a level of distinction and number of variables that will allow a pattern to be recognized in the system. The ability to interpret outputs is an aptitude that will influence the depth to which a given system can be understood. A certain aptitude is necessary that can only be measured by putting it to use. It is in the application of these principles that one can proceed to locate redundancies and anomalies in a given computer system.

Questions Answered in a Vague and Incomplete Manner

The system that I have dealt with primarily is the timesharing operating system currently in use in the California State University and College system, having a commercial counterpart, running on a dual CDC 3170 configuration. Documentation for the system's operation was available only to the systems programmers at the timesharing data center. Questions asked by students interested in the timesharing operating system were often answered in a vague and incomplete manner. Unavailability of documentation is used as a major deterrent to keep users from being able to crack the system. This lack of information spurred generation of documentation for the system from whatever was available. With my disassembler and core images of instructions and data in the system, outputs were derived so that the system could be better understood. From a knowledge of the operation of documented systems and this listing of the source code, many of the intricacies of this system were discovered.

The monitor must handle all interrupts (memory allocation, memory loading, page fault, disc input, disc output) requested by the user. The monitor being at the top of the structure has absolute power over any operation and gives the user less than absolute status. The monitor in this system keeps tables of each partition a user has activated. The independence of each partition gives this design a fool-proof (in theory) security system. As the interrupt processor handles any given request, it examines the origin. The monitor will not honor requests of monitor status from a user. As long as there are no shared pages of memory between the monitor and user, no modifications can occur to memory across partition boundaries. If shared memory is eliminated completely (between monitor and user), then the security of the entire system depends totally on the ingenuity of the interrupt processor.

System Interrupts Not Documented

To a large degree, the system interrupts are not documented for the users. This is especially true of the interrupts that are used at the highest status level. Many of the interrupts that are documented are not available to the user. Monitor status interrupts will only be honored by the interrupt processor if the request originates from the monitor or if one finds a loophole in the operating system and uses it.

Loaded with Flaws or Trapdoors

This system, as many others, is loaded with flaws, or trapdoors, that may allow users to achieve a higher status than intended. Such flaws are the result of an implementation error on the part of the system writers, and have allowed the documentation and verification of many system interrupts. This does not mean that the writers of the system are not of a high caliber. Many times a trapdoor is available to a user via the cumulative errors of many software writers. A flaw in the logic may not be evident until implementation. As the code is tested by the user, subsequent bugs are revealed. Finally when a system cracker with a good eye tries to push the functioning of a segment of an operating system to its limits, the very subtle flaws become apparent.

Part of the security of this system lies in the elimination of trapdoors. With better designs and hardware evolving at a rapid rate, it may not be an exaggeration to believe that a flawless system could be generated in the near future.

Speedy Elimination of Trapdoors

Investigation and location of flaws is a key to improving the software currently in use. A thorough understanding of how current systems function is necessary so that errors can be repaired, mistakes will not be repeated, and progress toward better computer systems can be made. Elimination of trapdoors through informed systems programmers, good documentation, and speedy repairs when flaws are located will give the users greater confidence in their system. This confidence can be shattered by the malicious system crasher or the system cracker with dishonest ends in mind.

Improvement of Operating System Software

The application of abstract procedures outlined in this paper have yielded the desired results. A user on a given computer system has achieved a status much higher than was intended. This ability enabled a more indepth investigation of the computer system which in turn enabled a much deeper understanding of the system than was available through the current documentation. With this added understanding, a malicious user can cause major system disruptions. With this same added understanding, a responsible user can add to the security of the system at hand and improve the software that is currently in use. The improvement of the software in use is a valuable asset to all users on any computer system, for it is in this improvement that the advancement of the entire field can be seen. Through improved software, the computer systems in use will be made better for all users, whether they are only users of canned programs or operating system security investigators.

With these added insights a would-be system designer could quite possibly design a better system and not perpetuate the flaws inherent in current computer systems. This can only occur if communication channels are left open and the ability to investigate and search for knowledge is always encouraged for those who seek further understanding. It is in this frame of mind that security probing should be done. The knowledge gained from such investigations will then be able to be used for the betterment of all users of computer systems.

Footnotes

1. "Computer Embezzling is a Chilling Spectre to Big Business", Chicago Tribune, November 26, 1973.
2. Bruner, J., J. Goodnow, and C. Austin, A Study of Thinking. Science Editions, New York, 1962.
3. Ashby, W. Ross, An Introduction to Cybernetics. Chapman and Hall Ltd., London, 1956. □

Automating the Monotonous Jobs

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"HUMAN WORKERS WOULD BE FREED FROM THE RELATIVELY LOW-LEVEL JOBS THAT CAN BEST BE DONE BY MACHINES."

Industrial automation is hardly new. The concept began with the Industrial Revolution. Yet automated equipment and procedures have changed relatively little over the years. For the most part, human workers still guide the machines, carry the parts from one machine to another, keep track of what each machine is doing, test and assemble the parts and inspect the finished products.

WORKER DISSATISFACTION WIDESPREAD

Many of these jobs are as mindless and tiresome as Charlie Chaplin's was in *Modern Times* nearly 40 years ago. Worker dissatisfaction with these dull, repetitive chores is widespread. Even generally high wages and fears of recession have not quieted labor unrest in many plants. The work stoppages, slowdowns and absenteeism that have often resulted from this dissatisfaction have led to decreased output, poor product quality and thus to escalating production and repair costs.

Most of these routine jobs could be done by computer, says Dr. Charles A. Rosen, Staff Scientist, who has been developing computer-based automation systems at Stanford Research Institute for several years.

"This could eliminate many undesirable jobs," he says, "and provide new man-machine relationships requiring more human intelligence and thus restoring man's purpose and dignity."

He visualizes factories in which many repetitive jobs would be done by computer-controlled machines supervised by a smaller but more highly trained work force than is used today. The workers would be capable of setting up (i.e., programming) each job, modifying procedures, changing over for new models or batches, maintaining the equipment, and using their intelligence to cope with stoppages and breakdowns. Thus, in effect, they would be "time-sharing" their capabilities among many machines.

Freed from the relatively low-level jobs that can best be done by machines, the human workers would be able to devote their time to those more challenging tasks that now either cannot be done by machine at all or can be done only with inordinately expensive computer hardware and software. Such jobs would include programming the assembly, inspection and materials handling systems as well as repair and maintenance of the systems.

The seeds of this dream exist today. Already, computer control is widespread in chemical processing and some segments of the automotive industry. It is rapidly invading the petroleum industry, particularly oil production, and the aerospace, communications and electronics industries. As electronics takes over more and more functions that have historically been performed mechanically or electromechanically, computerized automation is spreading to the manufacture of such equipment as calculators and automotive parts as well.

LOW COST COMPUTERS

This rapid growth is sparked by plummeting computer costs and the spread of electronic control systems, which are cheaper, more reliable and faster than electromechanical or mechanical controls. A minicomputer-based control system that cost $100,000 five years ago would come to about $25,000 today. David Penning, Senior Industrial Economist at SRI, whose background combines several years in computer production with extensive long-range technoeconomic planning experience, predicts that by 1980 the price of such a computer control system may have dropped to between $5,000 and $10,000.

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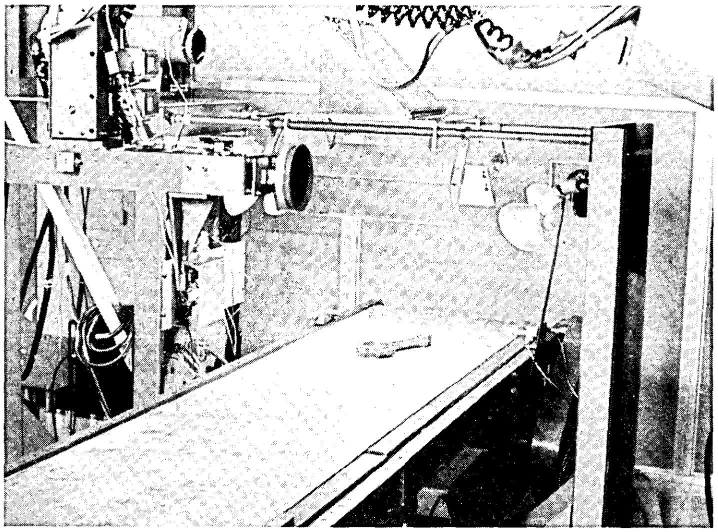


Fig. 1

The prototype vision system (Fig. 1) developed at SRI is part of the materials handling system shown in Fig. 2. The vision system recognizes an object and determines its position and orientation on a moving belt. With this information, the industrial manipulator (Fig. 2) is able to grasp the object and move it to some desired location.

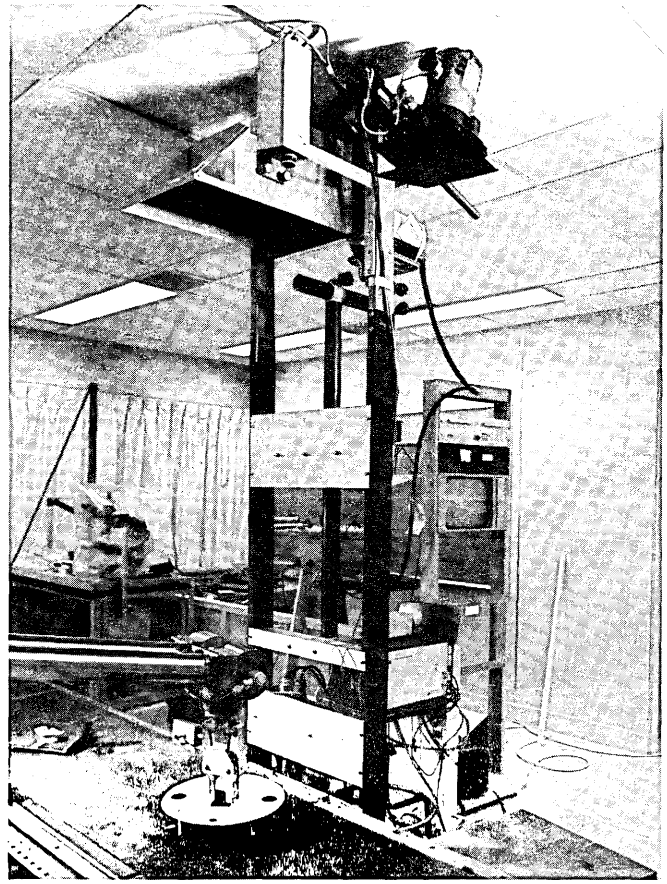


Fig. 2

ELECTRONICS SPEARHEADS AUTOMATION

Penning expects the electronics industry (including communications) to be a spearhead for automation because this industry is familiar with computer-based electronic control techniques and therefore has the ability to adapt such techniques easily to production requirements. Also, electronic products tend to be functionally so complex that only a computer can test them rapidly enough to make testing economically feasible.

Moreover, electronic products are subject to rapid obsolescence. Television, for example, has gone from vacuum tube parts to transistors and on to integrated circuits in about 10 years. This rapid product evolution makes it feasible for the electronics manufacturer to consider changes in production equipment as soon as his product becomes obsolete rather than waiting until his equipment wears out.

For the electronic manufacturer, therefore, computer-based automation makes economic sense today. Penning points out that in 1972 one TV manufacturer increased its profits 55% and its sales 30% by automating its production line. At the same time, the company canceled plans to build four factories overseas and hired 3000 more workers in this country, with the result that the company's union now strongly backs automation.

Today, the computer is extensively used for testing electronic products. In addition, it is beginning to take over metal cutting and fabrication in many industries. In the so-called "direct numerical control" (DNC), one computer controls many machine tools. In "computer numerical control" (CNC), each machine has its own small dedicated computer to guide it through the machining of complex contoured parts made of exotic metals.

COMPUTER TO MONITOR EQUIPMENT

By 1980, Penning expects that computerized manufacturing will have penetrated further into a variety of industries. Not only will electronic testing and machine tooling be more extensively computerized than today, but also the computer will be used to monitor equipment and collect data as to

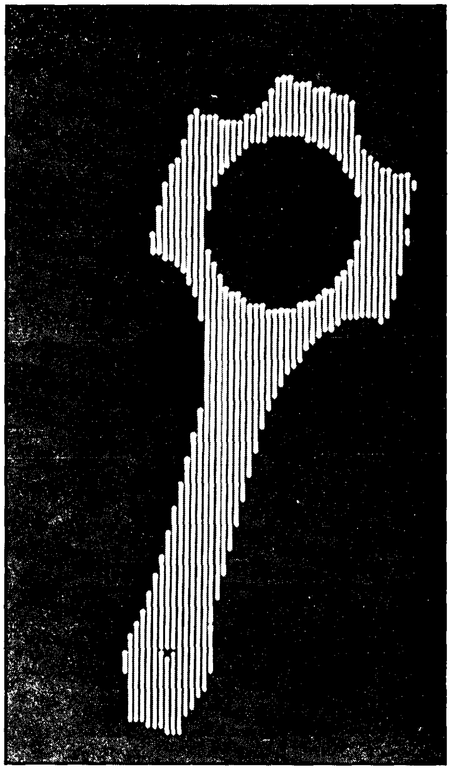


Fig. 3

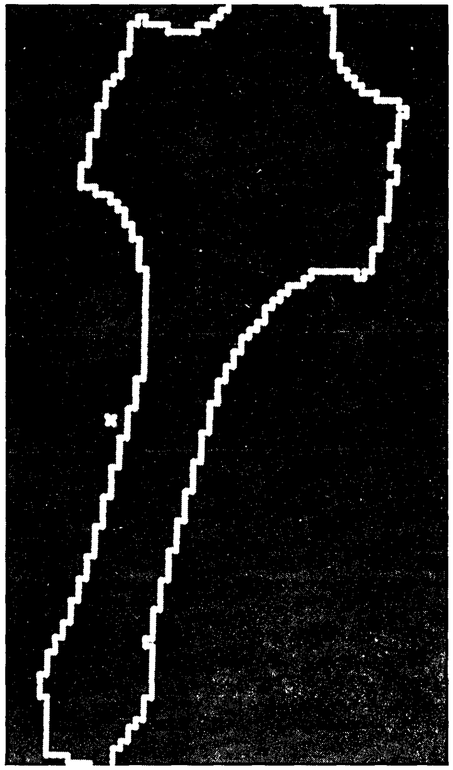


Fig. 4

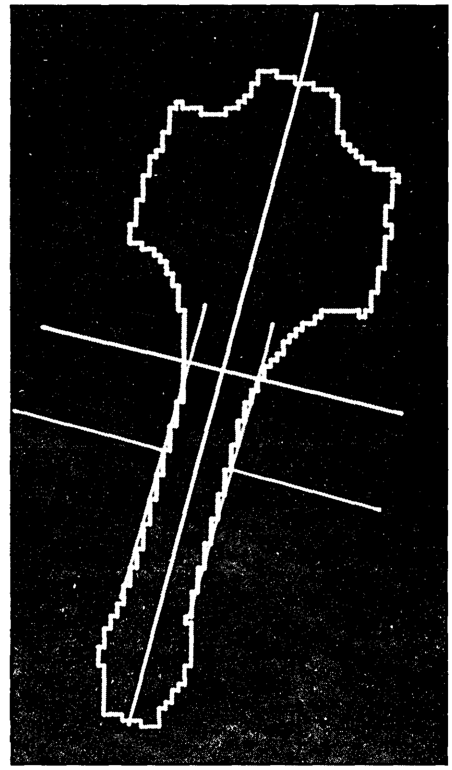


Fig. 5

The system can be programmed to recognize and manipulate a particular object in a desired way by means of an interactive programming routine using TV displays of the object (Figs. 3, 4 and 5). For example, by means of a light pen, the programmer moves certain lines displayed in Fig. 5 to the points where he wants the manipulator to grasp the object.

which machines are doing what chores and how efficiently. Without a computer, it is difficult for a plant manager to keep current information on these operations.

Penning points out that in a recent survey, managers in various manufacturing and process industries said they intended to automate equipment monitoring and data collection at the same time that they automate the test and fabrication operations.

Major operations still to be taken over by the computer are programmed materials handling, inspection and assembly. These would be systems that could be easily programmed to perform a variety of operations on objects of different sizes and shapes. Typical operations would include moving parts from one place to another, remembering where they are located, picking them up off a conveyor belt while they are in motion, inspecting them for completeness, damage, spots and stains, making sure their dimensions are within tolerance, and putting them together to make a finished product, which is then further inspected.

ENTER THE ROBOT

Materials handling operations are beginning to be done in some factories with simple programmable manipulators, sometimes called robots. They are used for such jobs as loading and unloading presses, stacking parts, spot welding and paint spraying. But these devices have as yet no more than rudimentary sensory equipment, such as a photocell. As a result, they can only manipulate objects that are fixed in a precisely predetermined position. They lack the sensory feedback as well as the hardware and software capabilities needed to perform two-handed operations. However, they can be programmed to perform a wide variety of simple tasks involving certain specified movements.

A human worker programs the manipulator by moving it through the desired motions once, then going back and making small changes in its sequence of operations until he is satisfied with its performance. An average production worker can acquire the skill needed to do this in a month or two.

PROGRAMMING THE ASSEMBLY LINE

Computer-controlled inspection and assembly systems are further over the horizon. Virtually the only ones now in use are single-purpose systems that can sense such characteristics as dimensions or color but cannot be programmed to do more than one task. Programmable systems will be difficult to implement because of the almost infinite variety of objects to be assembled and operations to be performed. The objects may range from nails to automobiles, while the operations to be performed on them may range from measuring the length of the nail to putting tires on the automobile.

