SCIENCE & TECHNOLOGY

June, 1970

Vol. 19, No. 6

computers and automation

Computer Simulates Working of Inner Ear

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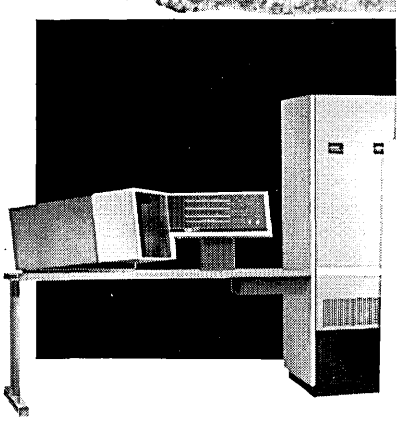

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The 16th Annual Edition of the

COMPUTER DIRECTORY AND BUYERS' GUIDE

will be published jointly by
The New York Times Book and Educational Division and Computers and Automation
as the Midyear issue of Computers and Automation (in soft cover)
and as Volume 4 of WHO'S WHO IN COMPUTERS AND DATA PROCESSING (in hard cover)

CONTENTS

- A Roster of Organizations in the Electronic Computing and Data Processing Industry
- A Buyers' Guide to Products and Services in the Electronic Computing and Data Processing Field
- Special Geographic Rosters of:
    1. Organizations selling computing and data processing services
    2. Organizations selling commercial time-shared computing services
    3. Commercial organizations offering courses, seminars or instruction in computing, programming, or systems
    4. Organizations selling consulting services to the computer field
    5. Organizations offering computing and data processing equipment on a lease basis
    6. Organizations selling software or computer programs
- Characteristics of General Purpose Digital and Analog Computers
- A Roster of College and University Computer Centers
- Rosters of Computer Associations and Computer Users' Groups
- A Roster of Programming Languages
- A List of Over 1700 Applications of Electronic Computing and Data Processing Equipment
- A World Computer Census
- A Summary of Binary Arithmetic and Related Number Systems
- Some Binary, Octal, and Decimal Conversion Tables
- A Summary of Boolean Algebra (Contrasted with Elementary Algebra)
- Ranges of Current Computer Speeds
- A Glossary of Key Ideas in the Computer Field

...and much more

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Letters To The Editor

Complimentary Subscriptions

For more than ten years while I was Head Librarian at the AiResearch Manufacturing Company's Phoenix plant, your company very kindly sent a subscription of ***Computers and Automation*** to us in the Library. It was made available to all employees. A large number of its articles were indexed, and it was regularly bound for permanent retention on our shelves. Your kindness was appreciated by the staff in the Library and by the many readers in the company's several engineering groups.

My son has recently been assigned duty as Commanding Officer of Naval Shore Electronics Engineering Activity in Japan. He has told me that he is setting up an engineering science library for the use of the staff immediately under his direction and for use by readers throughout the area.

Would it be possible for you to send him a courtesy subscription?

MRS. ALBERT H. MACKENZIE
1632 E. Claremont
Phoenix, Ariz. 85016

Ed. Note — We are glad that AiResearch Manufacturing Company's employees made good use of our magazine. However, it was sent to your library because it was a subscription paid for by AiResearch. As a paid-circulation magazine, we do not regularly have free or complimentary or controlled subscriptions. We would be glad to welcome your son as a regular paid subscriber.

March Front Cover — Comments

I want to tell you how much I enjoyed your front cover picture of children learning the computer by teleprinter and the follow-up story on page 50 of your March 1970 issue. It is very refreshing. This picture depicts the real meaning of data processing to me. The honest-to-goodness hard work it is and a very satisfying and meaningful contribution to society computers are.

Being a woman, in data processing, I've been embarrassed at many pictures shown in magazines advertising data processing machines by the way the models show various parts of their bodies so that you cannot get your mind on the subject for the intrusion of the model.

Now, maybe for men, perhaps this is okay, but there are other women in data processing too who also read these magazines and I'm sure some of them have been embarrassed for our sex as I have. I'm not knocking pretty girls for advertisements, for I'm sure they do a lot of selling.

We, as adults, should lean more toward building a desire for all to learn and work toward a better future of good morale and honest labor and lean away from the "poor books, movies and bad photos which adorn our magazines" syndrome.

It's a good feeling to know your company is portraying something good and wholesome and right for this generation to work toward. We have so little of it nowadays.

I commend you.

MRS. IRENE S. MCDOWELL
Box 3051
Shawnee, Kansas 66203

Ed. Note — Thank you for your kind comments. Your letter is but one more indication that the machine will never totally replace man — or woman!

The February Issue

I thought you might like to know how much I enjoyed three of the articles in your February, 1970 issue. I refer to: "The Tale of Crazy Freddie" [page 14], "A Hypothetical Interview Between the President of a Computer Software Company and a Patent Attorney Specializing in Protection of Computer Programs" [page 16], and "The Internal Revenue Service Looks at Computer Software" [page 20].

The "Crazy Freddie" article was especially amusing, but it also made its point very clear. The situation has really changed now that patenting of programs is possible and IBM has unbundled.

CHARLES FORSYTHE
Mutual Life Ins. Co. of New York
1740 Broadway (55th St.)
New York, NY 10019

Numbles

Well, you finally came through, ole buddy; you issued a Numble that was, to a degree, somewhat more worthy of your readers' talents. The message contained in Numble 703 is: "He Who Thinks Well, Need Not Think Much."

Time to solve required about 0.3 X 10^{-3} years, due to omission of the intermediate letters of the multiplication part.

G. P. PETERSEN
/s/ Numble Master
General Electric Co.
P. O. Box 11508
St. Petersburg, Fla. 33733

computers and automation

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computers and automation

Vol. 19, No. 6 — June, 1970

The magazine of the design, applications, and implications of information processing systems.

Special Feature:

Computers and Medicine

16 REAL-TIME ANALYSIS OF ELECTROCARDIOGRAMS BY COMPUTER
by Dr. G. A. Kien, T. V. Balacek, L. L. Linka, and W. V. Murphy
How an on-line multiprocessing computer facility which analyzes electrocardiograms can relieve physicians of time-consuming work, eliminate possible errors, and decrease variability in interpretations.

19 A CASE HISTORY: IMPLEMENTATION OF A COMPUTER-BASED PATIENT ACCOUNTING SYSTEM
by J. Peter Singer and Frank A. Petro
The planning, installation, and follow-up for the implementation of the Shared Hospital Accounting System (SHAS) at Stanford University Hospital.