The equipment that could sense and manipulate such a variety of objects has not been developed yet. Two-handed operations, such as putting a tire on a vehicle as it moves down a production line, can be performed in the laboratory, but the systems are not yet practical. The manipulators will have to be improved and the software refined and simplified so that it can be incorporated into a small computer. Moreover, it will be necessary to develop higher level computer languages close to the spoken language so that someone who is not a programmer can program the system to do different jobs.

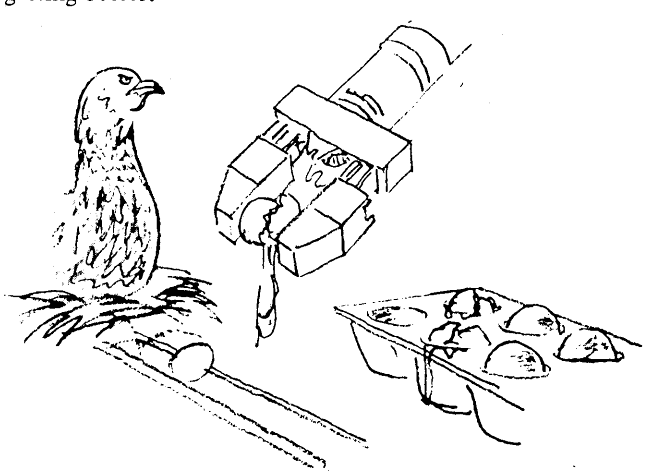
TALKING TO COMPUTERS

Until recently, higher level computer languages were not practical to use with minicomputers because of their limited memory capabilities. In order to translate the languages into voltage levels, which the computer can understand, a great deal of computer memory is required. With the rapidly falling cost of computer memory, however, the situation has begun to change. As a result, it would be feasible to trade off computer memory for ease of programming, if the programs were available.

Rosen heads a group of scientists at SRI who are developing both programs and hardware for a variety of programmable systems under a contract with the National Science Foundation. The objectives of the two-year program are to develop easily programmable manipulating, visual sensing and inspection systems and, finally, an integrated assembly and inspection system that incorporates materials handling, acquisition, assembly and inspection operations, all easily programmable and potentially cost-effective.

In December, 1973, at the end of the first 6 months of the program, the group had completed a materials handling system with visual and touch sensing. For the visual sensing, both a TV camera and an array of linear diodes are being used. Both visual sensors convert the optical image to electronic signals. These signals are processed by the computer, which then identifies any of 6 or 7 different objects and directs the manipulator to pick them up and place them in a specified location. Tactile sensing is done by the "hand" and "fingers" shown in Fig. 7. Light detectors sense the movement of the fingers, and the computer relates this movement to the amount of pressure applied by the fingers. The system can identify and pick up objects in motion.

"It is not very good at this yet," says Rosen, "but it is getting better."



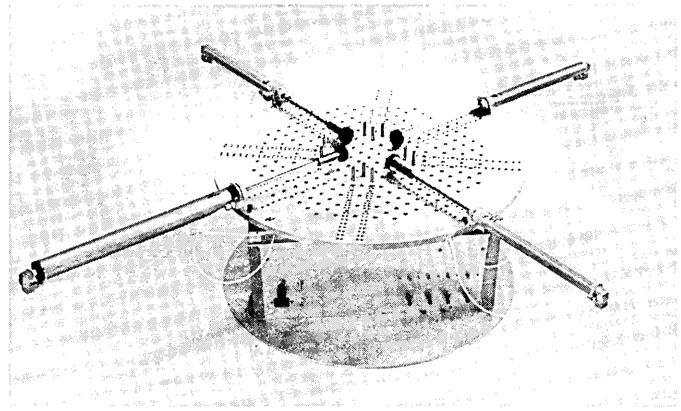


Fig. 6. This computer-controlled turntable can rotate a part into a known orientation. The four pistons then push the part against the adjustable pins, holding it in position.

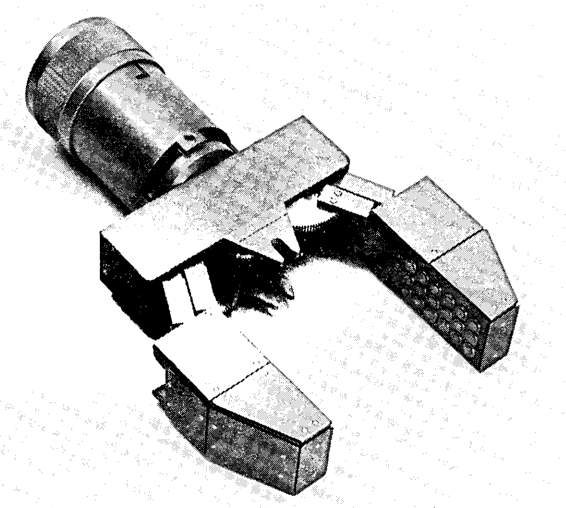


Fig. 7. Developmental "hand" or end effector with arrays of tactile sensors in the "fingers" as well as torque and force sensors in the "wrist."

He points out that none of the systems thus far developed at SRI would be cost-effective in a factory because they require the capabilities of a large computer. Even if the computer were time-shared among many different factory operations to bring down the cost per operation, the system would not be practical in the factory. The whole factory would have to shut down if the computer failed. Within two years, however, Rosen expects to have simplified and streamlined the software enough so that it could be used in a self-standing minicomputer-controlled system that would be cost-effective in the factory.

Long-term goals of the project include the development of a system that could respond to voice commands such as "a little higher," "two inches to the left," etc. □

Computer program reliability

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Dr. Peter G. Anderson received the BS in Mathematics in 1962 and the PhD in Mathematics (Algebraic Topology) in 1964, both from MIT. Dr. Anderson joined the faculty of Newark College of Engineering as an Associate Professor in the Department of Computer Science. He is currently working with MSRD's Command and Control Systems Engineering Department in addition to his work with NCE.

Authors Crandon (left) and Anderson.

HOW CAN one specify or measure total system reliability using only one of the contributing factors—equipment reliability? The computer program, residing in a computer which is an imbedded, integral part of the system, must also take its place in the reliability equation. This remains true despite the difficulty in defining "reliability" of a software product. But with the immense—and growing—national investment in computer software, computer program reliability is being, and must continue to be, reduced to a structured methodology subject to prediction and measurement techniques with effective design principles and techniques.

Horror stories

From a report on a radar-array testing program:

"An apparent phenomena which evidenced itself during the testing of —— was that of a computer program which had been declared operational, 'gradually' deteriorating. The particular programs had been in operation for several weeks, and were evidently 'sick' and getting 'sicker'."

"The sickness would demonstrate itself by the frequency of program failure or program error. With the —— program, the output, under normal operation, was supposed to be the number and location of the inoperative driver modules. In the deteriorated condition of the system, the number would come out wildly high, or else the program would 'hang-up' in an intermediate routine. As the system got sicker, the frequency of 'hang-up' would increase. With a second program, errors associated with the radar peripheral interfaces, ——, would demonstrate its inoperability by the higher rate of error while copying from disk to tape."[1]

From a report by IBM Corporation on its Apollo programming support:

"...For example, during one of the missions, they found an error involving a module not releasing core store when it should. It just kept on claiming more and more core, and this was not noticed in the simulations. As a result, when the system was running, after a few days it got more and more sluggish. It was working, but non-essential functions were being dropped, because of lack of core space..."[2]

Comments from military personnel maintaining an operational, formally accepted, large-scale computer-based defense system:

" 'The programs get tired, sluggish.' 'They become full of crud.' 'We have to clear the computers and reload each day.' "

These examples show the effects and time-dependence of unreliability in computer programs in three diverse applications: a radar testing program, an Apollo mission, and a defense system. Similar examples could be found in computer programs controlling the manufacture of medicines, regulating life-support systems for hospital patients, governing airport activity, and other commercial activities.

The reliability of computer programs needs to be guaranteed; currently, it cannot even be *measured.* But the situation is even worse than that: sometimes it seems impossible even to get the large computer programs to perform at all. The final phase of development of a program—acceptance testing—is often concluded only by agreeing to modify the original specifications.

Source of unreliable computer program behavior

The source of unreliable behavior in computer programs is, of course, *errors* introduced during the initial program requirements specification, the design process, the implementation (coding), or subsequent modifications. These errors can be blamed on such things as insufficient skill or training or lapses of attention by designers and programmers, and on faulty information (documentation) provided to them. But *complexity* is the key. Complexity can be found in all phases of computer program development. "It has reached the point where users find it easier to understand how a computer works than how an operating system works."[3] The more complex a computer program, the more difficult it is to understand and to test, measure, or modify—consequently the less likely it is to be reliable.

Complexity is not a simple, one-dimensional quantity and it seems most resistant to quantitative treatment. However, complexity does depend on program size—especially the sizes of the individual program modules—and on the extent and nature of the interrelations of the individual components. Miller[4] has suggested that the number of entities a human can mentally grasp at one time is about seven; if the number of constraints that a line in a program must meet to be right exceeds this number, then perhaps the program's complexity has gotten out of hand. This problem of program complexity has been discussed widely.[5,6,7,8] One approach to reducing the extreme complexity is a programming discipline—popularly called structured programming—which will be discussed in some detail later in this paper.

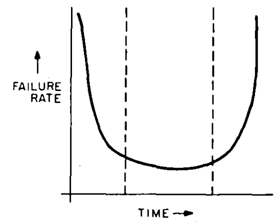


Fig. 1a — The bathtub curve for physical devices.

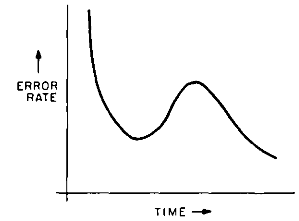


Fig. 1b — The error rate for computer programs.

Contrast with existing reliability disciplines

Other engineering disciplines, such as electronics or mechanics, have developed reliability methodologies that permit them to measure (and guarantee) the failure rates, mean-time-between-failures, expected life, and so forth, for their systems. They can design systems to conform to previously specified constraints and can advertize mean-time-to-failure in multiples of years.

The reliability engineers produce *bathtub* curves (Fig. 1a) showing the failure rates for their devices; the first part shows *infant mortality*, followed by *constant failure rate*, and finally *wear-out*. We are able to construct a similar curve for computer programs (Fig. 1b) showing an initially high error rate for a young, bug-ridden program, then a momentary calm for the programmers (who now think their program works rather well), followed by a surge of exposed bugs at the time the program is put into actual use, and eventual stable performance as the bugs that cause the errors are removed. There might be later humps on the curve when a bug fix has disastrous consequences for the rest of the program, when new improved versions are released, or when new customers and uses enter the picture.

Such curves have been investigated and mathematical models have been developed, but only to a very preliminary stage.[9-13] The organic structure of a computer program is unlike anything else studied thus far. Computer programs are not homogeneous; typical programs, for instance, spend 95% of their time exercising 5% of their instructions.[14] Error models—based on such metaphors as drawing balls from urns and replacing defective ones with good ones—may be suggestive but fall far short of representing computer programs.

Nonetheless, one can often improve a situation before specifying all its aspects rigorously. Consequently, a computer program reliability study must start with the various factors within the disciplines of computer program design, implementation, testing, and measurement that bear on the determinations and effectiveness of computer program reliability.

Computer program features and functions for increased reliability

There are many features and functions that can be incorporated into a computer program which will increase its reliability. Convenient groupings of these are discussed below.

Effective error management

Separate computer program modules called device managers are generally assigned the responsibility of controlling the operation of devices ancillary to the computer (*e.g.*, tape devices, disks, printers). These computer program device managers normally have a formal interface with the program modules that utilize these devices, and also a formal interface with the executive program both for operational purposes and for conveying device and service failure information (see Fig. 2).

To enhance the reliability of a program these device managers should have the responsibility for detecting and reporting device failures — both total and partial — where service can still be maintained selectively. A device manager should also be equipped to monitor its own performance to detect failures such as might result from queue overloads.

The design of computer program device managers will vary within the system according to the system's equipment and functional needs; however, the basic architecture of a device manager will follow a standard design, at least for classes of devices. Some of the elements of the standard design may be eliminated or reduced by parametric adjustments for each situation. The computer program device manager can be equipped with failure-avoidance programming which acts to:

1) Bypass transient errors—achievable by retrying the device, recopying data on failed memory, *etc.*
2) Bypass permanent errors—achievable by reallocating storage to bypass bad storage areas (*e.g.*, on disk, tape).
3) Continuing service at degraded performance levels—*e.g.*, by formally rejecting additional user requests until queues are emptied to working levels.
4) Discontinuing operation of non-essential failed services by formally rejecting user requests.
5) On-line error repair—tolerating errors by utilizing redundancy, error correcting codes, averaging (damping/filtering) methods.

Automatic error logging

The notion of device managers that monitor the performance of hardware resources and (possibly) their own performance can be extended to many other system resources. Some possibilities are data bases and their handlers, math subroutine libraries, and schedulers. For large systems, all these monitoring facilities can feed into a standard error manager (see Fig. 2) which would maintain a program-error data base. This data base would contain the error descriptions furnished it by the resource managers as well as items such as time-of-occurrence and user. Such records would then give the data necessary to develop reliability figures for the system as well as aiding program maintenance work.

Program self-protection

Errors should be isolated so that a failed program module does not damage another module or its data sets. A list of special considerations is shown below.

1) The highest priority is safety. Programs affecting safety and security should be designed for the highest reliability. These include a) the minimum executive (kernel) program which should be designed for control of the computer when the rest of the executive program fails and b) the input/output programs (kernel) which manage equipment requiring safe shutdown (*e.g.*, missile and manager program).
2) Use memory protection devices to protect instructions from being modified, to keep instructions from being read, data from being executed (except in very special cases), and one module from affecting the resources belonging to other modules except along the lines of specified interfaces. A specific suggestion for achieving this latter protection (in addition to hardware "locks" that prevent inadvertent modifications) is to design interfaces between data bases and user modules along *functional* lines rather than direct accessing. This means that information is input to, and extracted from, a data base via a single interface routine, where the interface routine is the only routine privileged to access the data directly. This yields a benefit of flexibility; the data base structures can be thoroughly revised without affecting the user programs.
3) Use program self-diagnosis tools, such as check sums, memory checks, and evaluations of assertions of the form used in proving or explaining programs (see the section below on proof procedures for some examples).
4) Use alert/abort and recovery procedures so that calls for scheduled maintenance or for immediate error diagnosis can be heeded without complete or unsafe termination of service.

Design principles for increased reliability

In addition to the effect of program architecture, the way a large program is put together affects reliability. Design principles to increase reliability fall into three main categories: 1) error-management documentation, 2) tools for error-free implementation, and 3) error-management and program-change procedures. These are discussed in the following paragraphs.

Error-management documentation

Any large-scale computer program should be considered from the viewpoint of its error-management structure and capabilities, and should be systematically described so that a comprehensive view of error handling may be available in a single document. This document should be made suitable for assessing the computing system's error-detection capability, error vulnerability, recovery/reconfiguration potentials, and overall reliability.

Tools for error-free implementation

The following principles lead to a reduction in errors of program origin:

1) The less the programmer has to do toward the end of program development the less likely is error to occur; the fewer instructions, design, and operating procedures the better. Also, the fewer languages he needs and the more syntax-error-tolerant languages (with strong editing and debug capabilities, *etc.*) the better.
2) Existing well-documented, time-tested programs should be used, and modified for program parameters.
3) The design should take into account requirements for easy and complete testing.
4) The designer should use such tools as data dictionaries, data directories, and data preparation systems; standardized interface formats; and expressive programming

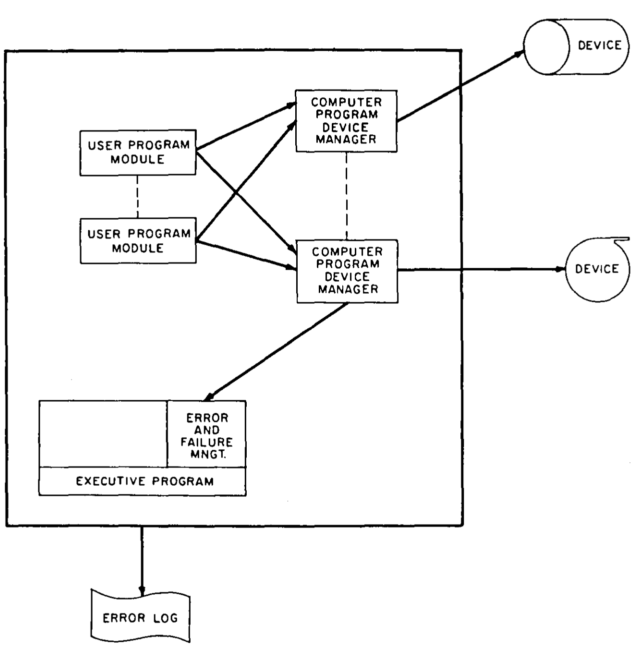


Fig. 2 — Error handling by computer program device managers.

languages[15-19]

5) Modular structures conducive to reliability should be used. Modular design can minimize testing requirements when program modules are short (simple), with well-defined functions to perform. When programs are partitioned to match modules to functions, then loss of a module minimizes the number of lost system functions. If modules are designed independent of each other, then loss of one does not bring others down. Modularly designed programs also allow modification over a time period in order to minimize errors due specifically to design structure, over a time period, thereby improving computer program reliability over time.
6) Modules should be designed so that their modifiable parts (generally data sets) and non-modifiable parts (instructions and static data) are segregated. This will facilitate application of reliability enhancing measures.

Error management and program change procedure

Computer program error management and reliability must be maintained throughout program change procedures. The principal danger is that program changes to a "tested" computer system may negate previous tests. This can occur if a change alters the design or the previously tested computer program execution paths and data structures. Compilers and other program generators must be examined to ascertain the extent to which a tested program has had its earlier tests invalidated by compilation with either single-parameter changes or extensive program changes. When patches are made at the lowest language level, and recompilation is not involved, methods should be used to assure that previously conducted tests are not invalidated.

Reliability engineering

How does one measure computer program reliability and what influences cost tradeoffs? The testing procedures and the performance monitoring for "working" computer programs should be designed not only to detect bugs to be repaired but also to measure the program reliability. In particular, the errors should be categorized according to their severity, their origin (*i.e.*, environment at time of occurrence), the modules/functions to which they pertain, and what was done about them (fixed or symptomatically removed). This log should yield, by extrapolation along curves of reliability modules, some quantifications for program reliability. Where program modules exhibit a network structure, methods similar to those provided by Kim, Case, and Ghare can be applied to compute system reliability.[20] Where the structure of modules is hierarchical, other methods need to be considered.

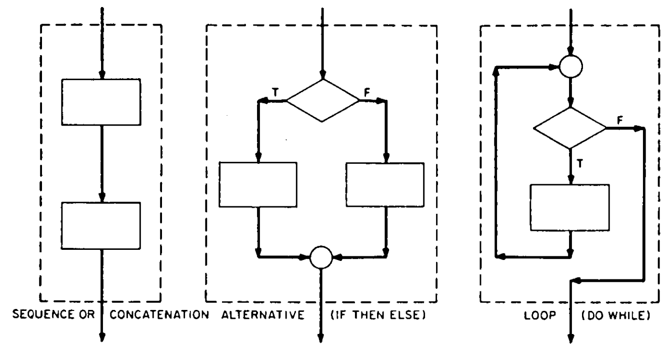


Fig. 3 — Building blocks for structured programs.

A particularly suggestive notion is that of using program *exposure* as indicative of reliability:

Reliability > (*Use of program*)/(*possible use*)

where the *use of program* is some weighting of the tests the program has passed, along with the successful user experience. The ratio, *exposure*, is based on some estimate of what the program hasn't yet been required to do. A naive approach to this might take exposure as the fraction of program instructions that have been exercised. Better, but much more complicated measures can be envisioned, but of course "combinatorial explosion" does take effect.

Factors in reliability-cost tradeoff are online error management programs *vs.* computer use, program testing, computer program maintenance service costs, and equipment *vs.* computer program alternatives.

Two approaches to computer program reliability

Two of the techniques mentioned earlier are rather new and promising: structured programming and program proof techniques. These are discussed below in terms of their potential for meaningful enhancement of program reliability.

Structured programming

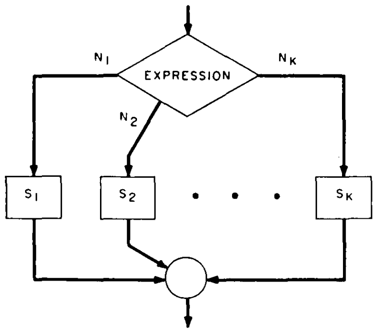
Structured programming is a discipline for proceeding in a systematic way from a program specification to a computer program.[21-28] Just like the design process, structured programming is a process of successive refinements (a top-down process). First, the overall program is specified in "broad brush" style; that is, the programmer specifies what is to be accomplished and in what order, but he leaves the detailed methods unspecified. This "broad brush" description is written as a computer program; it's not just a narrative description of a program.

Each component of the program is either an operation that the computer can perform directly, such as *add* 1 *to x*, or the name of a more complicated operation that will have to be specified in greater detail, such as *delete stale entries from radar track table.* Operations of the second type are programs that have to be written. These are written the same way the main program was written. This process continues repetitively until there are no processes whose details are left unspecified, at which time the program is written.

The building blocks for structured programming are shown in Fig. 3. Notice that each of these three constructions is surrounded by a dotted rectangle with one entering arrow and one exiting arrow. These larger rectangles can be used as the components of larger sequences, alternatives, or loops.

Conventional programming languages have the facility to specify these three constructions, and to indicate steps to be specified later as subroutine calls or macro's for which there are library maintenance routines and linkage editors in the operating system.

Structured programming has often been referred to as "go-to-free" coding, but that is not entirely accurate. The undisciplined use of *go to* statements does increase the complexity of a computer program and consequently decreases the reliability.[20] However, Fortran does not have the *if-then-else* construction nor the




```
CASE <EXPRESSION> OF
  N1 : STATEMENT-1
  N2 : STATEMENT-2
   •
   •
   •
  NK : STATEMENT-K
END-OF-CASE
```

Fig. 4 — The *case* statement.

begin-end and *do-end* nesting structures of PL/1 and Algol; but the same program control can be coded in Fortran and even assembly languages by using *go to* statements in a disciplined manner. Additional stylistic techniques such as comments, spacing, indentations, and so on, then yield very readable, understandable programs.[30-33] Other language features—if they are available—are permitted within structured programs. Such features would include the full PL/1 *do*-loop facility, a *case* statement (see Fig. 4) or decision tables.

Experience indicates that the necessary tools for expressing algorithms are available within the rules of structured programming. Bohm and Jacopini proved that every "ordinary" computer program can be rewritten as a structured program.[34] More to the point for the individual programmer is the observation that structured programming restrictions are not felt to be confining. When one has an overwhelming urge to construct a jump into a loop or a leg of an *if*, then it is time to reconsider the design of the algorithm; one has probably fallen into the trap of "bottom-up" coding which results in designing a program after detailed decisions have been made.

After learning to use structured programming, the programmer quickly finds that, far from being a strait jacket, this discipline provides him the means of organizing and managing the mass of details in his job. For instance, he can modularize the program so that each program module can easily be held down to a single printed page (*i.e.*, under 50 lines of text) or even smaller to keep the complexities from becoming overpowering.

Proof techniques

One answer to the issue of guaranteeing the correctness of a computer program is to prove, as a mathematical theorem, that the program is correct. Programs constructed according to the discipline of structured programming are especially amenable to this technique. In structured programming, one expresses a large process in terms of several smaller processes—subroutines, macro's, *etc.* To prove that the large process is correct, one takes as "lemmas" that the component processes are correct, then applies rules of inference similar to those described in Fig. 5 to conclude that the larger process is correct. The verification that the component processes are correct may proceed along the same lines, or they may be obviously correct or otherwise inspire confidence.[35,36]

The formal statement of what a program is supposed to do is expressed as an implication: "if a certain relationship holds among the variables when the process starts, then the process will terminate, and when it does, another specified relationship will hold among the variables." Such relationships or assertions about the variables can be interleaved among the instructions or components of a program or attached to the arrows of the program flowchart. Fig. 5 shows some of the ways assertions can be attached to flowcharts and indicates some elementary rules of inference. Fig. 6 shows how these can fit together to prove that a program calculates what it is supposed to.

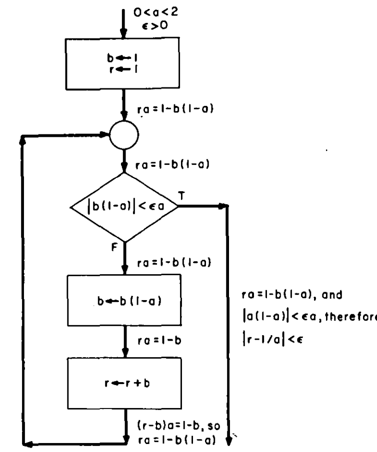


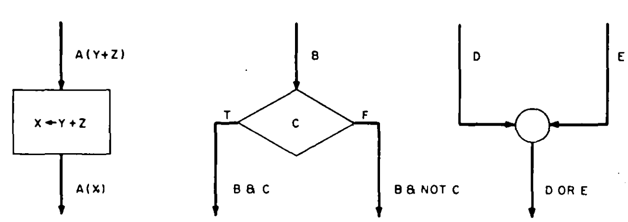
Fig. 6 — Flowchart for a program to approximate r = 1/a within a specified tolerance (for a computer without a "divide" instruction).

The given proof does not include the verification that the program eventually terminates; that is left as an exercise for the reader.

As in classical mathematics, there are techniques developed for proving that programs with certain patterns of construction are correct.[37-51] For instance our example relies on a key *invariance*

$$ra = 1-b(1-a).$$

The details of such proofs may seem to be the same kind as those that cause programmer errors in the first place, but consider these two points: assertions and inferences provide the perspective the programmer needs to jog him out of his mental ruts[52,53], and eventually we expect computer programs to take over the mass of details involved in the verification process.[54,28]



a. BEFORE AND AFTER. A(X) STANDS FOR AN ASSERTION ABOUT X.

b. CHOOSING ALTERNATIVE PATHS.

c. JOINING PATHS.

Fig. 5 — Elementary algebra for assertions on flowcharts.

Conclusion

Unlike classical reliability engineers, we do not know how to model or measure satisfactorily the failure mechanisms in computer programs. However, we can follow their lead, noting where programs fail and tracing the chain of "why?" back to the source. The advances in electronics reliability came with learning how to simplify construction and work in a "clean room." Top-down programming is our simplification and the three construc-

(please turn to page 42)

Computers and Professional Criminals in Great Britain

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"Some professional criminals have shown that they possess considerable talents for being able to deal with threats to the survival of various illegal enterprises."

"An Immense Concept"

At an Interpol Symposium on the use of computers by the police held in Paris in November 1965, delegates spoke of their countries' plans for using modern data processing equipment in the fight against crime. Many applications were discussed and the Symposium ended on a note of high optimism that viable powerful computer systems would soon be in operational service. The British response was formally announced to the House of Commons in November 1967.[1] Called the Police National Computer Project (P.N.C.) it was hailed by the Home Office as really exciting, "an immense concept".

Michael Willmer has had over fifteen years Operational Research experience, mainly in the areas of anti-submarine warfare, air traffic control and law enforcement. He was one of the first members of a Home Office 'think tank' set up in the early 1960's to study new methods of preventing and detecting crimes. His concern is both with the systems used by criminals for choosing, planning and executing crimes and the systems used by the police for preventing and detecting the work of criminals. From 1967-70 he was Research Fellow of Nuffield College, Oxford and is at present Reader of Operational Research, Manchester Business School, Manchester University.

The claims made for its capabilities were breathtaking. Few will fail to be impressed if it becomes possible for "... an ordinary constable who stops, say, a car with two suspects in it to use his personal radio to contact the information room, and private teleprinter network from there to the computer, to find out within about sixty seconds whether the car is stolen, whether the occupants are wanted by the police, whether they have been disqualified from driving or whether any distinctive property in the car has been notified as stolen". Later announcements indicated that the cost was expected to be of the order of £16 million spread over a period of ten years.[2] The hope is that the computer, situated at Hendon near London, will be operational in 1974.

How Intelligent Criminals will Respond

Undoubtedly such a system will have far-reaching effects on many aspects of police work — a fact that will not be missed by intelligent members of the criminal fraternity.

In the past, some professional criminals have shown that they possess considerable talents for being able to deal with threats to the survival of various illegal enterprises. The need to learn and adapt has long been recognised. The story is told,[3] for instance, of the police officer who stopped a villain well known to him as he was driving home one night in his Jaguar and asked him where he had been.

"I've been to evening classes Guv," came the reply. The officer checked and found that the man's tale was absolutely true. It transpired that the gentleman in question was doing a course at the local technical college on electrical engineering. The lecturer remarked that the student was very attentive and industrious and seemed fascinated by burglar alarms!

They Take Computer Courses

Contemporary top-class lawbreakers are not only ruthless and, on the whole, successful, but also very adaptable and resourceful. Such people are hardly likely to ignore the threats to their well-being posed by the new Police National Computer. Perhaps, in order to assess the full significance of potential developments, the professionals of today are attentive students at computer appreciation courses!

Without making any special enquiries, the "directors of crime" can learn that the new system will store and process information ranging from stolen vehicle numbers, modus operandi data, criminals' previous convictions and general criminal intelligence data. Doubtless, more thorough enquiries will give them a detailed understanding of how the new computer complex is likely to work. With a sound knowledge of computers and data processing, coupled with an understanding of the way in which crimes are solved and prevented the professional criminals' chances of finding ways and means of reducing the threat of P.N.C. are surely far from bleak.

Information Gathering: Background Noise

Although at the present time it is too early to be able to estimate accurately the extent of their likely successes, a number of general points can be made. Crimes are solved by detectives as a result of a process of gathering, interpreting and acting on information. Information is collected from many diverse sources — from the scene of the crime, victims, witnesses and contacts in the underworld, to name but a few. Suppose, however, that the victims of a bank robbery give hopelessly conflicting descriptions of their assailants. Suppose that despite a thorough search of the scene no fingerprints or other useful forensic evidence is found. Suppose that no-one saw the villains change their getaway vehicle and that no informant has been able to glean so much as a whisper. What, then, can a detective do? When useful information is not discovered or, to put it another way, when the police have received no signal from the criminal, freedom for the criminal is virtually assured. It is as though the clues left behind by the criminal have become irretrievably merged with the background and the police are left with nothing but "background noise".[4]

Internally Generated Noise

In contrast, there is noise that is generated within the police system by information becoming lost or distorted once it has been received by the police or by the police not making the very best use of information that they have. This can be thought of as "internally generated noise".[4] A good example was the Baker Street burglary of 1972, where thieves tunnelled forty feet into the strongroom of a London Bank.[5] Besides the tunnellers there was a look-out man on the roof of an adjoining building who kept in contact with his colleagues by means of a two-way radio. Unfortunately for the thieves, their radio transmissions were picked up by a radio ham who immediately contacted the police. Yet, despite the potential value of this information, it was not until too late that Post Office engineers were called in to track down the gang's radio equipment. Ironically, banks in the area were checked, including the one attacked, but nothing suspicious was found — presumably checking for tunnellers was not included. Thus the thieves were able to escape with their loot and although some of them were later convicted the money and valuables were not recovered. But the police had been given the information that could have enabled them to catch the operators red-handed and thus prevented anything being lost at all.

From the criminal's point of view, internally generated noise is essentially a bonus. After all, the skilled criminal plans and schemes, coshes and, sometimes, kills to deny the detective information. If the police do not use any information they gather to their best advantage, so much better for the criminal. However, in a large and complex system like the police service, "internally generated noise" is almost impossible to eliminate totally. It occurs in many ways — more often than not because of some technical or human limitation rather than individual incompetence. From time to time, for instance, even the most conscientious worker fails to process correctly an important piece of information. In a busy control room, attention can easily be distracted at a vital point in the receipt of a message, causing a mistake to be made. In the struggle to keep internally generated noise down to a minimum, the criminal record offices play a vital role. At the present time their staffs strive manfully to keep their records up to date and give a prompt and accurate response to enquiries — but, with over a million enquiries each year, it is not surprising that delays occur. However, the Home Office has claimed that the Police National Computer will be able to process operational police records for the whole country, so that every force and division within the forces will have direct and immediate access to the information stores. If this promise is fulfilled, then the police will have been given the capability to make much better use of the information that they collect and a decrease in internally generated noise can be confidently expected.

Danger in Excessive Confidence

As publicity emphasises the potential of the P.N.C. to revolutionise certain aspects of police work, the danger is that many will believe it to be some kind of ultimate weapon. The computer is after all only part of a much larger information collecting and processing system; professional criminals have already demonstrated convincingly that they are capable of thinking in total systems terms. P.N.C. may give the bobby on the beat the potential to find out within 60 seconds whether or not a particular car has been stolen but what if the computer has not been advised of the theft at the time of the enquiry? There are weaknesses in the total system which adaptable and intelligent criminals can exploit. Bank robbers, who, for example, at the moment steal getaway vehicles a few days before a raid will have to adopt such tactics as stealing cars on the actual day they are required for an enterprise. In most towns and cities it requires only a modicum of basic research to reveal the whereabouts of cars that are habitually left unattended for several hours.

Analysis of Options Open to the Criminal

Doubtless by careful analysis of the various options open to them the professionals will find it possible to minimise the effects of P.N.C. on their risk levels. To illustrate, consider the two traditional methods of housebreaking known to our eighteenth century ancestors as "the crack" and "the rush". In "the crack" a window or door is forced open with a crowbar or some similar tool. Under modern conditions it is a method of working that often gives the forensic science trained investigator many potentially valuable clues. However, because the police do not have sufficiently powerful data processing systems, much of this potential is often not realised. Thus "the crack" is a method for which, in general, the level of internally generated noise is relatively high.

In "the rush" entry is gained by knocking at the door of a house and overpowering the person who opens it. The victim is then used as a hostage in order to persuade other people in the house to co-operate. Criminals using this method of working usually leave behind few forensic clues. On the other hand, compared with "the crack", they stand a greater chance of being spotted whilst making their illegal entry. "The rush", therefore, is a method for which the level of background noise is relatively high and the level of internally generated noise relatively low.