24 COMPUTERS IN THE LABORATORY
by Moses M. Berlin
What factors determine the success of the use of computers in the laboratory?

28 THE HOSPITAL COMPUTER COMES OF AGE
by Morton Ruderman and A. Neil Pappalardo
How the evolution of the computerized hospital can be hastened by the delivery of total computer services to the hospital by commercial companies.

33 THE ROLE OF ADMINISTRATORS AND PHYSICIANS IN THE DEVELOPMENT OF HOSPITAL INFORMATION SYSTEMS
by Geoffrey G. Jackson
Why — and how — doctors and hospital administrators should help coordinate, automate, and control their hospital information systems.

36 In the Year 2001: SURGERY BY COMPUTER
by Dr. Robert Fondiller
An imagined tale in which Mr. Star Bright (a human) receives a new kidney with the assistance of Dr. Sawbones (a computer-controlled robot) — with some implications about the not-too-distant future of computers and medicine.

Regular Features

Editorial

6 The Limitations of Computers, by Edmund C. Berkeley

C&A Worldwide

23 Report from Great Britain, by Ted Schoeters

The Profession of Information Engineer and His Bridges to Society

41 What We Must Do, by John Platt

Multi-Access Forum

8 "The Invasion of Privacy" — Comments, by Richard W. Rosenbaum, F. R. Montgomery, and the Editor

9 "Computers, Language, and Reality" — Comment, by Eric Brodheim

9 To Help Liberate One's Mind from Newspeak, by Edmund C. Berkeley

14 Apollo 13: A Lesson Re Safeguard, by Daniel D. McCracken

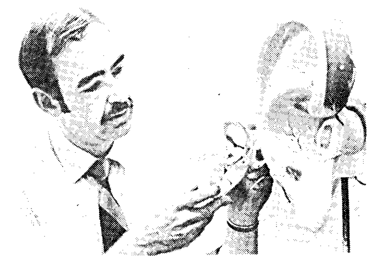
14 "The Assassination of President John F. Kennedy: The Application of Computers to the Photographic Evidence" — Comment, by Charlene Hofer

14 The Case for the Awareness of the Social Implications of Computers is Presented to the Candidates for National ACM Office, by Paul Armer, William S. Dorn, and Daniel D. McCracken

15 Addendum to "Guidelines for Contracting for Computer Related Services"

22 Postage Stamps Designed by Computer in the Netherlands, by Erik Albarda

22 Correction



The front cover picture shows Dr. Alfred Inselberg, a mathematician at IBM's Los Angeles Scientific Center, with a model of the human ear. Dr. Inselberg has programmed a computer to simulate the intricate workings of the inner ear; his purpose is to help specialists learn more about how it works. For more information, see page 49.

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. SEE PAGE 3.

Departments

48 Across the Editor's Desk — Computing and Data Processing Newsletter

62 Advertising Index

7 As We Go To Press

61 Calendar of Coming Events

62 Classified Advertisements

4 Letters to the Editor

60 Monthly Computer Census

58 New Contracts

59 New Installations

40 Numbles by Neil Macdonald

35 Problem Corner by Walter Penney, CDP

27 Punch Lines . . .

The Limitations of Computers

Every now and then, people who are as excited about computers as we are and who work as hard and concentratedly in the computer field as we do, should stop and look around them — and remind themselves of the limitations of computers: what computers cannot do and what computers cannot be expected to do.

I believe that the computer is one of the most remarkable machines that human beings have ever designed — but it is less remarkable than the machine designed by evolution that most of us carry around in our heads and by means of which we do our thinking and deciding, our recognizing and talking, etc.

I believe that a computer of the most modern generation, in which electronic components are packed together almost microscopically, is a fantastic device — but the packing density of nerve connections in the human brain is far more remarkable.

In Poughkeepsie, N.Y., I have watched Gardner-Denver wiring machines programmed by an existing computer wire up the pins in the back frames of another computer coming into existence. But the way in which new human beings come into existence and grow useful brains, subject to the directions of mothers and fathers, teachers and society, is far more remarkable still. It really will be an extraordinary day when human beings can manufacture (not using the regular process) an arbitrary computer with versatile general programming by causing a little artificial seed of protein and nucleic acids to grow.

Not only are there serious limitations in the design and construction and programming of computers, but there are serious limitations in the powers of computers.

I can tell a boy in a telegraph office (though there are very few such boys left any more) to go to such and such an address and deliver such and such telegram and to use his common sense about how to get there. But I cannot give any robot programmed by any computer such simple and direct instructions.

I do not know how to program a mobile computer equipped with a photoelectric eye, so that it will move up to a traffic intersection, determine which light is the traffic light, wait for it to turn green, and then cross through the intersection, without hitting any jaywalking pedestrian or erring vehicle.

And I cannot imagine anyone being able for years to come to program a computer so that it will act like a newspaper reporter: visiting a place where an important event has happened (such as the crash of an airplane loaded with some hydrogen bombs that did not explode, as in Palomares, Spain, 1966); talk to various persons nearby; put the information together; and send back a series of sensible dispatches for publication in a city newspaper.

We have now had our own DEC PDP-9 computer here in our office for just about two years. Its entire duties are research, development, instruction, training, education — and changing people's minds about computers. Of these duties, the most useful and exciting for us is the last one — changing people's minds, showing them that something thought not possible for a computer to do is actually possible. For every now and then we meet a person who thinks that computers have created more problems than they've solved; or who is baffled at the magic black box; or who is annoyed that he had received a computerized bill for something he did not buy. We seize the opportunity to take him to our computer, and let him there experiment with some interesting and entertaining interaction between himself and the computer.

But this machine and its programs are still acutely and inevitably susceptible to a large number of undesirable variations and factors. For example, every now and then, the fuse no. 2 from the bottom located in the back panel blows (the rate about once in ten days). And neither we nor the careful and intelligent servicemen who look after our computer are able to deal with this intermittent bug — for it happens too rarely for any of us to track it down. So our only solution for the time being is to keep extra fuses on hand — and if the machine starts to have a temper, be disobedient, or be obstinate, we go look at the second fuse from the bottom and see if it has blown.

The outcome of all this experience, and the philosophy derived therefrom, is essentially this:

1. The computer-assisted man and the man-assisted computer have a reasonable chance of doing something useful.
2. A man by himself has a reasonable chance of doing something useful.
3. But a computer by itself — watch out!