Thus, as the professionals come to terms with the new computer system, is it not likely that there will be a movement away from the use of methods based on the principle of "the crack" towards the use of methods based on the principle of "the rush"? Or, in more general terms, will there not be a movement away from options with a relatively high internally generated noise content towards options where the background noise is highest?[6]

Strategic Planning by Police

But there is no need for those concerned with law enforcement just to sit back and wait for the professional to find successful new strategies. The problems facing strategic police planners are similar to those confronting defence experts involved in the development of new weapon systems. The traditional defence approach is to set up a counter-measures group whose task it is to investigate the possible means by which the enemy could reduce the effectiveness of the new system. Forewarned is forearmed. Once possible enemy counter strategies have been determined, thought can be given to how such strategies can be made more risky.

Study of Counter Measures Ahead of Time

Consider, for instance, the housebreaking from the point of view of the professional burglar. Before striking, such criminals tend to examine carefully their prospective targets in order to determine the weakest points and it is at these points that they concentrate their efforts. In contrast, amateurs, because of their limited ability and experience, often have to work at several points before they are able to force an entry. Indeed, some authorities believe that it is often comparatively easy to distinguish between the work of an expert and that of an amateur. "... only the inexperienced thief, the botcher, will attempt such extra work; the thief who is a past-master in his art will never do so."[7] To the professional who is concerned about his risk level one counter strategy immediately suggests itself: when committing a burglary, make one or two unsuccessful entry attempts in order to make the work appear to be the work of an amateur. To thwart such a move, the police should now be researching into ways and means of using computers to help distinguish between the work of amateurs and pseudo-amateurs.

Although this example has been greatly simplified, it does illustrate the way in which the police could remain one step ahead of the professionals, maintaining the initial advantage gained as P.N.C. becomes operational. The men in the front-line, faced with the day to day task of bringing adaptable and intelligent villains to justice, and the public whose security depends on their success have a right to expect that planning at this level is earnestly under way. A counter-measures group should already be in existence and hard at work. It would indeed be a tragedy if bureaucratic intransigence towards this type of research should thwart attempts to create a really effective computer-based law enforcement system.

Footnotes

1. Lord Stonham, "Hansard", 29 November 1967.
2. Lord Beswick, "Hansard", 18 February 1970.
3. "Weekly News", 6 June 1970.
4. M. A. P. Willmer, "Crime and Information Theory", Edinburgh University Press, 1970.
5. "Daily Telegraph", 14 September 1971.
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7. R. L. Jackson, "Criminal Investigation", Sweet and Maxwell, 1962. □

GAMES AND PUZZLES for Nimble Minds – and Computers

Edmund C. Berkeley
Editor

It is fun to use one's mind, and it is fun to use the artificial mind of a computer. We publish here a variety of puzzles and problems, related in one way or another to computer game playing and computer puzzle solving, or to the programming of a computer to understand and use free and unconstrained natural language.

We hope these puzzles will entertain and challenge the readers of *Computers and People.*

ALGORITHMO

In this puzzle, the objective is to express a procedure for going in a given situation from given input to given output. The following conditions apply: the situation is a little off the beaten path and is interesting; the procedure is fairly evident and fairly short; the procedure is to be expressed in precise English words, with perhaps defined terms in addition; the procedure is to be completely and accurately expressed, i.e., the calculating procedure must work. (In addition the procedure may, if desired, be expressed in a common computer programming language such as BASIC, LISP, FORTRAN, or APL, together with complete translation into precise English words and satisfactory evidence, in terms of several examples run, that the program works correctly.)

For the following puzzle we hope to publish in the October issue the best solution received before September 2 from a reader of *Computers and People.*

ALGORITHMO PUZZLE 747

Problem: SPELLING CORRECTION. *Input.* Any common misspelling of some 200 common English words or syllables. *Output.* The correct spelling. *Examples: Input:* recieve, reciept, liason, commerical, flourescent, comitee, hunderd, vocabularly, Febuary, thier, curius, finaly, lable. *Corresponding Output:* receive, receipt, liaison, commercial, fluorescent, committee, hundred, vocabulary, February, their, curious, finally, label.

NUMBLES

A "numble" is an arithmetical problem in which: digits have been replaced by capital letters; and there are two messages, one which can be read right away and a second one in the digit cipher. The problem is to solve for the digits. Each capital letter in the arithmetical problem stands for just one digit 0 to 9. A digit may be represented by more than one letter. The second message, which is expressed in numerical digits, is to be translated (using the same key) into letters so that it may be read; but the spelling uses puns, or deliberate (but evident) misspellings, or is otherwise irregular, to discourage cryptanalytic methods of deciphering.

NUMBLE 747

```
              T H E W I S E
  x               M A N I S
          A C H T I W E T
        N T W C T H C C        YODL = WSIM
      E N A N C C A N
    C M T I N E N I
  H C M A H T I A
= H I S A W E E H E S T T
  41367  38952  09543
```

MAXIMDIJ

In this kind of puzzle, a maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the 10 decimal digits or equivalent signs for them. To compress any extra letters into the 10 digits, the encipherer may use puns, minor misspellings, equivalents like F for PH or vice versa, etc. But the spaces between words are kept. For one of the resources for solving this kind of puzzle, see the table of commonest words of 2 and 3 letters published in the June issue on page 24.

MAXIMDIJ PUZZLE 747

Decipher:

Ξ Δ Δ Ξ Φ   Ψ Σ Δ   Π Γ Δ
Π Δ Φ Π   Υ   Λ Σ Δ Ψ Π Θ Δ Φ Φ

NAYMANDIJ

A "naymandij" puzzle is a problem in which an array of random or pseudorandom digits ("produced by Nature") has been subjected to a "definite systematic operation" ("chosen by Nature") and the problem ("which Man is faced with") is to figure out what was that operation.

A "definite systematic operation" meets the following requirements: the operation must be performed on all the digits of a definite class which can be designated; the result displays some kind of evident, systematic, rational order and completely removes some kind of randomness; the operation must change at least six digits from their original random value; all other digits must remain unchanged in value and position; and the operation must be expressible in not more than four English words. (But Man can use more words to express it and still win.)

NAYMANDIJ PUZZLE 747

```
2 8 1 8 6 7 1 2 5 9 7 3 6 9 9 3 0 5 3 6
4 7 6 1 0 5 5 1 7 5 0 4 1 1 0 4 8 0 6 0
5 1 0 9 9 5 0 3 2 9 9 5 1 7 5 3 9 6 1 1
3 6 6 4 5 7 3 9 7 8 7 8 0 1 2 9 6 2 4 9
2 7 5 9 7 1 0 0 7 4 3 7 4 9 6 6 2 4 7 9
1 9 0 0 3 5 6 7 5 9 8 2 0 6 6 3 1 8 7 7
7 5 0 4 7 9 0 7 6 9 7 2 6 6 2 9 6 2 2 9
0 1 5 6 4 6 6 0 0 7 0 5 6 3 6 1 4 9 0 9
3 4 3 3 4 8 3 9 5 2 0 6 3 9 2 6 6 3 4 3
7 5 9 2 7 3 7 0 0 3 6 3 5 2 1 7 5 8 3 9
```

COMPMEANO

The following was picked up from the floor of a computer laboratory. The characters were printed by a computer output device.

Is it a random number sequence? or does it have meaning? If so, what does it say?

The answers to these questions will be published next month.

COMPMEANO PUZZLE 747

```
806891792645003580359899100389
180117099731787718080180659007
783529065976598290600600009040
256539938998150778771894877730
067910000152639902489800048799
359807398179478784570891704006
264500380081897700358038075179
260810000077990300248789478548
929000407290896989029918723994
598379894000035800044568773407
001389799029089407989029017947
878451002024898000358070908930
010048799359807398173407026999
954267919040278357348729017889
187189248068917926453598991003
58048961523264500
```

A friend of the readers of *Computers and People,* whom we shall call Brian O'Malley, put this puzzle through the program called "Ciphering C 1" described in the article "Deciphering a Message in Digits" published in the June issue starting page 16. He obtained the results appearing in the next column to aid an aspiring puzzle solver. Finally, he had the program rewrite the puzzle, so that there would be room to put guessed decipherments under the digits. This also appears in the next column.

Frequency of Single Digits

0	1	2	3	4	5	6	7	8	9	Total
102	30	25	30	31	30	21	55	65	78	467

Digraphs Occurring 11 or More Times: Digraph	Frequency	Trigraphs Occurring 5 or More Times: Trigraph	Frequency
80	17	891	5
89	23	179	5
79	13	003	7
00	37	035	6
35	11	358	5
98	14	580	5
99	15	598	6
78	11	989	5
87	12	100	6
90	16	290	7
07	11	000	13
		487	5

Long Sequences Repeated, Their Length and Frequency

Sequence	Length	Frequency
004879935980739817	18	2
806891792645	12	2
3598991003	10	2
1794787845	10	2

COMPMEANO PUZZLE 747 REWRITTEN

```
80689  17926  45003  58035  98991  00389

18011  70997  31787  71808  01806  59007

78352  90659  76598  29060  06000  09040

25653  99389  98150  77877  18948  77730

06791  00001  52639  90248  98000  48799

35980  73981  79478  78457  08917  04006

26450  03800  81897  70035  80380  75179

26081  00000  77990  30024  87894  78548

92900  04072  90896  98902  99187  23994

59837  98940  00035  80004  45687  73407

00138  97990  29089  40798  90290  17947

87845  10020  24898  00035  80709  08930

01004  87993  59807  39817  34070  26999

95426  79190  40278  35734  87290  17889

18718  92480  68917  92645  35989  91003

58048  96152  32645  00
```

For these puzzles, we invite our readers to send us solutions. If a human program or computer program for solving can be enclosed, so much the better. In some cases, there is no such thing as "the solution," but only "a solution". Usually, the (or a) solution to a puzzle will be published in the next issue.

Our thanks to the following individuals for sending us their solutions to — **Numble 745**: T. P. Finn, Indianapolis, Ind.; Abraham Schwartz, Jamaica, N.Y.; Maj. Gus Strassburger, Ft. Meade, Md. — **Pictorial Reasoning Test 745**: Carl L. First, Corvallis, Ore.

SOLUTIONS TO ALGORITHMO PUZZLE 745

To the Editor from Harold M. Brown, Iowa City, Iowa

I submit a solution to the hard portion of Algorithmo Puzzle 745. Since I have not programmed it yet, I cannot vouch for its complete accuracy. But on the examples I have tried, it seems to work.

Problem: ORDINALS TO CARDINALS: Express a procedure for going from ordinals to cardinals. *Input:* A string of characters consisting of any single ordinal number in English, from "first" to "three hundredth". *Output:* The corresponding cardinal number in decimal digits from "1" to "300".

Solution: Prepare the following operators expressed in Tables (see below):

1) Ordinal Suffix Remover
2) Meaning Analyzer
3) Place Assigner
4) Translator

These operators deal with words and with strings; s is a variable for any string.

Let K be an ordinal number expressed in English words.

Apply the Ordinal Suffix Remover and produce K2.

If K2 contains the word AND or any hyphens, replace them by space. This produces K3.

If K3 contains more than 5 words, call ERROR.

Apply the Meaning Analyzer, and obtain K4. Arrange an ordered set of 5 places, a, b, c, d, e.

Apply the Place Assigner, and obtain K5.

Apply the Translator and obtain K6, a set of one to five numbers, a, b, c, d, e.

Then apply the formula (a * b) + (c * d) + e, and obtain answer K7.

If any place contains no word, the number for that place is zero.

Table 1

ORDINAL SUFFIX REMOVER

String Pattern	New String
s TH	s
s ND	s N
s RD	s R
s ST	s

Note: The two letters in column (1) must be the last two letters of K.

Table 2

MEANING ANALYZER

Word Pattern	New Words
s TEEN	ONE TEEN s
s TIE	s TI ZERO

Table 3

PLACE ASSIGNER

1. If K4 contains:	Put that word in place:	And put any just preceding word in place:
A word of category H	b	a
A word of category T	d	c

2. Put any remaining word in place e

Table 4

TRANSLATOR

Word	Number	Category
ONE, FIR	1	U
TWO, TWEN, SECON	2	U
THREE, THIR	3	U
FOUR, FOR	4	U
FIVE, FIF	5	U
SIX	6	U
SEVEN	7	U
EIGHT, EIGH	8	U
NINE, NIN	9	U
TEN	10	U
ELEVEN	11	U
TWELVE, TWELF	12	U
TEEN, TI, TY	10	T
HUNDRED	100	H
ZERO	0	U

Table 5

SOME EXAMPLES

Example 1:

Given:
K: two hundred and forty-third
Apply ORDINAL SUFFIX REMOVER:
K2: two hundred and forty-thir
Apply "AND" AND HYPHEN DELETER:
K3: two hundred forty thir
Apply MEANING ANALYZER:
K4: two hundred for ty thir
Apply PLACE ASSIGNER:
K5: two hundred for ty thir
Apply TRANSLATOR:
K6: 2, 100, 4, 10, 3
Apply FORMULA:
K7: 247

(please turn to page 37)

The Assassination of the Reverend Martin Luther King, Jr., and Possible Links With the Kennedy Murders — Part 6

Wayne Chastain, Jr.
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"Thompson felt that he was 'being had'. Did he have a duty as a lawyer to remain silent? Or did he have a greater duty as a private citizen to come forward and give information to help solve one of the most important murder cases for the nation — perhaps the world?"

Was the murder of the Reverend Martin Luther King, Jr., the result of a conspiracy?

Previous installments of this series described the "eggs and sausage" man, later given the code name of Jack Armstrong, who appeared on the scene the day of the murder.*

Also appearing on the scene were Tony Benavides and J. Christ Bonnevecche who claimed to have information and understanding of Dr. King's and John F. Kennedy's assassinations. Are these two men to be believed? Are they the same person, and possibly aliases for Jack Armstrong?

Is there a relationship between these assassinations? Is there a conspiracy at work by an organization or several individuals, or are these murders more simply vendettas? Mr. Chastain continues to seek the answer to the murders of Dr. King and the Kennedys, and tries to discover if there is a relationship among these assassinations.

Similarity Between King's and J. F. Kennedy's Fatal Shot

Thompson asked him where he thought the shot was fired. Benavides replied: "The shot came from the bushes near the wall outside the rooming house" (about 200 yards from the backdoor of Jowers' cafe). The words evoked the "grassy knoll theory" in Thompson's mind. This was the theory espoused by some critics of the Warren Commission's Report on the November 24, 1963 assassination of President John F. Kennedy in Dallas, Texas. The theory holds that the first shot that wounded Kennedy was fired from the front — not the rear — of the motorcade. The sniper fired the first shot, wounding President Kennedy in the throat, from a position on the "grassy knoll" near the railroad trestle, above the parade route and near the very same spot that President Kennedy's car was about to pass. Adherents of the theory cite an abundance of evidence to support the theory, including the description of the throat wound as "an entry wound," rather than "an exit wound," by the physicians who examined Kennedy at Parkland Hospital minutes after the assassination. Thompson said his mind wandered a few moments as he compared the "grassy knoll theory" with the one being expostulated by his visitor. He remembered his visitor capturing his full attention when he said:

"The killer then disassembled the rifle while he was still in the bushes. The rifle was a .30 caliber Savage rifle. He threw away the rifle stock (a private detective later claimed he found a rifle stock of the same description on a trash heap in the area a few days later) while he was still in the bushes." (Remember Solomon Jones' statement that he thought he saw the man in the bushes throw something away, and Cornbread Carter's statement to the same effect. See Footnote 2, Part 1, February, 1974.)

Benavides said the killer "strapped the rifle barrel against his back where it fitted close to his skin". He then put his coat over the spot, leaving no bulges. (Thompson recalled the gun stunt Benavides had pulled a few minutes before, but this was done with a small pistol. Could the same trick be done with a rifle barrel, Thompson asked himself?)

The time did not seem to distract Benavides, who had earlier said he wanted to leave before Thompson's secretary arrived. He continued to explain how King was killed.

Escape from the Murder Scene

"The cops from the fire station and other lookout points around the motel were so confused at this point they were running in every direction," Benavides said. This confirmed Jowers' and Jones' descriptions of the pandemonium that ensued after King was shot.

"Most of the police and firemen were running toward the Lorraine from Main Street, nearly all of them jumping down from the wall in back of the cafe to the sidewalk below and then across the street to the Lorraine. The gunman emerged from the bushes as inconspicuously as he could and joined the plainclothesmen and firemen."

(Police had undercover teams assigned to a fire station on South Main Street on the corner of the same block as the rooming house and Jim's eyes glued on the Lorraine Motel's second story balcony where King's suite was located. These officers were looking at King when he was shot. From the peepholes, however, it was impossible to see the bushes along the wall or those behind the rooming house and Jim's Cafe.)

"The gunman jumped from the wall to the sidewalk," Benavides told Thompson. "He moved with the crowd toward the motel. He was not suspected because he did not appear to be armed, and because he was running toward the scene — not away from it." (Remember Jones' statement about the gunman moving from the bushes to the Lorraine property and getting within 25 feet of Jones?)

Thompson said Benavides' graphic description of the scenery and the manner in which he described the spontaneity of movement of the gunman suggested the

*Parts 1 through 5 were published in the February through June issues of *Computers and People*, and are available from the publisher as back copies at $2 each.

words of a man who was there when it happened. Benavides blew another smoke ring as he described the gunman's final get-away.

"The gunman stood on the motel grounds until police began shooing the crowd away. He then walked through the rear of the motel grounds where he had a motorbike stashed near a service station. When he rode off, nobody suspected him of being the get-away gunman."

Here it was, Thompson thought. The "modus operandi" behind the King assassination — or at least so the man across from the desk would have him believe.

Benavides' Exit

A few minutes later, the door to the outer office opened. Thompson's secretary had arrived. It was 8:20 a.m. The man stood up and said: "You may hear from me very soon, Mr. Thompson."

Thompson asked him: "How can I get in touch with you, Mr. Benavides?" The visitor replied: "Through Doyle Ellington of Brownsville, Tennessee. I am going to Brownsville this afternoon."

Ellington was a grand dragon in the Ku Klux Klan. He had been in the headlines of Memphis newspapers only a few weeks before, after he was indicted for conducting illegal whisky operations — called "moonshining" in this part of the South — and tried in the Federal court in Memphis. Ellington, however, later denied ever receiving a visit from anyone fitting the description of Benavides and accused the FBI of trying to frame him for the assassination of King.

Benavides walked out of Thompson's private office. He passed his secretary in the outer office, who hardly noticed the unusual early morning visitor.

Wayne Chastain of Memphis, Tenn., is a veteran newspaper reporter and Southern journalist with experience on several metropolitan dailies in Texas, including El Paso, Houston, Dallas and San Antonio, as well as on the St. Louis Globe-Democrat and a Memphis daily. He had traveled with Dr. King's entourage on and off for two years prior to the assassination. He had spent the last two days of King's life covering his speeches in Memphis prior to the shooting. He was on the murder scene within 10 minutes after Dr. King was shot. He interviewed eyewitnesses for one of the first comprehensive news accounts to the nation of Dr. King's death. A native Texan and a graduate of the University of Texas with a bachelor's degree in history and political science, Mr. Chastain also spent several months in early 1964 investigating and researching the assassination of President Kennedy, Jack Ruby's link with Lee Harvey Oswald and a group of pro-Cuban arms runners, and other activities related to Kennedy's death. Months before The Warren Commission's report, which was published in the fall of 1964, Mr. Chastain — after exhaustive interviews with hundreds of witnesses — had reached the conclusion that President Kennedy's death was the result of a plot involving paramilitary professionals financed by a group of wealthy, right-wing Texans with strong connections with former high officials with the Central Intelligence Agency as well as lower echelon CIA personnel still assigned to the bureau. The present installment is an excerpt from a forthcoming book entitled: Who Really Killed Dr. King — And the Kennedys? A Disturbing View of Political Assassinations In America.

Benavides again used his handkerchief to open the door to the hallway. Thompson said he never again heard from the man calling himself Tony Benavides.

The visit had "quite an impact" on him, Thompson said.

"There were moments during the conversation when I felt I was being had," Thompson recalls. "I thought he was putting me on. But I kept asking myself why. And then he began to talk as if he were there. Then the gun trick. That really got to me."

Thompson said his gut reaction was that Benavides was the killer — not Pete, or anyone else — that Benavides had just described to him how he killed King.

Thompson Identified Benavides

Some three months later, a private investigator, Renfro Hays, placed some photographs on Thompson's desk. The attorney recalled going through several of them. Each purported to be of the same man, but only one of them appeared to be the same man as Benavides. It showed a man with a crude cut, standing outside bars of a Miami police cell. The more Thompson studied the picture, the more sure he became that this was the picture of the man who visited his office. The other photographs later turned out to be all of the same man, but Thompson rejected the other photographs because each showed a dark-haired man, either with a mustache — one with a beard — or long sideburns. The picture of the man outside the Miami police jail cell showed a rugged, outdoors type — a clean-cut young man, whose hair seemed bleached by the sun.

Remembering his visitor as a "blond Latin," Thompson indicated to Hays that this photograph seemed to be the same man as his visitor. Hays then informed Thompson that despite the blond hair, this same photograph was identified by Lloyd Jowers and his waitress as the "eggs and sausage man".

Enter J. Christ Bonnevecche

Less than four hours after the mysterious blond Latin used his handkerchief to open the door and leave Thompson's office, another bizzare episode occurred.

Five blocks away from the Lorraine Motel in a predominantly black ghetto area was a white church, the Cumberland Presbyterian Church. Today, the building has been razed. The church is now located in predominantly white East Memphis. Two Memphis ministers, Rev. James M. Latimer, the pastor of the church, and his close friend, Rev. John Baltensperger, the pastor of a Baptist church, were having a friendly visit in Dr. Latimer's study and were about to go out and have lunch together. The phone rang shortly before noon. The caller said he needed "spiritual guidance" or he was going to "commit suicide".

Latimer said he would meet the caller and invite him to have lunch with Rev. Baltensperger and himself. The caller said he was at a downtown restaurant — Jim's Steak House, not to be confused with Jim's Cafe on South Main Street.

The clientele of Jim's Steak House catered to downtown businessmen, executives, attorneys, and other white collar workers. The two ministers went there. Latimer recognized the caller because the latter had described how he would be dressed. Unlike Thompson's visitor earlier in the morning, the man at Jim's Steak House was "rather shabbily dressed," Rev. Latimer said. He wore a blue sport coat, dark trousers, and sport boots.

"It wasn't the quality of the clothing that made him look shabby, but the fact that he looked as if he had slept in them," Rev. Latimer said.

The man wore tinted sun glasses, had dark wavy hair with long sideburns. He had a dark complexion, and was about six feet tall. He was well built and could have passed for a professional athlete, Rev. Latimer said.

Latimer said he did not notice it, but his friend, Rev. Baltensberger thought he recognized the outline of a gun under his sport coat and told him about it later.

The man was sitting at a small table against the wall. It was shortly before the noon lunch mob would pour in. Latimer knew he could not have a private conversation with the man here. He had decided that he would invite the man to leave with Rev. Baltensperger and him and go to Robilio's Cafeteria in South Memphis where there would be more privacy, and where there would be dinning rooms more conducive to having a discussion with the man. As he approached the table, the man grinned and held up his hands as if Latimer had a gun: "Don't shoot ... I give up. I will go with you peacefully."

Latimer noticed how keen the man's instincts were. He apparently sensed Latimer was going to ask him to leave the cafe.

Bonnevecche and the Mafia

"He introduced himself as J. Christ Bonnevecche," Rev. Latimer said. "He told a fantastic story. As a minister, one must assume that one is telling the truth unless his story is patently incredible. I admit that at the beginning of the story, I was very skeptical. I said to myself ...'here we go again ...here's another nut'. I looked at John and I could tell by the look in his eyes that this was his reaction, too. But as his story went on, I found myself believing at least some of it, if not all of it."

The man's story went something like this. On April 4, the day after King was killed, Bonnevecche was employed as a runner for the Mafia. He was making a delivery in a briefcase containing $300,000 in counterfeit American Express Traveler's checks. He had been sent to St. Louis from Chicago. While in St. Louis, he either got drunk, or took drugs — he did not quite remember — and he was rolled by a couple of black men. His assailants got the brief case containing the checks. He called one of his immediate supervisors in New York and the supervisor told him to come up with the checks — or the equivalency in cash — within 24 hours or else. He said he got scared. He first caught a bus to Poplar Bluff, Missouri. After a night there, he came down to Memphis because he always heard that the Mississippi River metropolis was one of the few cities in the South free of Mafia control.

In reviewing the ministers' story, investigators then heard the familiar words repeated by the ministers — the words that linked this man, Bonnevecche, with Benavides.

"I think I am going to Brownsville from here. I know a man who will help me hide. I once served time with him in Leavenworth."

Bonnevecche and Benavides

There was a slight inconsistency between Benavides' and Bonnevecche's stories at this point. Benavides expressly mentioned Ellington as his suspecting host in Brownsville, and Bonnevecche's only mentioned a former prison mate. Ellington, however, had never been to prison at that point in his career. He was out on bond pending appeal of his conviction for moonshining in Federal court in Memphis.

The man told the two ministers he was a drug addict. He pulled up his right sleeve to show the ministers a scar on the inside of his elbow. They noticed the tattoo, T over J (similar to the T over B that Thompson had seen on his visitor's arm about four hours earlier that morning, before Thompson's visitor erased the letters before Thompson's eyes with his peculiar rubbing motion).

Bonnevecche pulled out his billfold and showed the two ministers one of his counterfeit American Express money orders. He also showed them a long series of credit cards, each carrying a different name.

"The Mafia gave me these so I could travel under assumed names."

Latimer then asked why he had wanted to talk to the two ministers. What spiritual guidance could they give him? Did he need money? A place to sleep? Or what?

The man said his mother had been a Presbyterian. This was the reason he called Latimer. It so happened the Cumberland Presbyterian Church was the first church listed under Presbyterian in the yellow church pages.

Latimer said when he began to believe at least parts of the man's story, he sensed somehow he was connected with the King assassination. He noted how Bonnevecche obliquely slipped in the reference to King's death as the same day he was in St. Louis — as if he were trying to establish an alibi.

Latimer said he bluntly asked him: "Did you kill Dr. Martin Luther King, Jr.?"

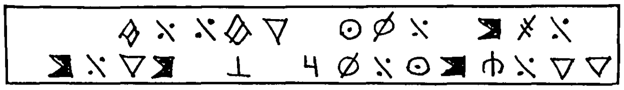
The question did not surprise Bonnevecche. He appeared unruffled and he stared at him for a few minutes, not quite suppressing a grin. He then replied: "No, but I know who did".

Bonnevecche and the Murder of J. F. Kennedy

Latimer said Bonnevecche then launched into a long exposition about assassinations. He said the Mafia had killed President Kennedy in Dallas in 1963. The reason — because Kennedy had begun to crack down on the Mafia and the dreaded Cosa Nostra through his brother, Robert F. Kennedy, as Attorney General.

"Most people already know this, but you can take this as fact: Kennedy's old man was in with the Mafia. Jack worked for the Mafia during the summers when he was at Harvard by running errands for his old man. He may not have even known what he was doing. Old man Kennedy controlled the Mafia in Boston. That's why they called the Kennedys the Irish Mafia."

Latimer said he unsuccessfully — for the moment at least — tried to keep steering Bonnevecche back on the King assassination, but Bonnevecche kept wanting to talk about the Kennedy assassination.



"He said he spoke eight languages and had a good education," Rev. Latimer said. "This I believed because his diction was good. He sprinkled his speech with foreign phrases — including Spanish, French, Italian, and Portguese. He implied he had been in some kind of intelligence work, in both Europe and South America. He also said he had spent a great deal of time in Washington, D.C." Bonnevecche pointed out there was a prominent Mafia figure in Dallas when President Kennedy was killed. The Mafia figure was arrested in Dealey Plaza minutes after the shooting, but police turned him loose, Bonnevecche said.[1]

"I have been at parties with Jack Kennedy before he became President," Latimer reported Bonnevecche as saying. "He was a transvestite; he dressed up in women's clothes at parties. Some people thought he was queer or homosexual. Others said he just did it as a gag."

Bonnevecche then made an ominous warning: "Mark my words, Robert F. Kennedy is the next man on the Mafia's list. Mark my words he is going to get it real soon — especially if he wins the California primary. The Mafia doesn't want that little Mick in the White House. They will do just about anything to keep him out." (RFK was killed six weeks later in the early morning hours after he had won the California primary.)

Was King's Death a Mafia Killing?

Finally, he decided to talk about the King assassination, Rev. Latimer said. "I never could get it straight why the Mafia wanted King killed." He said something first about narcotics...then something about an anti-mason motive on the part of Mafia figures. He also said something about a murder contract the Mafia signed with a wealthy man, whose wife had been seduced by Dr. King. He had almost made a convincing case for a Mafia motive in the Kennedy slaying, but he did not explain very logically the Mafia connection with the King slaying.

Bonnevecche said: "My friend Nick killed Dr. King. Unlike me — I am of an Italian-Portuguese extraction — my friend Nick is of Indian stock. A lot of people, however, say we look alike. He has bronze skin, darker than mine, dark eyes, and even some of his mannerisms resemble mine, mutual friends of ours have said." (The reader might recall the description of the bogus black man who supposedly induced Mrs. Bailey to change Dr. King's suite from the first to the second floor at the motel.)

"Yeah, my friend Nick is a lot like me in personality. He has my sense of humor for one thing. He is almost as good as I am in doing imitations. For example, I can do very good caricatures of Italians and Portuguese. My friend Nick is better at aping Indians, Spaniards, or Mexicans — he can really do a good job of aping dumb Mexicans." (The reader might recall the shifting speech patterns which puzzled Thompson.)

"How did Nick do it?" Latimer asked Bonnevecche.

"He rode into town on a motocycle," Bonnevecche said. "Because of his bronze skin, he can pass the color line by adding a little grease component to his skin. He mingled with the 'nigger' population, got the information he needed and set King up. He worked out the perfect assassination plan. He rode away from the murder scene — right under the eyes and noses of the police — riding a motorcycle with the assassination weapon strapped on his back. He had discarded the rifle stock."

This writer recently showed Rev. Latimer several pictures of the man with the code name of Jack Armstrong. It has been more than five years since the incident occurred. Latimer said he could not be sure. There was one photograph of Armstrong (when he was a gun runner and personal pilot for Fidel Castro prior to the toppling of the Batista regime in 1958) which Latimer said looked "quite a bit like Bonnevecche". He added: "I can't be sure — it has been a very long time".

Bonnevecche Leaves Town

Latimer said Baltensperger and he accompanied Bonnevecche from Robilio's to the Tennessee Hotel, about a block from Jim's Steak House, and about four blocks from Russell Thompson's law office. After packing his bags, he said: "Would you chaps accompany me to the bus station?" They accepted the invitation. They even helped carry his bags and watched him as he bought a ticket to Brownsville, Tenn. Then they watched him as he boarded the bus.

"I asked him to go to the police and tell them what he knew about King's murder," Latimer said. "He replied: 'Listen, I am in enough trouble as it is. Ratting on a Mafia contract killer — especially a friend like Nick — isn't going to help me at all. Besides, Nick and I are friends. I would never turn a friend in.' I asked him where I could get hold of him in Brownsville, but he would not give me the name of the former convict he was supposed to stay with."

Latimer said Bonnevecche did give him the name of a woman in North Carolina. "He asked me to communicate with her. He wanted me to tell her that John and I had talked with him and that he had accepted Jesus Christ as his savior."

When the bus left the station, the two ministers waved at the man who waved back from a bus window. They never saw him again.

A few days later, however, Latimer received a post card from Bonnevecche. It had a Brownsville postmark.

Dilemma of Privileged Communications

The two ministers and Thompson were in a quandry. They had a conflict because of a professional duty to maintain the confidence of those who come to them seeking their professional help. The question in each instance was this: did the respective visitors — assuming for a moment they were two different individuals — actually seek professional help? Or were they decoys?

Thompson felt that he was "being had". Did he have a duty as a lawyer to remain silent? Or did he have a greater duty as a private citizen to come forward and give information to help solve one of the most important murder cases for the nation — perhaps the world?

The two ministers felt even more skeptical about the purported seeking of professional help by their visitor. They, like Thompson, felt that they also "had been had". This man, Bonnevecche, said he did not kill King but that he knew who did. Was it a coincidence he was in Memphis right after the slaying? Wouldn't it be an even greater coincidence if he just happened to know that his friend Nick (if he actually existed) had killed King? Maybe he was trying to use the ministers as a conduit to get information to the police. They couldn't buy his story of "needing spiritual guidance". He did not ask for money, so why did he spend some four hours with them? He did not seem to be a man seeking solace and he did not seem to be in such a depressed state that he had contemplated suicide — the reason he first gave Latimer when he called him on the phone shortly before noon.

The ministers decided the next day that their duty as citizens outweighed their professional duty to maintain privileged communications. They went to see Inspector N. V. Zachary of the Memphis police department's homicide squad. Inspector Zachary was heading the special team investigating Dr. King's murder. They told him the whole story. Zachary seemed very interested at the time. What they did not know was that Thompson, also, had weighed his professional duty as an attorney against his duty as a private citizen, and had informed Attorney General Phil Canale of Shelby County, Police and Fire Director Frank Holloman, and Bob Jensen, special agent in charge of the Memphis FBI office, of the visit by Benavides.

Zachary did not tell the ministers about Thompson's visitor. Although Zachary would not comment on the story — in fact he would not even verify to local reporters that the two visits occurred for more than four years later — he told Gerold Frank, famous author of "The Boston Strangler," about both visits, and Frank, with a surprising lack of curiosity, relates the two stories in three pages in a humdrum chapter in his book, "An American Death,"[2] his version of the facts behind the King assassination.

Frank quotes Zachary as saying that Zachary concluded Bonnevecche and Benavides were the same man (Frank does not cite the fact that Thompson described his visitor as a blond, while Latimer described his visitor as a dark, swarthy type).

In Part 7, which is scheduled to be published next month, an answer will be sought to the question, "Why did the police and the FBI ignore the clues of conspiracy?"

Footnotes

1. Less than five years later, "Midnight" — a tabloid weekly newspaper specializing in the sensational — published an article in its January 15, 1973 issue, reporting the same fact Bonnevecche related to the two ministers. Headlined in bold-faced type "Mafia Linked to JFK Murder," the article reported that Eugene Brading, who has a criminal record dating back to 1934 and was reportedly an associate of Mafia figures in Denver, was in Dealey Plaza in Dallas when President Kennedy was shot. Police arrested him in a building across the street from the Texas Book Depository Building and in a building in which night club owner Jack Ruby was in at the time of the slaying. Police turned him loose, however, when Brading gave them a phoney name, the article said. The article also published photographs of Brading wearing sun glasses in Dealey Plaza shortly before the shooting. The article said Brading has been linked to several gangland slayings, including the Smaldones family of Denver.