Edmund C. Berkeley
Editor

THE ASSASSINATION OF PRESIDENT JOHN F. KENNEDY: THE APPLICATION OF COMPUTERS TO THE PHOTOGRAPHIC EVIDENCE

— REPORT NO. 1

The May 1970 issue of Computers and Automation contained the longest and probably one of the most important articles that we have ever published, "The Assassination of President Kennedy: The Application of Computers to the Photographic Evidence". In this article Richard E. Sprague, President, Personal Data Services, Hartsdale, N.Y., stated that an analysis of the evidence proved:

- that the Warren Commission conclusions (that Lee Harvey Oswald was the sole assassin and that there was no conspiracy) are false;
- that there were at least four gunmen firing from four locations, none of which was Oswald;
- that the conspiracy to kill Kennedy involved over 50 persons (of whom several are identified in the article), including members of the Dallas police, and elements of the Central Intelligence Agency of the United States.

The evidence published in this article included eleven important photographs, of which one shows Jim Hicks, who admitted he was the radio communicator among the firing teams at Dealey Plaza, with his radio transmitter in his back left pocket. The article also included a tabulation of over 500 photographs (counting a movie sequence as one photo) taken in and around Dealey Plaza, Dallas, Texas, Nov. 22, 1963, at the time of President Kennedy's assassination and shortly thereafter.

The assassination of President Kennedy was the most photographed murder in history. Of the 500 photographs, the Warren Commission looked at 26. Both a spatial chart and a timing chart of the events and photographs are included in the article.

Sprague, a computer professional for over 24 years, has, as an avocation, studied both the old and new evidence for over 6 years, and has analyzed over 400 of the 500 photographs. The work in computerized analysis of over 300 still photos and over 25,000 frames of movie sequences has been started.

This article has drawn an unusual amount of attention. Some of the attention it has received includes:

- a United Press dispatch on May 1;
- an Associated Press dispatch on May 1;
- more than 20 interviews of the author over the telephone by radio and TV stations, resulting in many broadcasts;
- a considerable number of letters, requests, and orders in regard to the article; and
- publication of newspaper accounts in at least 16 newspapers.

The list of these newspapers so far is the following:

- Birmingham News, Birmingham, Ala., May 2
- Boston Globe, Boston, Mass., May 1
- Detroit Free Press, Detroit, Mich., May 2
- Fort Worth Star Telegram, Fort Worth, Texas, May 2
- Ledger Star, Norfolk, Va., May 2
- Milwaukee Journal, Milwaukee, Wisc., May 1
- Minneapolis Star, Minneapolis, Minn., May 1
- Nashville Banner, Nashville, Tenn., May 1
- News-Free Press, Chattanooga, Tenn., May 2
- Philadelphia Inquirer, Phila., Pa., May 3
- Reporter Dispatch, White Plains, N.Y., May 2
- San Francisco Examiner, San Francisco, Calif., May 2
- Staten Island Advance, Staten Island, N.Y., May 2
- Tennesseean, Nashville, Tenn., May 3
- Washington Post, Washington, D.C., May 3
- York Gazette and Daily, York, Pa., May 6

Conspicuous by their absence are newspapers of New York, Los Angeles, and Chicago.

Computers and Automation has been informed that agents of the Central Intelligence Agency of the United States have been installed in these cities (and in other places) to prevent many kinds of news about political assassinations from being published in these cities and elsewhere. It is certainly interesting to see the confirmation of this quite unproved hypothesis by the failure to publish any information about the article in almost all major newspapers of New York, Los Angeles, and Chicago.

AS WE GO TO PRESS

HONEYWELL, INC. AND GENERAL ELECTRIC CO. HAVE AGREED IN PRINCIPLE TO FORM A NEW SUBSIDIARY which will include the present Honeywell computer operations and General Electric business computer equipment operations. Honeywell will own 82 1/2% of the subsidiary and GE will own 18 1/2%; the new company will be managed by Honeywell. The proposed agreement covers both domestic and international computer equipment interests, including the transfer to the new company of the GE shares in the Bull-GE companies.

In announcing the new company, Honeywell Board Chairman James H. Binger said: "The combined customer base is one of the most significant aspects of the transaction. We are dedicated to using the full resources of both organizations to enhance customer support worldwide." Additional announcements of plans to combine the computer operations of Honeywell and GE, which on a worldwide basis are now about equal in size, are expected.

SENATE HEARINGS ARE UNDERWAY ON A BILL WHICH WOULD SEVERELY LIMIT THE NON-BANKING ACTIVITIES OF ONE-BANK HOLDING COMPANIES. If the bill (H.R. 6778) should pass, it would be considered a victory for the Association of Data Processing Service Organizations (ADAPSO), which has long been seeking a means to prevent banks from selling EDP services to the public. ADAPSO officials maintain that the federal and state charters under which banks are organized gives them an unfair competitive advantage.

HERBERT R. J. GROSCH HAS BEEN REPLACED AS DIRECTOR OF THE CENTER FOR COMPUTER SCIENCES AND TECHNOLOGY AT THE NATIONAL BUREAU OF STANDARDS by James P. Nigro, a former deputy. Grosch, who during his term as Director has been involved in standards disputes with several leading computer companies, will retain the title of Senior Research Fellow.

MULTI-ACCESS FORUM

"THE INVASION OF PRIVACY" — COMMENTS

I. From Richard W. Rosenbaum
Systems and Industrial Relations Research
2618 Colonial Way
Bloomfield Hills, Mich. 48013

You have given your readers an unexpected and valuable fringe benefit through your enlightened "Invasion of Privacy" editorial in the April issue of your magazine.

I, for one, feel more pity than contempt for the poor paranoids who devote the major part of their miserable lives earning a subsistence collecting private trivia.

The most depressing element of the whole issue, in my judgment, is that Americans allow these psychopathic sores on the tail of progress to be supported out of the public treasury.

Hooray for your unstinting courage.

II. From F. R. Montgomery
7615 E. 53rd
Indianapolis, Ind. 46226

I read with deep interest your April editorial on "The Invasion of Privacy." This subject has been one to which I have given serious consideration for several years.

Having spent several years as a member of the Armed Forces, having owned and operated various automobiles since 1937, having held (or maybe it holds me) a Social Security Account Number since 1939, having been the recipient of many credit cards (some unsolicited), and having used credit to purchase a home, cars, furniture, etc. — I can realize that the wealth of information concerning my private affairs that is in the hands of government and other agencies is not too desirable. Based upon this realization, I believe constructive action needs to be taken to assure that these files are not misused.