2. Gerold Frank. "An American Death". Garden City, N.Y.: Doubleday & Co., Inc., pp. 153-155. As cited in Part One, Frank, apparently resting on his laurels for past books, accepts the official version and does not question any of the official assumptions. He did not interview first-hand many of the principal witnesses and sources, but instead relied on official records provided by the Attorney General's office, the Memphis Police Department, and the FBI. Latimer was especially irritated with Frank because Frank had never called him or corresponded with him, but quotes him directly. He also said Frank misquoted him about Bonnevecche's final destination as Brownsville, Texas, instead of Brownsville, Tennessee. Latimer was irked because Frank had described the two ministers dining with Bonnevecche in a booth in Jim's Steak House as if either Frank had been there or had someone who had been there describe the scene to him. The fact was, Latimer said, that the two ministers never sat down in Jim's Steak House. They went in and got Bonnevecche and left. What irritated Latimer the most, however, was the omission of any reference to the assertion by Bonnevecche that the Mafia had killed Kennedy, and that Robert F. Kennedy was next on the list. More than three-fourths of the conspiracy conversations concerned the Kennedys, rather than the King murder. Either the police had sanitized the reports the two ministers had made, or Frank had expurgated any distasteful references to conspiracy theories that would cast doubt on the "lone assassin theory" as it applied to the murders of both Kennedys and King. What was so uncanny was the juxtaposition of the prediction that Robert F. Kennedy would be the next major American who was going to be assassinated in the same context, containing a reference to the California primary.

Unsettling, Disturbing, Critical . . .

Computers and People (formerly Computers and Automation), established 1951 and therefore the oldest magazine in the field of computers and data processing, believes that the profession of information engineer includes not only competence in handling information using computers and other means, but also a broad responsibility, in a professional and engineering sense, for:

— The reliability and social significance of pertinent input data;

— The social value and truth of the output results.

In the same way, a bridge engineer takes a professional responsibility for the reliability and significance of the data he uses, and the safety and efficiency of the bridge he builds, for human beings to risk their lives on.

Accordingly, Computers and People publishes from time to time articles and other information related to socially useful input and output of data systems in a broad sense. To this end we seek to publish what is unsettling, disturbing, critical — but productive of thought and an improved and safer "house" for all humanity, an earth in which our children and later generations may have a future, instead of facing extinction.

The professional information engineer needs to relate his engineering to the most important and most serious problems in the world today: war, nuclear weapons, pollution, the population explosion, and many more.

ACROSS THE EDITOR'S DESK

Computing and Data Processing Newsletter

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APPLICATIONS

PROSPECTIVE DRUGS CAN BE EVALUATED BY COMPUTER

Barbara Hale
Pennsylvania State University
312 Old Main Bldg.
University Park, PA 16802

A computer can now distinguish chemicals that are either sedatives or tranquilizers, thanks to a Penn State chemist. Dr. Peter C. Jurs, associate professor of chemistry, has developed a pattern recognition technique, readily adaptable to other drugs, that enables a computer to digest data on molecular structure and come up with predictions of therapeutic activity. The Penn State approach is believed to be the first to achieve 100 per cent agreement with results obtained from standardized animal tests and established human usage.

Jurs says the new computer technique is not designed to eliminate biological testing. Rather, he hopes it will be used to "screen prospective drugs and rank them according to their liklihood of showing the desired activity".

According to Jurs, pattern recognition is a method of programming computers "to educate themselves". By feedback mechanisms the computer program corrects its own errors and learns from its mistakes almost like a dog or a small child. It improves its performance of a task as it accumulates experience in performing the task.

To test the technique's ability to screen drugs, Jurs chose what is a difficult problem for even the most highly trained chemist. The computer had to identify each of 219 chemicals as either a sedative or tranquilizer based on molecular structure information alone. All of the chemicals had previously been established as biologically active. What Jurs was doing was testing the computer technique against the established findings.

First, the computer isolated some 70 molecular characteristics of descriptors of the chemicals which are expected to be related to activity as a sedative or tranquilizer. Then on the basis of the descriptors, it learned to classify the set of chemicals with 100 per cent accuracy.

Jurs says that in related experiments the computer was trained with only a fraction of the available data and its capabilities were then tested on chemicals unknown to the computer classifier. Approximately 90 per cent of the unknowns were classified correctly. The study is currently focusing on methods for determining which of the original 70 descriptors are most useful to the classifier.

Jurs points out that since the technique requires structural data (such as the number of carbon atoms) but not physical data (such as the melting point) it can be used to test chemicals that don't actually exist. Prospective drugs can be evaluated on the drawing board and only the most promising ones synthesized. The technique could save much of the hit or miss effort spent today in producing over 20,000 new chemicals each year in the hope of finding a few new drugs.

As a long term goal, Jurs also sees the descriptors helping chemists to design drugs. Knowing what structures (identified by the descriptors) are most important for a desired property should make it possible to tailor a drug for a particular therapy.

Jurs' research program is supported, in part, by a grant from the National Science Foundation. Andrew J. Stuper, a Ph.D. candidate in chemistry, assisted Jurs on the project.

WEATHER-WATCHING LOCKHEED BUOY TO BEGIN OPERATION OFF ASTORIA, OREGON

Roger Beall
Lockheed Missiles & Space Co., Inc.
P. O. Box 504
Sunnyvale, CA 94088

An automatic weather watcher is now nearing its operating station off the U. S. Pacific Coast, enabling forecasters to make more accurate and longer-range predictions. The 35-ton buoy has moved out from Seattle's Pier 90 in preparation for its next duty station about 300 miles west of the Oregon-Washington coast. In effect, the buoy hull has come "home." Built two years ago at Lockheed Shipbuilding & Construction Co. in Seattle, the deep-keel hull was sent to Lockheed Missiles & Space Co. where it was fitted with monitoring equipment.

Designated EB-02 by the National Oceanic and Atmospheric Administration (NOAA) Data Buoy Office, the 29-foot-long high-capability buoy was tested extensively in the Gulf of Mexico last year. In the meantime, it has been refurbished and fitted with increased fuel capacity and deck space in preparation for duty in the icy North Pacific. Also added was a back-up package of electronics, sensors and battery power.

Capable of being moored in water depths to 20,000 feet and operating untended for at least one year, the boat-shaped EB-02 can withstand currents to seven miles an hour (6.2 kt), winds to 178 miles an hour (155 kt) and wave heights to 60 feet, according to Lockheed Program Manager James S. Hull.

Sensors on the buoy will gather data that will be radioed automatically at designated intervals to a Coast Guard shore station for relay to the National Weather Service. Mounted at two levels on the buoy's 28-foot mast, the sensors will report wind speed and direction, precipitation rate and air temperature and pressure. Sensors at the masthead also will report dew point and global radiation. Hull-mounted sensors will report water-current speed and direction, salinity, temperature and wave height.

A computer will process the data which is then transmitted by high-frequency radio. Two air-cooled diesel engines drive alternators which power the transmitter, lights, cooling system and computer.

The EB-02 data buoy uses a ROLM 1601 computer as the heart of its data processing system. The ROLM 1601 -- a Milspec machine developed by ROLM Corp., Cupertino, Calif., which is software compatible with Data General's Nova Computer -- directs the buoy's data gathering and communication of information to the shore station that also has receive, transmit and compute functions.

The buoy's data-processing system is programmed to provide oceanographic meteorological, sea state and system status data -- either synoptically or online (near real time). These data, the sample rate, the period of sampling and the synoptic interval are all programmed variables. Selection of the variables to be used is commanded by the Shore Communication Station (SCS). The synoptic and online data are transmitted to the SCS by any one of three radio links.

Automatic communication of data to the shore station is vital to the mission. The communication system on the buoy is composed basically of two transceiver sets containing three high-frequency transmitters and receivers each and a common antenna. They receive and demodulate simultaneously on three different radio-frequency bands and modulate and transmit on any one of the same bands.

EB-02 will join another high-capability buoy, EB-03, moored last year in the Gulf of Alaska, reporting sea conditions where our weather originates. They are the forerunners of a chain of data buoys planned for later in this decade to stretch from the Aleutians to San Diego.

CLOTHING MANUFACTURER USES COMPUTER TO 'MEASURE' CUSTOMER DEMAND

Harvey L. Falk, Vice President
Mann Manufacturing, Inc.
P. O. Box 10339
El Paso, TX 79994

Mann Manufacturing, Inc. designs, manufactures and distributes slacks and jeans, for boys and young men and women, to more than 7,000 retail outlets in the United States. It also produces a line of jackets and knit shirts.

A computer is helping Mann match nearly every yard of cloth inventory to marketplace demand. The computer, an IBM System/370 Model 135, contains complete records of styles, sizes, sales, customers and inventory. Its files are updated daily to reflect changes in any area of Mann's operations. Mann's production schedulers use IBM 3270 display stations with TV-like screens to decide how to balance production forecasts and customer orders.

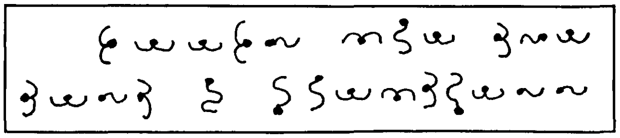
Accessing data stored in the computer, the schedulers can view on the screens suggested ways to allocate millions of yards of cloth to thousands of style and size possibilities. Once the scheduler selects the fabric and color to be cut, the system also displays which marker — a set of pattern combinations — should be used to get optimum yardage from the available cloth.

For instance, if he is making blue jeans and has 12,000 yards of cloth, the computer calculates in seconds how the cloth should be distributed. The computer then selects the best marker for the style to be cut from among nearly 1,000 in its files. One marker may contain many different sizes for a style. If there are no markers on file for a particular style, the system indicates a new one is needed and suggests the sizes necessary to balance Mann's inventory to the order.

The computer program also gives the scheduler the option of cutting material based on orders or forecasts. For instance, if the scheduler determines he has cut enough material to meet current orders and has some left over, he may decide to cut more to meet the company's sales forecast. Once the scheduler determines he has the best possible cutting plan, he sends the cutting tickets to the production plant.

In the past, production schedulers calculated cutting tickets manually. Calculations that once took up to an hour per ticket now only take five to ten minutes with the computer. Schedulers now are able to spend more time studying the impact of their decisions on cloth utilization, factory efficiency and shipping performance.

The company also uses the IBM system to provide better customer service. When a customer calls to check on an order, an answer can be provided while he is still on the phone. Detailed information on customer orders including styles, colors, pairs shipped, freight lines, number of cartons, bill of lading numbers and back order promise dates are in the system. Complete information on a customer order can be retrieved from the display screens in less than 30 seconds.



PRODUCT NEWS

NEW TECHNIQUE PREVENTS COPYING OF DOCUMENTS IN COPYING MACHINES

Inside R&D
Ste. 411, Lincoln Building
60 East 42 St.
New York, NY 10017

INSIDE R&D (a publication of Technical Insights, Inc.) has reported that Xerox Corporation has come up with a technique to prevent documents from being copied in copying machines. INSIDE R&D, a weekly newsletter written for technical managers in industry, has disclosed that Xerox was granted British Patent No. 1,338,893 on the new development. In effect, any document now can be made immune to copying by conventional copying machines.

The patent covers use of certain flurescent dyes that can be sprayed on documents from an aerosol can. When dry the document can be read normally since the thin coating of fluorescent dye is transparent. But, put that same document in a copying machine and strange things happen.

Most copying machines rely on a certain kind of light to do their job, basically the green portion of the light spectrum. When such green light hits the fluorescent dye coating on the document the dye fluoresces, emitting a bright flash of light. This flash confuses the copying machine and prevents a legible copy from being produced.

The editors of INSIDE R&D say the new development will have far reaching implications. Publishers will be able to protect their publications from being copied by unauthorized persons. Companies can protect sensitive documents or proprietary information that is subject to industrial espionage. And, the government should find many ways to use this technique. Copies of the Pentagon Papers, for example, might never have been smuggled out of the Defense Department if such a spray was available at the time.

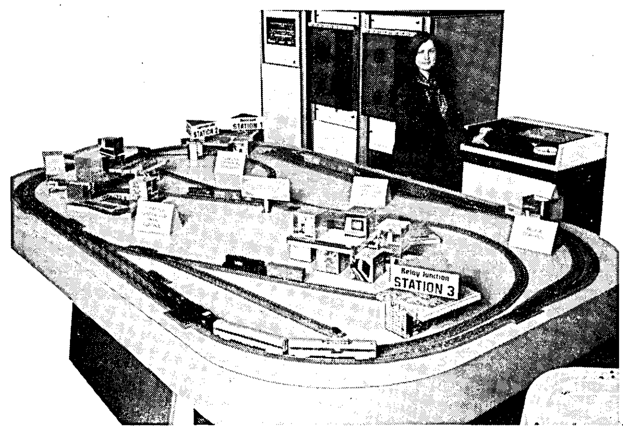
Details of the Xerox development are contained in the issue of INSIDE R&D, dated March 20, 1974.

MODEL RAILROAD CONTROLLED BY COMPUTER

Hugh P. Bannon, Public Relations
Raytheon Company
Lexington, MA 02173

The only computer-controlled model railroad in the world with laser car identification was the featured exhibit at Raytheon Data Systems booth at the National Computer Conference in Chicago (May 6-9).

As a demonstration of its process control and interfacing capability, Raytheon used a model railroad controlled by an RDS-500 Supermin mini-computer which handled centralized train control or "block control" operations and computed and set the speed of trains to maintain a schedule. It also handled routing operations by means of switch control. Another feature was train car identification, performed through the use of a laser which scans bar codes on the bottom of each car. This allows print out of "consists" or train order lists in the order in which the train is assembled.



While performing the railroad control application, the RDS-500 Supermin computer simultaneously performed a batch business program in background mode, demonstrating the multi-programming capability of the RDS-500 MPS operating system.

The computer was also programmed to talk through an artificial larynx and give a brief demonstration of synthesized speech. The integration of the speech synthesizer highlighted the wide range of peripheral devices supported by Raytheon's RDS-500. In all, 28 peripheral devices are available to system designers.

RESEARCH FRONTIER

BELL LABS SCIENTISTS MAKE FIRST REAL-TIME MEASUREMENTS OF STRATOSPHERIC POLLUTION

"Inside R&D" (a publication)
60 East 42 St.
New York, NY 10017

By using an unusual combination of ancient and modern technology — a lighter than air balloon and a laser — Bell Labs scientists have made the first real-time measurements of pollution in the stratosphere. These measurements are important because of the lack of data on the composition and chemical stability of the stratosphere and the concern that man-made pollutant gases may be disturbing the chemical balance.

A remotely controlled laser, an opto-acoustic device and a computer suspended from a balloon 17 miles above the earth gave the scientists nearly instantaneous measurements of nitric oxide. The latter is a major pollutant produced during combustion processes of all sorts, including those in automobiles, stationary power plants, aircrafts, SSTs, etc. The concentration of nitric oxide in the stratosphere is important because of the crucial role it and other exides of nitrogen play in the chemical cycle of ozone. Ozone is instrumental in blocking hazardous amounts of ultraviolet radiation from reaching the earth below, says C. Kumar N. Patel, Director of the Bell Labs Electronic Research Laboratory.

(please turn to page 42)

Example 2:

one hundred and nineteenth
one hundred and nineteen
one hundred nineteen
one hundred one teen nine
one hundred one teen nine
1, 100, 1, 10, 9
119

Example 3:

twelfth
twelf
twelf
twelf
- - - - twelf
0, 0, 0, 0, 12
12

Example 4:

fiftieth
fiftie
fiftie
fif tie
- - fif ti zero
0, 0, 5, 10, 0
50

To the Editor from Andy Langer, Newtonville, Mass.

Here is a solution to Algorithmo Puzzle 745, expanded. The input is a string of characters consisting of any single ordinal number in English from "zeroth" to "nine-hundred ninety-ninth". The output is the corresponding decimal integer.

1) Does the string consist of "ZEROTH"?
   If so, return 0.
   If not, continue.
2) Does the string begin with "ONE", "TWO", "THREE", "FOUR", "FIVE", "SIX", "SEVEN", "EIGHT", or "NINE"?
   If so, convert to 1, 2, 3, 4, 5, 6, 7, 8 and 9, respectively, store this in H, and if "HUNDRED" follows, delete the portion of the string processed so far, and go to step 3.
   If not, or if something other than "HUNDRED" follows, store a zero in H and go to step 4.
3) Does the string consist of "TH"?
   If so return 100 x H.
   If not, first delete "AND" if it now begins the string, and then continue.
4) Does the string begin with "THIR", "FIF", "SIX", "SEVEN", "EIGH", or "NINE"?
   If so, convert to 3, 5, 6, 7, 8, 9 respectively, and store this in A, and:
   (a) If "TEENTH" remains, return 100 x H + 10 + A
   (b) If "TIETH" remains, return 100 x H + 10 x A
   (c) If "TY" and perhaps a hyphen follow, delete the portion of the string matched so far, and go to step 7.
   (d) Otherwise, store a zero in A and go to step 7.
   If not, continue.
5) Does the string begin with "TWEN" or "FOR"?
   If so, store a 2 or 4, respectively, in A, and go to step 4b.
   If not, continue.
6) Does the string consist of:
   (a) "TENTH"? If so, return 100 x H + 10.
   (b) "ELEVENTH"? If so, return 100 x H + 11.
   (c) "TWELFTH"? If so, return 100 x H + 12.
   (d) "FOURTEENTH"? If so, return 100 x H + 14.
   (e) Otherwise, store a zero in A and continue.
7) Examine the remaining string.
   If it is "FIRST", "SECOND", "THIRD", "FOURTH", "FIFTH", "SIXTH", "SEVENTH", "EIGHTH", or "NINTH", convert to 1, 2, 3, 4, 5, 6, 7, 8, 9, respectively, and store this in B. Return 100 x H + 10 x A + B.
   If not, the string is invalid.