Your editorial does make some constructive suggestions in regard to "safe-guarding privacy and giving the American people rights"; however you have used the main portion of your editorial to blast the FBI, to attempt to impose your political thinking about Vietnam on your subscribers, and to suggest ways to confuse any data bank.

I agree with part of your editorial, but, as you have realized by now, I disagree with much of it. I especially would not consider any list of potential Fifth Columnists (the ones to be placed in concentration camps in the event of a national emergency) as being repugnant. If you had made any study of Fifth Column activities in the Central European nations during the 1930's and 1940's, then surely you would realize that we need this safeguard. The matter of a law to force notification being made to individuals placed on such a list, to give them opportunity to refute the reasons for their being placed thereon, which could result in possibly their name being taken off, I am all for.

Considering the fact that you are the Editor, and as such are in a position to express certain views, why not use your position to suggest constructive change? I receive the indication from this editorial that you are caught up in the thinking of many present-day radicals that the only way to change is by means of destruction; this, therefore, would suggest that you are incapable of suggesting constructive change. I hope I am wrong in this thought, and that you will come up with some constructive suggestions in this area!

III. From the Editor

The invasion of privacy is being greatly hastened by the advent of large computerized data banks, combined with the interests of two kinds of government: efficient government whether or not dictatorial, and dictatorial government even if not efficient.

Of all subjects connected with computers, the invasion of privacy appears to be stirring the most interest, attention, and concern, because everyone has his privacy at stake — and that is very valuable to him.

I do not believe, nor do I seek to imply, that the only way to bring about change is through destructive changes. In the April editorial "The Invasion of Privacy," for example, we urge citizens to seek constructive change: to seek the passage of laws regulating the control and use of any personal data file maintained by any agency, governmental or not. We suggest another constructive change: that they can prevent additional information being collected about them by rejecting unsolicited credit cards. And if constructive changes fail to happen, we suggest (only slightly with tongue-in-cheek) ways to confuse any data bank.

When some part of the government of the United States advocates a single, national, computerized data bank, with promised safeguards, this raises questions in the minds of many citizens. Many people have lost faith in the statements and promises of the United States government because of the stream of untruths (or covers, or credibility gap, or lies) which the government has told in the years 1960 to the present — from the U 2 flight over the Soviet Union by the CIA pilot Gary Francis Powers under President Dwight D. Eisenhower, to the reasons now offered for the United States invasion of Cambodia under President Richard Nixon. There are other people who are still accepting the statements and promises of the United States government.

In regard to the inter-relation of computers and privacy, *Computers and Automation* welcomes and tries to give a fair hearing to all points of view and all reasonable suggestions that need to be considered in coming to rational proposals and safe legislation, in the interests of all people of the United States. □

"COMPUTERS, LANGUAGE, AND REALITY" — COMMENT

Eric Brodheim, President
PDA Systems, Inc.
12 E. 86th St.
New York, N.Y. 10028

Your editorial on "Computers, Language, and Reality" [March, 1970 issue] re-emphasizes the fact that language is a very ambiguous method of expressing a thought or concept. This is not only a hurdle to be surmounted in effectively understanding the operation of computers, but is a root cause of the seemingly irrational behavior that we ascribe to other nations.

While we, as human beings, tend to think of an algebraic symbol as a variable, a computer will think of that symbol as a storage location. A high-level language programmer might be oblivious to this fundamental distinction and rely on the compiler to effectively translate from his thought process to the computer's. If the compiler has been well designed and if the program is "routine", the chances are that this will work. However, as everyone who has dealt with computers has learned (usually the hard way), relying on translators without also understanding the "thinking" process of the computer is very dangerous, especially when an "unusual" program is involved.

This is a very good analogy to human experience. We tend to assume that a thought expressed in English by a person brought up under the Western system can be translated into (say) Russian and still convey the original thought. Given a reasonably competent interpreter and "routine" conversation, such as in barter, discussion of the weather, etc., this is true.

However, once the subject matter switches to abstract topics, such as "peace", this process breaks down. To us peace implies the absence of war. To the Russians it means the tranquility that will result after the (inevitable) triumph of socialism. Perhaps the closest in the Russian vocabulary to the Western concept of "peace" is "peaceful coexistence" — a state in which the process of true "peace" is held in abeyance. Therefore, we can both truly insist that our desire is peace and yet mean almost contradictory things. Therefore, when we continually accuse each other of being "irrational", all too often it is not irrationality but lack of effective understanding that is the cause.

The above point is certainly true in the case of the computer. All too often the computer is faithfully executing its instructions, as the computer understands them, while the programmer insists that it is not doing what he instructed it to do, as he understands it. All too often both will be right. The trouble is that the programmer is not thinking like the computer but as himself. Similarly, when we wish to effectively communicate with people of a different background, we can learn a lesson from our computer experience: we must learn to think as they do.

Once we do that, perhaps our frustration, as with the computer, will diminish, and the ***effective*** interchange of ideas, rather than words, can commence. Failure to resolve this difficulty will have the same effects as with a computer. As the level of the required communication rises without the mechanics of communication being resolved, the level of frustration and of mistrust will rise until efforts at communication will cease — alas, very possibly for the wrong reason. □

TO HELP LIBERATE ONE'S MIND FROM NEWSPEAK

Edmund C. Berkeley, Editor
Computers and Automation
815 Washington St.
Newtonville, Mass. 02160

In the editorial "Computers, Language, and Reality" in the March 1970 issue of ***Computers and Automation,*** I proposed the thesis that we human beings greatly need more adaptable, less conventional patterns in our minds so as to think better and to escape limitations from culture, history, language, propaganda, etc. And I quoted George Orwell's remark in ***1984:***

> The purpose of Newspeak was not only to provide a medium of expression for the world view and mental habits proper to the devotees of Ingsoc, but to make all other modes of thought impossible.

I also said that when a computer professional enlists himself in the service of society and humanity one of the questions he is faced with is:

> How do I escape from the provincial world-view, mental habits, cultural conventions, biases, "Newspeak", etc., of my own country, community, and associations?

Referring to a list of a dozen books that I had thought useful to help liberate one's mind from the overwhelming propaganda and Newspeak of today, I offered a copy of the list to readers who circled a certain number.

Over 300 readers have asked for this list. With evidence of that much interest, it is appropriate to publish the bibliography (with some notes) in ***Computers and Automation*** rather than send individual copies through the mail to the persons who have requested it.

Following is the list. Some of these books are, in the edition referred to, out of print, but may be back in print in another edition.

1. In General

Russell, Bertrand / ***Sceptical Essays*** / W. W. Norton and Company, Inc., 70 Fifth Ave., New York, N.Y. 10011 / 1928, hardbound, $?