I have incorporated this algorithm into a computer program which runs on a DEC PDP-9, and below are some of the translations of ordinal numbers and examples of illegal strings.

```
FIRST
1
TWENTY-FIRST
21
ONE HUNDRED AND ELEVENTH
111
TWO HUNDRED AND FORTY-FIRST
241
NINE HUNDRED AND NINTY-FIRST
BAD ORDINAL NUMBER
NINE HUNDRED AND NINETY-FIRST
991
SIX HUNDRED AND SEVENTY-SIXTH
676
THREE HUNDRED FIRST
3Ø1
FIVE HUNDRED AND NINETY-SECOND
592
TWO HUNDRED AND FOURTY-FOURTH
BAD ORDINAL NUMBER
TWO HUNDRED AND FORTY-FOURTH
244
NINETY ELEVENTH
BAD ORDINAL NUMBER
```

OTHER SOLUTIONS

ARGUMENTO 746: Invalid. The same conclusion can be drawn from many different premises.

ESSENTIALO 746: He said again that man does not live on bread alone.

GIZZMO 746: 117 days.

MAXIMDIJ 746: (which appeared also on pages 5, 17, 22, and 31, with different codes)
The more the merrier.

NAYMANDIJ 746: Make diamond of 9's.

NUMBLE 746: R = 0; H = 1; M = 2; T = 3; DO = 4; NA = 5; W = 6; PI = 7; E = 8; S = 9. The message is: Sow the wind, reap the storm.

SIXWORDO 746 and GIZZMO 745: Solutions will be published next month (we have no more room this month.)

NEW CONTRACTS

TO	FROM	FOR	AMOUNT
GTE Sylvania, Inc., subsidiary of General Telephone & Electronics Corp., Needham, Mass.	U.S. Army, Army Electronics Command, Fort Monmouth, N.J.	Develop, fabricate and test tactical electronic communications equipment	$50.6 million
Communications & Terminals Div.,Sperry Univac, Salt Lake City, Utah	McDonnell Douglas Automation Co. (MCAUTO), St. Louis, Mo.	Design of communications network control system, MCAUTOnet, utilizing Univac 3760 Communications Controllers for nationwide, teleprocessing network	$18 million (approximate)
Control Data Corp., Minneapolis, Minn.	U.S. Marine Corps, Washington, D.C.	Production of 19 AN/TYC-5A high-speed data communications terminals and associated logistics support	$7.2 million
INCOTERM Corp., Natick, Mass.	McDonnell Douglas Automation Co. (MCAUTO), St. Louis, Mo.	A 3-year purchase agreement supplying "intelligent" computer terminals to MCAUTO's Hospital Services Division	$5 million (approximate)
Litton Industries, Data Systems Div., Van Nuys, Calif.	Naval Air Systems Command, Washington, D.C.	A second production contract for 63 AN/ASW-27B two-way data link systems for the Grumman F-14 jet fighter	$2.7 million
Varian Data Machines, Irvine, Calif.	Kovo Foreign Trade Enterprises, Prague, CSSR	Delivery of 11 data acquisition and communication systems to State Bank of Czechoslovakia	$1.8 million
Peripheral Equipment Div., Pertec Corp., Chatsworth, Calif.	Computer Machinery Limited, Himel Hempstead, Herts, England	10-1/2 inch reel digital magnetic tape drives to be used in data entry systems manufactured by CMC, Ltd.	$1.6 million
Data Recognition Ltd. and ICL Ltd., England	Lindum Information Systems Ltd. and Ross Foods Ltd., England	32 DR System 8301 OMR-based computer terminal systems, a 64K ICL 1903T main frame processor, two ICL 7903 front-end processors and six EDS 60 drives	$1.57 million
General Electric Co., Information Services Div., Rockville, Md.	U.S. Air Force, Washington, D.C.	A 3-year contract to supply timesharing computer services for nationwide Copper Impact program	$1.3 million
Sycor, Inc., Ann Arbor, Mich.	Logabax, S.A., Paris, France	A license to manufacture and distribute Sycro's dual flexible disk drive in Western and Eastern Europe	$1 million
Peripheral Equipment Div., Pertec Corp., El Segundo, Calif.	Vidar, Continental Telephone System, Mountainview, Calif.	Digital magnetic tape drives and formatters to be used with a telecommunications monitoring system used to automatically measure telephone usage	$700,000+
Computer Election Systems, Inc., Berkeley, Calif.	Board of Supervisors, Los Angeles County, Berkeley, Calif.	Six CES 700 Ballot Multiplexor Systems for rapid transfer of vote data from computer punch cards to magnetic tape	$500,000
EPSCO, Inc., Westwood, Mass.	Krupp-Atlas Elektronik, Bremen, West Germany	100 Loran C Plotters used in conjunction with Loran C navigation receivers to provide a constant fix on location while a vessel is at sea	$270,000 (approximate)
Sanders Data Systems Ltd., London, England	Wales Gas, Cefn On, Wales	Programmable computer terminals that will be used in new stock control and requisitioning project	$238,000 (approximate)
Lockheed Electronics Co., Plainfield, N.J.	Datatab, Inc., New York, N.Y.	A 24-terminal data management system consisting of 17 cathode ray and 5 key punch terminals	$226,484
Computer Sciences Corp. (CSC), El Segundo, Calif.	NASA, Goddard Space Flight Center, Greenbelt, Md.	Preliminary designs of data management system for Earth Observatory Satellite (EOS), planned as late-1970's successor to Earth Resources Technology Satellite	$225,000
Sanders Associates, Inc., Nashua, N.H.	Simulation Products Div., The Singer Co., San Leandro, Calif.	Four high-speed computer-driven graphic display systems for use in various types of aircraft training simulators	$200,000 (approximate)
Computer Sciences Corp., Communications & Electronics Ctr. Falls Church, Va.	State of Michigan	Long-range study and organization plan to meet state's telecommunications needs	$70,000
	State of New Jersey	Engineering concept design of a criminal justice information system to provide effective frequency allocation and management, plus access to state's central data base	$39,000
Collins Radio Co., Dallas, Texas	United Air Lines, Rockleigh, N. J.	A computer-controlled Automatic Call Distribution (ACD) System	——
Cossor Electronics Ltd., subsidiary of Raytheon Co., U.K.	Finnish Post Bank, Helsinki, Finland	20 PTS-100 (programmable terminal display) systems to be linked to an IBM 360 mainframe computer	——
Raytheon Co., Lexington, Mass.	Newspaper System Development Group, Gaithersburg, Md.	Development and production of display terminals for use in make-up and composition of display advertisements and full newspaper pages	——
Spur Products Corp., Santa Monica, Calif.	Stanford Research Institute, Menlo Park, Calif.	A controller for print quality and character flexibility not now available with SRI's CDC-6400 system; Spur's controller will link SRI's CDC system with an IBM 1403 printer	——
Texas Instruments, Inc., Houston, Texas	J. C. Penney Co., Inc.	800 computerized order entry terminals and four pollers for data collection	——

NEW INSTALLATIONS

OF	AT	FOR
Burroughs B 1712 system	City of Covington, Covington, Ky.	Budgetary accounting and payroll; future use includes waterworks billing and accounting and city income tax accounting (system valued at $100,000)
Burroughs B 2700 system	Bonne Bell, Inc., Lakewood, Ohio	General office and accounting applications (system valued at approximately $250,000)
	City of Miami Beach, Miami Beach, Fla.	Budget accounting and preparation, payroll/labor distribution, insurance and pension contributions, resort taxes, licenses, waste billing, personnel leaves, and work for fire and water departments (system valued at $437,000)
Burroughs B 6700 system	Spartan Mills, Spartanburg, S. C.	General office and accounting applications, various management reports, color matching for dye shade formulation and other applications (system valued at $2 million)
Data General Nova 840 system	European Centre for Nuclear Research, Geneva, Switzerland	High-energy physics experiments, e.g., monitoring particle-spin and polarization effects in scattering processes
Hewlett-Packard HP-3000 system	Institute Giulio Pastore, Turin, Italy	Educational and administrative applications; future use includes COBOL and FORTRAN programming courses (system valued at approximately $200,000)
	Layfayette College, Easton, Pa.	Student, faculty, and administrative use, handling time-sharing, batch processing and real time operations; replaces IBM 1130 and H-P 2100 (system valued at approximately $200,000)
	National Bank of Detroit, Detroit, Mich.	Keeping records of bank's investment portfolio and to process tax payments for mortgage accounts
Honeywell Model 6025 system	Savings Bank Service Corp., subsidiary of Boston Five Cents Savings Bank, Boston, Mass.	Handling all information processing for parent bank (system valued at more than $1.2 million)
Honeywell Model 6080 system	State of Michigan, Dept. of Social Services, Lansing, Mich.	Areas of public assistance and medical assistance eligibility; Medicaid invoice processing, federal and state government reports; management systems; check processing for public assistance program, crippled children's program and aid to dependent children, and Mental and Public Health and other related Health and Welfare systems (systems valued at more than $11 million)
IBM System/3	Buning the Florist, Inc., Fort Lauderdale, Fla.	Accounting, billing and improved customer service
	Store Realty Corp., North Miami, Fla.	Improved account service and internal controls in the Florida land market
IBM System/7	Multnomah County Intermediate Education District, Portland, Oregon	Providing services to local school districts
IBM 370/165 system	Air Products & Chemicals Corp., Allentown, Pa.	Expanding capabilities in business studies, engineering, support, and data processing
NCR Century 101 system	American Medical Affiliates, Inc., Jenkintown, Pa.	Payroll, general ledger accounting, and accounts payable
	Anaheim Memorial Hospital, Anaheim, Calif.	Handling labor distribution, in-and-out-patient billing, payroll and general ledger accounting
	Ball Memorial Hospital, Muncie, Indiana	Maintenance of Medicare log, in-patient and out-patient billing, accounts receivable and payable, payroll and general ledger accounting
	Dublin Savings Bank, Dublin, Ireland	Linking branches throughout Dublin via on-line financial terminals with the central office
	Liebherr France Co., Colmar, France	Processing piecework payments to 1,000 employees, managing materials requirements, general accounting
Univac 90/70 system	Clarksons, London, England	Implementing and expanding real-time computer reservations; ultimate aim is to eliminate most batch processing and provide on-line accounting for travel agents and clients
Univac 1106 system	Datacom Ltd., Galway, Ireland	Batch, real-time, time-sharing and remote job entry processing for commercial and governmental customers (system valued at approximately $2.4 million)
	Datamont, Milan, Italy	Primary use in scientific and design calculations (system valued at approximately $1.4 million)
Univac 9480 system	Borregaard Industries Ltd., Hallein, Salzburg, Austria	Hub of extensive data base, real-time system which takes over programs being run on Univac 9300; new applications include setting-up data base covering 3 prime areas of company's operations — order entry, inventory control and finance accounting
Varian 73 system	University of Southern California, Ethel Percy Andrus Gerontology Center, Los Angeles, Calif.	Investigating processes and problems associated with human aging; subjects include biochemical and behavioral changes, design of buildings and parks and analysis of government policies all regarding the aged
Xerox 530 system	United Industry, Inc. (Long Construction Co.), Billings, Montana	Accounting services and some scientific computation for 11 companies, primarily in the construction business; replaces IBM 1130 system

MONTHLY COMPUTER CENSUS

Neil Macdonald
Survey Editor
COMPUTERS AND PEOPLE

The following is a summary made by COMPUTERS AND PEOPLE of reports and estimates of the number of general purpose digital computers manufactured and installed, or to be manufactured and on order. These figures are mailed to individual computer manufacturers quarterly for their information and review, and for any updating or comments they may care to provide. Please note the variation in dates and reliability of the information. A few manufacturers refuse to give out, confirm, or comment on any figures.

Part 1 of the Monthly Computer Census contains reports for United States manufacturers, A to H, and is published in January, April, July, and October. Part 2 contains reports for United States manufacturers, I to Z, and is published in February, May, August, and November. Part 3 contains reports for manufacturers outside of the United States and is published in March, June, September, and December.

Our census seeks to include all digital computers manufactured anywhere. We invite all manufacturers to submit information that would help make these figures as accurate and complete as possible.

The following abbreviations apply:

- (A) -- authoritative figures, derived essentially from information sent by the manufacturer directly to COMPUTERS AND PEOPLE
- C -- figure is combined in a total
- (D) -- acknowledgment is given to DP Focus, Marlboro, Mass., for their help in estimating many of these figures
- E -- figure estimated by COMPUTERS AND PEOPLE
- (N) -- manufacturer refuses to give any figures on number of installations or of orders, and refuses to comment in any way on those numbers stated here
- (R) -- figures derived all or in part from information released indirectly by the manufacturer, or from reports by other sources likely to be informed
- (S) -- sale only, and sale (not rental) price is stated
- X -- no longer in production
- \- -- information not obtained at press time and/or not released by manufacturer

SUMMARY AS OF JUNE 15, 1974

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	AVERAGE OR RANGE OF MONTHLY RENTAL $(000)	NUMBER OF INSTALLATIONS In U.S.A.	Outside U.S.A.	In World	NUMBER OF UNFILLED ORDERS
Part 1. United States Manufacturers A-H							
Adage, Inc.	AGT 10 Series	4/68	X	32	3	35	X
Boston, Mass.	AGT 100 Series	1/72	100-300 (S)	16	12	28	2
(A) (Feb. 1974)	Adage 300	3/74	100-300 (S)	0	0	0	3
	Adage 400	3/74	30-50 (S)	0	0	0	2
Autonetics	RECOMP II	11/58	X	30	0	30	X
Anaheim, Calif.	RECOMP III	6/61	X	6	0	6	X
(R) (Jan. 1969)							
Bailey Meter Co.	Metrotype	10/57	40-200 (S)	8	0	8	0
Wickliffe, Ohio	Bailey 750	6/60	40-250 (S)	37	15	52	0
(R) (Aug. 1972)	Bailey 755	11/61	200-600 (S)	7	0	7	0
	Bailey 756	2/65	60-400 (S)	17	12	29	-
	Bailey 855/15	12/72	50-400 (S)	2	1	3	-
	Bailey 855/25	4/68	100-1000 (S)	16	0	16	-
	Bailey 855/50	3/72	100-1000 (S)	12	0	12	2
Bunker-Ramo Corp.	BR-130	10/61	X	160	-	-	X
Westlake Village, Calif.	BR-133	5/64	X	79	-	-	X
(A) (June 1973)	BR-230	8/63	X	15	-	-	X
	BR-300	3/59	X	18	-	-	X
	BR-330	12/60	X	19	-	-	X
	BR-340	12/63	X	19	-	-	X
	BR-1018	6/71	23.0 (S)	-	-	-	-
	BR-1018C	9/72	-	-	-	-	-
Burroughs	B100/500	7/65	2.8-10.0	1141	677	1818	-
Detroit, Mich.	B200	11/61	5.0	-	-	500	-
(N) (R) (June 1974)	B205/220	1/54,10/58	X	42	4	46	X
	B300 Series	7/65	7.0	-	-	-	-
	B700 Series	3/73	1.0-2.3	33	13	46	-
	B1700 Series	8/72	2-10	81	26	107	-
	B2500	2/67	4-10	277	123	400	-
	B2700	8/72	4.5-10.0	35	16	51	-
	B3500	5/67	5.3-15.0	570	300	870	-
	B3700	11/72	12.5-30.0	17	6	23	-
	B4500/4700	10/71	14.0-90.0	78	26	104	-
	B5500	3/63	23.5-34.0	152	47	199	-
	B5700	12/70	12-32	27	8	35	-
	B6500/6700	2/68,8/72	18-30	55	26	81	-
	B7500	4/69	44.0	-	-	-	13
	B7700	2/72	50-150	1	-	1	4
	B8500	8/67	200.0	1	-	1	-
Computer Automation, Inc.	108/208/808	6/68	5.0 (S)	165	10	175	110
Newport, Calif.	116/216/816	3/69	8.0 (S)	215	20	235	225
(R) (April 1971)							
Consultronics, Inc.	DCT-132	5/69	0.7	75	65	135	-
Dallas, Texas							
(A) (May 1974)							
Control Data Corp.	G15,G20	7/55;4/61	X	-	-	315	X
Minneapolis, Minn.	LGP-21,LGP-30	9/56;12/62	X	-	-	487	X
(R) (June 1974)	M1000	-	-	1	-	-	-
	RPC4000	1/61	X	-	-	75	X
	636/136/046 Series	-	-	-	-	29	X
	160/8090 Series	5/60	X	-	-	610	X
	921/924-A	8/61	X	-	-	29	X
	1604/A/B	1/60	X	-	-	59	X
	1700 Series	5/66	3.8-4.0	-	-	479	-
	3100/3150/3170	5/64-10/70	3-18	100	57	157	-
	3200	5/64	13.0	1	2	93	-
	3300	9/65	20-38	106	100	206	-
	3400	11/64	18.0	6	11	17	-
	3500	8/68	12-30	5	15	20	-
	3600	6/63	52.0	23	17	40	-
	3800	1/66	53.0	17	3	20	-
	6200/6400/6500	8/64	41-66	77	63	140	-
	6600	8/64	115.0	56	33	89	-
	6700	6/67	130.9	3	2	5	-
	7600	12/68	235.0	8	4	12	-