Bertrand Russell, of course, was one of the greatest men of the 20th century. This book of his sheds a great deal of light in many directions. Take for one example this quotation:

> A hundred years ago there lived a philosopher named Jeremy Bentham, who was universally recognized to be a very wicked man. I remember to this day the first time that I came across his name when I was a boy. It was in a statement by Rev. Sydney Smith to the effect that Bentham thought people ought to make soup of their dead grandmothers. This practice seemed to me as undesirable from a culinary point of view as from a moral point of view, and I therefore conceived a bad opinion of Bentham. Long afterwards, I discovered that the statement was one of those reckless lies in which respectable people are wont to indulge in the interests of virtue. I also discovered what was the really serious charge against him: that he deemed a "good" man as a man who does good. This definition, as the reader will perceive

at once if he is right-minded, is subversive of all true morality. . . .

The 18 chapters include: On the Value of Scepticism; Is Science Superstitious?; Can Men be Rational?; The Harm that Good Men Do; The Recrudescence of Puritanism; Free Thought and Official Propaganda; the Danger of Creed Wars.

Flesch, Rudolf / *The Art of Clear Thinking* / Harper and Brothers, 49 East 33 St., New York, N.Y. 10016 / 1951, hardbound, 212 pp, $2.75

This is an interesting, useful, and original book filled with fresh and stimulating examples. Part of the book gives good techniques for spotting fallacies, analyzing propaganda, and arriving at the truth.

The 21 chapters include: Do You See What I See?; Danger — Language at Work; The Pursuit of Translation; How Not to be Bamboozled; Why Argue?; The More or Less Scientific Method; The Harnessing of Chance; Thinking Begins at Home; Freedom from Error?

Little, Winston W., W. Harold Wilson, and W. Edgar Moore / *Applied Logic* / Houghton Mifflin Co., 2 Park St., Boston, Mass. 02108 / 1952, hardbound, 351 pp, $?

> This text is the outgrowth of long experimentation with a course in effective thinking, which has been for nineteen years an integral part of the program of general education at the University of Florida. . . .
>
> The purpose of this text is to help you improve your thinking. Thinking is effective when it is based on adequate evidence, when it follows sound procedures and when it produces satisfactory results in the form of problems solved or sound decisions made.

Part 1 (pages 1 to 62) contains a useful, interesting, and important discussion of 38 fallacies, many of which have standard names; all of these fallacies are left out of discussion in courses in symbolic logic, Boolean algebra, etc.

Beardsley, Monroe C. / *Thinking Straight: Principles of Reasoning for Readers and Writers:* Second Edition / Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632 / 1956, softbound, 332 pp, $?

> If anything is to be found out, whether positive or negative — if any progress is to be made toward dealing with the unpleasant and dangerous situation that started the whole thing off [smog is the sample situation the author is discussing] — it is evidently going to take a good deal of thinking. . . . Truth is what thinking is after. . . . Thinking is good thinking when it eventuates in knowledge.

The thirty chapters include: The Nature of Deduction; Meaning and Context; Designation and Connotation; Emotive Language; Slanted Discourse; The Appeal to Emotion. Nineteen fallacies are listed in an appendix.

Miller, George A. / *Language and Communication* / McGraw-Hill Book Company, Inc. 330 West 42 St., New York, N.Y. 10036 / 1951, hardbound, 298 pp, $?

> This book is aimed at . . . . courses in the psychology of communication. . . . The spread of information through a group of people is one of the most important social events that can occur. . . .

The chapters include: The Phonetic Approach; The Statistical Approach; Rules for Using Symbols; The Verbal Behavior of Children; Verbal Habits; Words, Sets, and Thoughts; The Social Approach. The last mentioned chapter discusses: communications nets; communication in small groups; communication in large groups; the effectiveness of mass media (including an interesting and important discussion of the measurement of propaganda); and rumor.

The author is deservedly famous, and is a past president of the American Psychological Association.

Postman, Neil and Charles Weingartner / *Teaching as a Subversive Activity* / Delacorte Press, 750 Third Ave., New York, N.Y. 10017 / 1969, hardbound, 219 pp, $?

> Our intellectual history is a chronicle of the anguish and suffering of men who tried to help their contemporaries see that some part of their fondest beliefs were misconceptions, faulty assumptions, superstitions, and even outright lies. The mileposts along the road of our intellectual development signal those points at which some person developed a new perspective, a new meaning, or a new metaphor. We have in mind a new education that would set out to cultivate just such people.

The 13 chapters include: The Inquiry Method; Pursuing Relevance; What's Worth Knowing:; Meaning Making; Languaging; New Teachers; Strategies for Survival.

2. On Propaganda, Fads, Crusades, and Lies in General

Lee, Alfred McClung, and Elizabeth Briant Lee, editors, and the Institute of Propaganda Analysis / *The Fine Art of Propaganda, A Study of Father Coughlin's Speeches* / Harcourt, Brace and Company, Inc. 757 Third Ave., New York, N.Y. 10017 / 1939, softbound, 140 pp, $0.75

> If American citizens are to have a clear understanding of conditions and what to do about them, they must be able to recognize propaganda, to analyze it, and to appraise it. . . . This study reports what scientific investigation has revealed regarding the present devices of undemocratic propagandists and the tests by which these techniques can be detected.

The chapters include: Our Bewildering Maze of Propaganda; The Tricks of the Trade; Name Calling; Glittering Generality; Transfer; Testimonial; Plain Folks; Card Stacking; Band Wagon; The Tricks in Operation.

Gardner, Martin / *Fads and Fallacies in the Name of Science:* 2nd edition / Dover Publications, Inc., 180 Varick St., New York, N.Y. 10014 / 1957, softbound, 363 pp, $1.50

The author is a well-known writer and well-regarded scientific writer. He points out his subject in his statement:

> One curious consequence of the current boom in science is the rise of the promoter of new and strange 'scientific' theories. He is riding into prominence, so to speak, on the coat-tails of reputable investigators.

The chapters include: In the Name of Science; Flying Saucers; Down with Einstein!; Dowsing Rods and Doodlebugs; Geology vs. Genesis; Lysenkoism; Apologist for Hate; Medical Cults; Food Faddists; General Semantics, Etc.; From Bumps to Handwriting.

Hoffer, Eric / *The True Believer: Thoughts on the Nature of Mass Movements* / Mentor Books, 501 Madison Ave., New York, N.Y. 10022 / 1962 (first published 1951), softbound, 160 pp, $.60

> This book deals with some peculiarities common to all mass movements . . . All mass movements generate in their adherents a readiness to die and a proclivity for united action; all of them . . . breed fanaticism, enthusiasm, fervent hope, hatred, and intolerance; all

movements . . . draw their early adherents from the same types of humanity. . . . This book passes no judgments . . . . it merely tries to explain.

There are four parts: The Appeal of Mass Movements; The Potential Converts; United Action and Self-Sacrifice; Beginning and End. The 18 chapters include: The Desire for Change; The Interchangeability of Mass Movements; Misfits; The Ambitious Facing Unlimited Opportunities; Unifying Agents.

McGaffin, William, and Erwin Knoll / ***Anything but the Truth: The Credibility Gap — How the News is Managed in Washington*** / G. P. Putnam's Sons, 200 Madison Ave., New York, N.Y. 10002 / 1968, hardbound, 250 pp, $5.95

Newspaper reporters began talking about the Credibility Gap in the mid-1960's when they were too shy to speak of lies — the lies that increasingly, alarmingly, emanate from their government through its official spokesmen, including the President of the United States. It is a new idea to Americans — the idea that the government lies to them — and one that does not go down easily. It runs counter to the American grain. It does not square with what the civic textbooks say about democracy, or what the Founding Fathers said about the people's right to know, the people's need to know.

The nine chapters include: The Gap and How it Grew; The Vanishing Press Conference; Falsehoods and Foreign Affairs; The Saigon Follies; To Close the Gap.

3. Some Particular Struggles Between Doctrine and Reality

Fulbright, J. William / ***The Arrogance of Power*** / Vintage Books, 33 West 60 St., New York, N.Y. 10023 / 1966, softbound, 264 pp, $1.95

Having done so much and succeeded so well, America is at that historical point at which a great nation is in danger of losing its perspective on what exactly is within the realm of its power and what is beyond it. Other great nations reaching this critical juncture have aspired to too much, and by overextension of effort have declined and then fallen. The causes of the malady are not entirely clear, but its recurrence is one of the uniformities of history: power tends to confuse itself with virtue, and a great nation is peculiarly susceptible to the idea that its power is a sign of God's favor, conferring upon it a special responsibility for other nations — to make them richer and happier and wiser, to remake them, that is, in its own shining image. Power confuses itself with virtue and tends also to take itself for omnipotence. . . . .

The four parts (and 11 chapters) include: The Higher Patriotism; America and Revolution; The Revolution in Latin America; The Vietnamese Revolution; The Vietnam Fallout; Reconciling Hostile Worlds;. Human Nature and International Relations.

The author is Chairman of the Senate Foreign Relations Committee of the United States Senate.

Frank, Jerome D. / ***Sanity and Survival*** / Vintage Books, 33 West 60 St., New York, N.Y. 10023 / 1967, softbound, 330 pp, $1.95

After about half a million years of effort, man has finally created the ultimate weapon. The amount of destructive power at every nation's disposal is now limited only by the amount of resources it is willing to invest in nuclear warheads and delivery systems. At least two countries have stockpiled enough fissionable material to wipe out mankind. . . .

In the past, the more weapons a nation had, the safer and more powerful it was. But today this behavior increases the insecurity of all nations. This behavior is strangely similar to that shown by many mental patients: they too try to cope with threats to their personal security by behavior that aggravates them, and do so for the same reason. . . .

One major theme . . . . is that everyone's perceptions are influenced by his world view, based on his particular cultural background, personal experience, and training. These determine which features of his environment catch his attention, the importance he attaches to them, and how he describes them to others. . . . .

The 12 chapters include: The New Predicament — Genocidal Weapons; No More War?; Why Men Kill — Biological Roots; Why Men Fight — Psychosocial Determinants; Why Nations Fight; The Image of the Enemy; Psychological Aspects of Prewar Crises and War.

The author is a distinguished psychologist and psychiatrist.

Bristol, James E., and 7 other authors / ***Anatomy of Anti-Communism:*** A Report Prepared for the Peace Education Division of the American Friends Service Committee / Hill and Wang, 141 Fifth Ave., New York, N.Y. 10010 / 1969, softbound, 138 pp, $1.50

The arguments we make are essentially strategic. As we see it, blind fanatical anti-Communism is and has been disadvantageous to our country and to its people. It has not stopped "Communism"; it has not advanced human liberty abroad or at home. . . . . . Anti-Communism in one form or another has been tried, and tried, and tried — and has failed. The ultimate penalty of doctrinaire anti-Communism is our own destruction — along with that of the Communists.

This book is an important, thorough study (not in the least pro-Soviet or pro-Communist) of a doctrine (a set of beliefs pushed forward by an establishment) which has cost over one trillion dollars and hundreds of thousands of deaths. The doctrine is still deeply imbedded in American thought, but not in the thought of many other Western countries such as England, France, or Canada.

The chapters include: How We Got That Way: History of Anti-Communism; What Is It? The Anti-Communism Complex; What It Does To Us: Consequences of Anti-Communism in Domestic and Foreign Policy; What it Really Is: Anti-Communism — Myth and Reality; What We Can Do About It: Alternatives to Anti-Communism. There is a "Selected Bibliography" including 25 references, some of them are books by Dwight D. Eisenhower, J. William Fulbright, George F. Kennan, and the Staff of the Senate Republican Committee.

Lane, Mark / ***A Citizen's Dissent*** / Fawcett Publications Inc., Greenwich, Conn. 06830 / 1968, paperbound, 320 pp, $.95

This is an interesting and important record of events dealing with the unpopular dissent by Attorney Mark Lane to the conclusions drawn by the Warren Commission that investigated the assassination of President John F. Kennedy. The book reports incident after incident of favorable publicity given to his opponents, and the silence, distortion, and suppression which was his treatment. ☐

APOLLO 13: A LESSON RE SAFEGUARD

Daniel D. McCracken, Chairman
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(The following letter was sent to the members of the United States Senate, I think it may be of interest to your readers.)

> "Surely, if we can walk on the moon, we can make the Safeguard program work." — Senator Henry M. Jackson, Senate floor, August 6, 1969

Few people will ever forget what they were doing during the critical hours when the crippled Apollo 13 spacecraft was being guided homeward. Something went wrong with the system, and suddenly the lives of three brave explorers were hanging by a thread.

The Safeguard ABM system is, from a computer standpoint, very much more complex than Apollo. And unlike Apollo, which is fired only after exhaustive systems checks and week-long countdowns, Safeguard would have to stand poised in hair-trigger mode for years at a time. Unlike Apollo, which is operated by large teams of graduate engineers, Safeguard would be operated by relatively junior military personnel.