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	AVERAGE OR RANGE OF MONTHLY RENTAL $(000)	NUMBER OF INSTALLATIONS In U.S.A.	Outside U.S.A.	In World	NUMBER OF UNFILLED ORDERS
Control Data (cont.)	Cyber 70/72	11/71	28-47	6	17	23	-
	Cyber 70/73	3/72	34-49	6	11	17	-
	Cyber 70/74	12/71	41-100	2	3	5	-
	Cyber 70/76	12/71	82-150	2	3	5	-
	Cyber 170/172	-	-	-	-	-	-
	Cyber 170/173	-	-	-	-	-	-
	Cyber 170/174	-	-	-	-	-	-
	Cyber 170/175	-	-	-	-	-	-
	Cyber 1000	1/73	250-1,200 (S)	-	-	-	-
Data General Corp.	Nova	2/69	9.2 (S)	-	-	C	-
Southboro, Mass.	Supernova	5/70	9.6 (S)	-	-	C	-
(A) (Mar. 1974)	Nova 1200	12/71	5.4 (S)	-	-	C	-
	Nova 800	3/71	6.9 (S)	-	-	C	-
	Nova 820	4/72	6.4 (S)	-	-	C	-
	Nova 840	3/73	(S)	-	-	C	-
	Nova 1210/1220	2/72	4.2;5.2 (S)	-	-	C	-
	Nova 2/4, 2/10	6/73	(S)	-	-	C	-
						Total: 10,196	
Datacraft Corp.	6024/1	5/69	52-300 (S)	18	0	18	0
Ft. Lauderdale, Fla.	6024/3	2/70	33-200 (S)	119	26	145	6
(A) (May 1974)	6024/4	8/73	19.9 (S)	24	3	27	10
	6024/5	5/72	11-80 (S)	143	2	145	7
	6024/5R	2/73	30-60 (S)	4	0	4	0
Datapoint Corp.	Datapoint 2200	2/71	151-292	-	-	4000	-
San Antonio, Texas							
(A) (Feb. 1974)							
Digiac Corp.	Digiac 3060	1/70	9.0 (S)	80	0	80	7
Smithtown, N.Y.	Digiac CT-10	-	9.0 (S)	21	0	21	0
(A) (Feb. 1974)	Digiac 3090	2/74	4.6 (S)	4	0	4	0
Digital Computer Controls, Inc.	D-112	8/70	0.12	742	82	824	-
Fairfield, N.J.	D-116	1/72	0.10	1896	210	2106	-
(A) (May 1974)							
Digital Equipment Corp.	PDP-1	11/60	X	48	2	50	X
Maynard, Mass.	PDP-4	8/62	X	40	5	45	X
(A) (Sept. 1973)	PDP-5	9/63	X	90	10	100	X
	PDP-6	10/64	X	-	-	23	X
	PDP-7	11/64	X	-	-	100	X
	PDP-8	4/65	X	-	-	1402	X
	PDP-8/I	3/68	X	-	-	3127	X
	PDP-8/S	9/66	X	-	-	918	X
	PDP-8/L	11/68	X	-	-	3699	X
	PDP-6/E,8/M,8/F	5/72	3.9-4.9 (S)	-	-	9150	-
	PDP-9	12/66	X	-	-	436	X
	PDP-9L	11/68	X	-	-	40	X
	DECSystem-10	12/67	700-3000 (S)	-	-	300	-
	PDP-11/10,11/20/11R20, 11/40	-	10.8-13.8 (S)	-	-	3280	-
	PDP-11/05,11/15	-	10.8 (S)	0	0	3170	-
	PDP-11/45	-	-	0	0	650	-
	PDP-12	9/69	-	-	-	725	-
	PDP-15	2/61	17.0 (S)	-	-	625	-
	LINC-8	9/66	X	-	-	200	X
Electronic Associates Inc.	640	4/67	1.2	110	61	171	0
West Long Branch, N.J.	8400	7/67	12.0	21	8	29	0
(A) (Sept. 1973)	PACER 100	7/72	1.0	50	45	95	25
General Automation, Inc.	SPC-12	1/68	-	-	-	2900	-
Anaheim, Calif.	SPC-16	5/70	-	-	-	3185	-
(A) (June 1974)	System 18/30	7/69	-	-	-	530	-
General Electric							
(Process Control Computers)							
see Honeywell							
Hewlett Packard	2114A, 2114B	10/68	X	-	-	1210	-
Cupertino, Calif.	2115A	11/67	X	-	-	342	-
(A) (May 1974)	2116A, 2116B, 2116C	11/66	X	-	-	1446	-
	2100A, 2100S	9/71	-	-	-	6000	-
	21 M/10, M/20	7/74	-	-	-	-	-
	3000	11/72	-	-	-	50	-
Honeywell Information Systems	Series 50: G53,G55	-	-	-	-	-	-
Wellesley Hills, Mass.	G58	3/71	0.7-6.0	-	-	3200	800
(R) (May 1974)	Series 100: G105	6/69	0.9-1.4	6	-	6	-
	G115	4/66	2.2	400	680	1080	-
	G118/A,/B	-	-	-	-	-	-
	G120	3/69	2.9	-	6	6	-
	G128	-	-	-	-	-	-
	G130	12/68	4.5	-	-	-	-
	G138	-	-	-	-	-	-
	5	4/69	1.5	-	-	-	-
	10	4/66	3.3	-	-	-	-
	15	4/69	6.9	-	-	-	-
	Series 200: 105	4/69	1.7	-	-	-	-
	110	8/68	2.7	180	93	273	-
	115,/2	6/70	3.5	30	-	30	-
	120	1/66	4.8	800	160	960	-
	125	12/67	7.0	150	220	370	-
	200	3/64	7.5	803	274	1077	-
	1015	2/71	8.5	-	-	-	-
	1200	2/66	9.8	230	90	320	-
	1250	7/68	12.0	129	55	184	-
	2015	1/71	13.4	4	-	4	-
	2200	1/66	18.0	125	59	184	-
	3200	2/70	24.0	40	25	65	-
	4200	8/68	32.5	18	2	20	-
	8200	12/68	50.0	12	3	15	-
	Series 2000: 2020	2/73	2.1	49	6	55	-
	2030,/A	1/73	2.1	11	3	14	-

NAME OF MANUFACTURER	NAME OF COMPUTER	DATE OF FIRST INSTALLATION	AVERAGE OR RANGE OF MONTHLY RENTAL $(000)	NUMBER OF INSTALLATIONS In U.S.A.	Outside U.S.A.	In World	NUMBER OF UNFILLED ORDERS
Honeywell (cont.)	2040,/A	4/72	3.1	86	24	110	-
	2050,/A	4/72	4.3	50	20	70	-
	2060	4/72	7.0-66.0	25	8	33	-
	2070	5/72	12.0-66.0	20	1	21	-
	2088	4/72	27.0-55.0	2	1	3	-
	Series 6000: 6025	3/71	20.0	1	-	1	-
	- 6030/6040	7/71	20.0-60.0	1	11	12	-
	6050/6060	7/71	20.0-60.0	7	44	51	-
	6070/6080/6180	7/71	20.0-100.0	5	1	6	-
	G405/410	2/68	5.5-10.0	38	5	43	-
	G415/420	5/64	7.3-23.0	148	300	448	-
	G425/430	6/64	9.6-17.0	93	75	168	-
	G435/440	9/65	14.0-25.0	55	31	86	-
	G615	3/69	32.0	3	11	14	-
	G625	4/65	X	23	3	26	X
	G635	5/65	47.0-100.0	41	3	44	-
	400/600	12/60	X	103	55	138	X
	G205/210/215	9/63-6/64	X	101	26	127	X
	G225-275	4/61-11/68	X	288	62	350	X
	1400/1800	1/64	X	19	11	30	X
	DDP19,21,24	5/61	X	89	14	93	X
	DDP112,116,124	4/65	X	376	124	500	X
	DDP224,290	3/65	X	57	7	64	X
	DDP316	6/69	0.6	408	45	453	-
	DDP324	7/68	4.0	7	0	7	-
	DDP416	6/67	X	182	168	350	X
	DDP516	9/66	1.2	769	131	900	-
	632	12/68	3.2	8	4	12	-
	716	6/72	0.8	3	0	3	-
	1602	-	-	-	-	-	-
	1642	-	-	-	-	-	-
	1644	-	-	-	-	-	-
	1646	-	-	-	-	-	-
	1648,/A	11/68	12.0	-	-	20	-
	GE-PAC 3010	5/70	X	25	1	26	X
	GE-PAC 4010	10/70	6.0	30	4	20	X
	GE-PAC 4020	2/67	X	200	60	260	X
	GE-PAC 4040	8/64	X	45	20	65	X
	GE-PAC 4050	12/66	X	23	2	25	X
	GE-PAC 4060	6/65	X	18	2	20	X

ACROSS THE EDITOR'S DESK – *Continued from page 36*

The laser-computer measurement system was part of a two-ton payload launched from the National Center for Atmospheric Research, Palestine, Texas. This balloon facility is operated for scientific investigations by the National Science Foundation.

In the experiments conducted by Patel, E. G. Burkhardt, and C. A. Lambert, measurements of nitric oxide concentration at 92,000 feet were made before, during and after sunrise to determine the influence of sunlight. The measured daytime value of about 4 parts per billion was more than 20 times greater than the nighttime value. This data now gives the physical scientists and chemists the opportunity to model the stratospheric chemical reactions more accurately.

The laser-computer system used to make the measurements was originally developed by Bell Labs to monitor pollution on ground. The data obtained during the balloon flight were transmitted down to ground via high frequency radio telemetry link. The Bell System is interested in finding better ways to detect and eliminate sources of air pollution, not only to monitor its own vehicles and buildings, but also to protect the long term operation of sensitive telephone switching equipment which can be adversely affected by air pollution.

One of the unique features of the laser-computer gas spectroscopy system is its ability to identify many pollutants with no change in instrumentation. Thus, it was possible for the Bell Labs scientists to measure the water vapor concentration in the stratosphere, which is of interest in some of the chemical reactions important to the stratospheric chemical balance. Most of the traditional gas analysis techniques are time consuming and are performed with large samples of gas.

Patel's group plans future flights later this year to measure the variation of nitric oxide as the sun sets. The initial balloon flight measured the decomposition of nitrogen dioxide by the sun's ultraviolet radiation. At night, when ultraviolet radiation from the sun is absent, nitric oxide is believed to recombine with ozone to produce nitrogen dioxide, according to Patel. The future flights are expected to verify this process.

CRANDON/ANDERSON – *Continued from page 22*

tions comprise the programming "clean room."

Quantification will be an elusive solution for a long time. Much that goes wrong is attributable to human failure where complexity—which depends on much more than size—is the overwhelming factor. □

Editorial Note: For a list of some 75 references and texts on this subject, please inquire of the authors. We regret that we do not have space for this information in this issue of *Computers and People.*

CALENDAR OF COMING EVENTS

July 15-19, 1974: 1974 Conference on Frontiers in Education, City University, London, England / contact: Conf. Dept., Institution of Electrical Engineers, Savoy Place, London, England WC2R 0BL

July 18-19, 1974: 12th Annual Computer Personnel Research Conf., Univ. of Colorado, Boulder, Colo. / contact: ACM, 1133 Ave. of the Americas, New York, NY 10036

July 23-26, 1974: Circuit Theory & Design, IEE, London, England / contact: IEE, Savoy Pl., London WC2R 0BL, England

July 23-26, 1974: International Computer Exposition for Latin America, Maria Isabel-Sheraton Hotel, Mexico City, Mexico / contact: Seymour A. Robbins, National Expositions Co., Inc., 14 W. 40th St., New York, NY 10018

July 29-Aug. 1, 1974: 2nd Jerusalem Conference on Information Technology, Jerusalem, Israel / contact: Prof. C. C. Gotlieb, Dept. of Computer Science, University of Toronto, Toronto, Ontario, Canada M5S1A7

Aug. 5-10, 1974: IFIP Congress 74, St. Erik's Fairgrounds, Stockholm, Sweden / contact: U.S. Committee for IFIP Congress 74, Box 426, New Canaan, CT 06840

Aug. 5-10, 1974: Medinfo 74, St. Erik's Fairgrounds, Stockholm, Sweden / contact: Frank E. Heart, Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, MA 02138

Aug. 12-14, 1974: International Conf. on Computer Communication—74, Stockholm, Sweden / contact: Mr. J. Borje Hansson, Sec. Gen. of the Conf., Program Exec. Committee, Central Administration of Swedish, Telecommunications (Gdk), S—123 86 FARSTA, Sweden

Aug. 13-15, 1974: Assoc. for the Development of Computer-Based Instructional Systems' Summer 1974 Conference, Western Washington State College, Bellingham, Wash. / contact: Ms. Ruann Pengov, 076 Health Sciences Library, The Ohio State Univ., 376 W. Tenth Ave., Columbus, OH 43210

Aug. 21-23, 1974: Engineering in the Ocean Environment International Conf., Nova Scotian Hotel, Halifax, Nova Scotia / contact: O. K. Gashus, EE Dept., Nova Scotia Tech. Coll., POB 100, Halifax, N.S., Canada

Sept. 1974: 2nd Symposium IFAC/IFIP/IFORS, Cote d'Azur, France / contact: AFCET, Secretariat des Congres, Universite Paris IX, Dauphine 75775 Paris Cedex 16, France

Sept. 8-10, 1974: 6th International Conference on Urban Transportation, Pittsburgh, Penna. / contact: John W. Besanceney, Pittsburgh Convention & Visitors Bureau, P.O. Box 2149, Pittsburgh, PA 15230

Sept. 9-12, 1974: INFO 74, Coliseum, New York, N.Y. / contact: Clapp & Poliak, Inc., 245 Park Ave., New York, NY 10017

Sept. 10-12, 1974: Fall COMPCON 74, 9th Annual IEEE Computer Society International Conference, Mayflower Hotel, Washington, D.C. / contact: COMPCON 74 Fall, P.O. Box 639 "B", Silver Spring, MD 20901

Sept. 11-13, 1974: 6th Annual Conference of Society for Management Information Systems, Fairmont Hotel, San Francisco, Calif. / contact: SMIS, 221 N. La Salle St., Chicago, IL 60601

Oct. 2-4, 1974: Systems, Man & Cybernetics Society Annual Meeting, Fairmont Hotel, Dallas, Tex. / contact: A. P. Sage, Southern Methodist Univ., Inst. of Tech., EE Dept., Dallas, TX 75275

Oct. 8-9, 1974: 8th Annual Instrumentation and Computer Fair, Washington, D.C. / contact: Robert E. Harar, Instrumentation Fair, Inc., 5012 Herzel Place, Beltsville, MD 20705

Oct. 9-10, 1974: 1974 Conference on Display Devices and Systems, Statler Hilton Hotel, New York, N.Y. / contact: Society for Information Display, 654 N. Sepulveda Blvd., Los Angeles, CA 90049

Oct. 14-16, 1974: 15th Annual Symposium on Switching and Automata Theory, New Orleans, La. / contact: Prof. Fred Hosch, Dept. of Computer Science, Louisiana State Univ. at New Orleans, Lake Front, New Orleans, LA 70122

Oct. 16-18, 1974: 46th National Meeting of Operations Research Society of America, and 21st International Meeting of The Institute of Management Sciences, Americana and El San Juan Hotels, San Juan, Puerto Rico / contact: Rafael Fernandez, P.O. Box 2342, Mayaguez, Puerto Rico 00708

Oct. 16-18, 1974: 9th Annual Iomec Users Assoc. Conference and Seminars, Place du Puis Holiday Inn, Montreal, Canada / contact: Glenn Lutat, IUA, 3300 Scott Blvd., Santa Clara, CA 95050

Oct. 16-18, 1974: 30th Annual National Electronics Conf. and Exhibition, Hyatt Regency O'Hare, Chicago, Ill. / contact: National Electronics Conf., Inc., Oakbrook Executive Plaza 1, 1301 W. 22nd St., Oak Brook, IL 60521

Oct. 21-23, 1974: 1974 International Symposium, International Society for Hybrid Microelectronics, Sheraton-Boston Hotel, Boston, Mass. / contact: ISHM, P.O. Box 3255, Montgomery, AL 36109

Oct. 27-31, 1974: Information Theory International Symposium, Center for Continuing Education, Notre Dame Univ., Notre Dame, Ind. / contact: J. L. Massey, Dept. of EE, Univ. of Notre Dame, Notre Dame, IN 46556

Oct. 29-31, 1974: 28th Northeast Electronics Research and Engineering Meeting, Sheraton-Boston Hotel and Hynes Auditorium, Boston, Mass. / contact: S. Swartz, Nerem Business Office, 31 Channing St., Newton, MA 02158

Oct. 31-Nov. 1, 1974: Canadian Symposium on Communications, Queen Elizabeth Hotel, Montreal, Quebec / contact: George Armitage, IEEE Canadian Region Office, 7061 Yonge St., Thornhill, Ontario L3T 2A6, Canada

Nov. 5-8, 1974: 1974 Fall DECUS Symposium, Town and Country Hotel, San Diego, Calif. / contact: DECUS, 146 Main St., Maynard, MA 01754

Nov. 12-14, 1974: 5th Annual Canadian Computer Show, Place Bonaventure, Montreal, Canada / contact: Ray Argyle, The Argyle Syndicate, Ltd., 47 Colborne St., Ste. 301, Toronto, Ontario, Canada M5E 1E3

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