Year after year, every minute of every year, the most complex assemblage of electromechanical devices ever devised by man would be scanning the skies, ready at every instant to fire nuclear megaton-warhead missiles over American cities.

Apollo 13 shows us that complex systems can and do fail. With Safeguard millions of lives, not three, would be hanging by a thread. □

"THE ASSASSINATION OF PRESIDENT JOHN F. KENNEDY: THE APPLICATION OF COMPUTERS TO THE PHOTOGRAPHIC EVIDENCE" — COMMENT

Charlene Hofer
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Freeman, S. Dak. 57029

I was impressed by the publication in your May issue of the article by Richard E. Sprague, "The Assassination of President John F. Kennedy: The Application of Computers to the Photographic Evidence."

Although the primary question which Mr. Sprague implies may be "Who killed John F. Kennedy and why?", there is certainly a secondary question of "Who is concealing the truth about that event and why?" Why have many Warren Commission documents been locked up in the National Archives of the United States to remain there for 75 years? Why did the chief autopsy surgeon personally burn his preliminary draft of his report on Kennedy's autopsy? Why has the complete Zapruder film never been shown on national television? Etc., etc.

I am convinced that the evidence in Sprague's article does show that literally hundreds of people have participated in the suppression of truth about the assassination of John F. Kennedy. From that premise, I raise three questions:

1. Is it conceivable that all of the people who have in one way or another withheld, concealed, or suppressed important information about the events of the assassination are knowingly involved in a conspiracy surrounding this evil act?
2. Is it conceivable that the suppression of truth is the result of the machinations of individuals in positions of power whose possession of power would be threatened or lost if the truth were revealed?
3. Or, as is suggested in the editorial in that issue, is it not more possible that the suppression of truth has resulted from a "concert" or combination of ideas or attitudes — which resulted in a series of actions giving the appearance of organized concealment or a common goal, but which in fact are based on many differing, individual motives?

The concept of a "concert" of ideas or attitudes may be significant in understanding not only the suppression of truth about the assassination of John F. Kennedy; it may also be significant in better understanding the power structure in our country. When similar, individual ideas are developed and exercised by people in power, the result may not be the desired goal of any of the individuals whose ideas were combined in "concert". When that happens, the individuals may not be aware of the effect of their ideas. The people implementing the ideas may not be aware of the distortion of goals which resulted from the combination of ideas or attitudes, at least until some drastic, seemingly irreversible action has occurred. The ideas which are combined may originate either within the power structure or outside of it; the net result can be the same.

Examining events in terms of their being the result of a "concert" of ideas or attitudes may offer a more accurate and more believable explanation than either the notion that events are planned by a high-level conspiracy, or that they are totally accidental. Many aspects of the current history of this country could be considered in these terms: the war in Vietnam, the flourishing of the military-industrial complex, the suppression of minority groups, air pollution — and the concealment of the truth about the assassinations of John F. Kennedy, Martin Luther King, and Robert F. Kennedy. □

THE CASE FOR THE AWARENESS OF THE SOCIAL IMPLICATIONS OF COMPUTERS IS PRESENTED TO THE CANDIDATES FOR NATIONAL ACM OFFICE

Paul Armer, William S. Dorn, and Daniel D. McCracken
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The letter below was sent to the 32 candidates for national ACM office nominated by the nominating committee. There were 21 replies. Several of those who did not reply in writing had indicated that they planned to do so, and may simply have missed the deadline.

We would characterize the responses as highly encouraging from our point of view. Not that everyone agreed with us 100% — we didn't expect that. But a majority did express a sincere sympathy with the idea that computer professionals should adopt a habit of seeing technical activities in social context.

We would not want to misrepresent the situation: there was disagreement with some of our points by some candidates. Some, for instance, said that social concerns should be expressed individually and through organizations other than the ACM. A number were concerned that if our ideas were carried to the extreme it would amount to transforming the ACM into a lobbying organization; we fully agree that this must not happen.

After careful consideration we have decided against issuing a list of endorsements, since in many cases all the candidates for an office were in general agreement with each other.

In summary: without suggesting that everyone agreed with us on every point, we can say that we were very pleasantly surprised and encouraged by the generally positive nature of the candidates' positions. If this is an accurate indication of things to come, we look forward to a new era of social consciousness in the ACM.

Letter to All Nominees for National AMC Office

It is our conviction that one of the major problems facing our society, one approaching crisis proportions, is the tendency for technical people to ignore or deny the social implications of their work. We believe that this is true of too many computer professionals as individuals, and, unhappily often, with the ACM as an organization.

We look toward a day when the stance of the ACM will be to promote acceptance of responsibility for the social implications of work with computers as a major function of the organization, ***as well as*** maintaining the more narrowly defined technical activities that are its legitimate primary concern. Toward this end, we seek your response to these ideas so that we may be guided in our voting for ACM candidates in May. We also plan to release a summary of the responses to the technical press in the field.

So that you may know more precisely the position on which we solicit your comments, we offer the following sketch of the logic of the situation as we see it.

1. Technological change almost always has social consequences. The automobile is changing our families and our cities. The Pill is changing our population growth rate and our sexual mores. Computers have led to more effective government but also to a loss of privacy; to better economic forecasts but also to the exploitation of the poor and the ignorant through computer astrology; to more effective education in the colleges but also to fraudulent data processing schools.

2. These social side effects are sometimes positive and sometimes negative. The benefits are usually the primary motivation for technological innovation in the first place, and things sometimes work out just as hoped.

3. But not always. There are all too often negative side effects. These are seldom anticipated; they may sometimes in a certain sense be unpredictable.

4. Technical people have an obligation, simply as a part of being human, to be concerned with the social consequences of their professional efforts. They have an added responsibility placed on them because of their technical competence, since they may sometimes be in a better position to evaluate the potential consequences of innovation than others. They have, at an absolute minimum, the obligation to decide for themselves whether the projects to which they lend their skills and energies further worthwhile goals, and to desist from the work if not.

5. ACM members, both as individuals and as a body, ought to devote a part of their energies to the study of the social side effects of their work; to seek to correct or minimize the negative side effects; to seek the adoption of ameliorative legislation where appropriate; to speak out against projects that are technically feasible but socially destructive.

If we were to try to reduce this position to one sentence it might be this: we believe that technical people, both as individuals and through their professional organizations, must adopt a habit of seeing technical activities in a very much larger social context than has been our usual practice in the past. The narrow compartmentalized thinking that we see as the root of part of our present ills represents sub-optimization with a vengeance. What is efficient, interesting to work on, and even "useful" if viewed narrowly enough, may in a larger context be seen to solve one problem at the expense of creating or worsening others, or to solve a technical problem at the cost of human dignity, for instance.

We invite your reaction to these ideas, in terms of how you view the future role of the Association: how it should seek to urge its members to act as individuals, and how it should seek to operate as a body.

Please understand: we have not elected ourselves to the position of ACM conscience. Each human being answers to his own conscience. But ***our*** consciences tell us that the ACM should change, and we wish to be guided in our voting for candidates by the responses we hope you will give.

We speak in this matter strictly as individuals, and not as spokesmen for any organization.

Responses may be directed to the address shown on the letterhead. The press release will be based on replies received by April 1. □

ADDENDUM TO "GUIDELINES FOR CONTRACTING FOR COMPUTER RELATED SERVICES"

Following is the biography of Robert Martin, the author of "Guidelines for Contracting for Computer Related Services", page 18, April, 1970 issue of ***Computers and Automation.***

Robert Martin is a member of the Program Development Staff at Computer Science Corp., 1920 L St. N.W., Washington, D.C. Since entering the computer field in 1962, he has been active in technical and marketing roles with Honeywell, Inc. and Computer Usage Company. He has been marketing to federal, state, and local governments since 1965, and has a special interest in the effective and efficient use of computer hardware and software by government. He received a Master's Degree in Philosophy from Baylor University in 1960, and has completed one year of study toward a Doctorate at Brown University. He is a member of the National Association for State Information Systems. □

REAL-TIME ANALYSIS OF ELECTROCARDIOGRAMS BY COMPUTER

Dr. G. A. Kien, T. V. Balacek,
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The medical profession has for many years attempted to inspire the general population of the United States to receive thorough physical examinations routinely. They have met with limited success because many of the routine tests involved, such as electrocardiograms (ECG) and spirograms, are relatively time consuming and represent a tedious task when they are included as part of a regular physical examination. Also, the in-depth interpretations of the analyses of such tests as ECGs require a physician, preferably a Cardiologist, who is well-trained in that area of medicine – and even then interpretive judgements may vary. To remedy this situation and relieve physicians of time consuming work, eliminate possible error, and decrease variability in interpretations, TELEMED Corporation has established an on-line multiprocessing computer facility for real-time analysis of electrocardiograms.

An Electrocardiogram Defined

An electrocardiogram is a record, taken from the body surface, of variations in electrical potential produced by the heart. The muscular activity or pumping action of the heart is caused by an inward and outward flow of ions through membranes of the heart muscle. These alternating or pulsating flows of ions precede muscular contraction and relaxation, producing a polarization of the heart. Vectorally speaking, the resultant of these various waves with their combined strength and direction is called the electrical axis of the heart. The electrical axis is affected by the patient's present physique and the condition of the heart, whether normal or damaged or diseased.

Alteration of any segment(s) of the heart will produce a corresponding change to the electrical axis of the heart, as well as to the vital parameters measured. Analysis of the component parts (waves) that make up the electrical axis of the heart will reveal the location of the damaged area. The overall measurement of the heart action is classically accomplished through the 12 lead scalar electrocardiogram.

In approximately 1962, a method whereby this classical procedure could be computerized was proposed. The progress which has occurred since then has resulted in the evolution of the computer analysis format described in this article.

Hardware

A duplex arrangement of Xerox Data Systems Sigma 5 computers has been programmed to measure and interpret the waves of the standard 12 lead electrocardiogram. These computer systems in their present configuration are capable of handling up to 8600 ECGs a day by accommodating simultaneous transmission and analysis of data.

A mobile electrocardiograph unit is installed at the location (hospital, clinic, nursing home, doctors office, etc.) where the ECG is to be taken. The electrocardiograph unit is an automatic three channel data acquisition unit. It utilizes the 10 inputs of the classical 4 limb and 6 chest electrodes. A patient is wired with leads on both arms and legs (the lead on the right leg is ground), and leads on the chest. Switching circuits in the electrocardiograph unit make appropriate combinations, 12 in total, for sequential recording on three channels.

The first three combinations include the 3 possible pairs-combinations of the active limb electrodes. The next three combinations include the same pair combinations as the first three, except each combined signal is attenuated and mixed with the remaining unattenuated limb electrode signal. Finally, the six chest electrodes are each mixed with the attenuated signals from all three limb electrodes combined.

While the resultant signals are being used to drive a conventional chart recorder, they are also used to frequency modulate carrier signals in the 1-2.4 KHz range. These

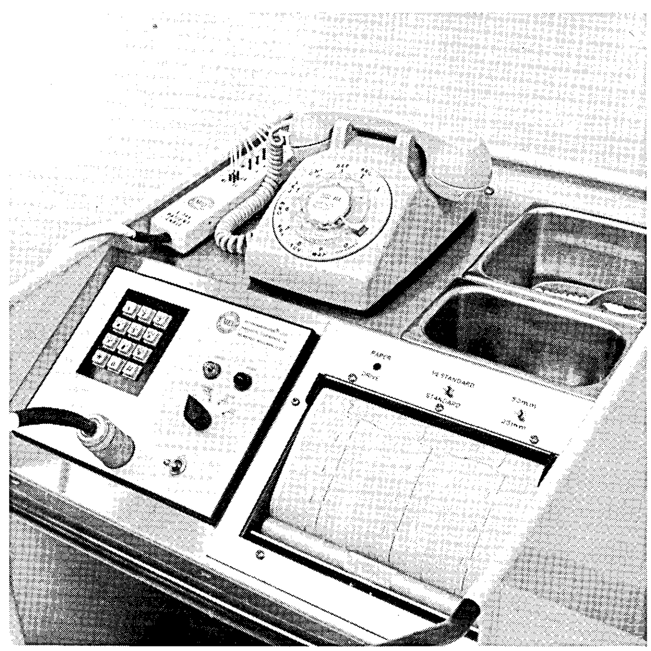

Figure 1

The mobile ECG car provides a classical 12 lead scalar trace while frequency modulated signals in the 1-2.4 KHz range are simultaneously transmitted to the computer center over normal voice-grade telephone lines.

"For an emergency electrocardiogram, the system can bypass any queue and analyze the electrocardiogram immediately, thereby providing an interpretation in under five minutes, no matter what the input load."

are in turn transmitted to the computer center over normal voice-grade telephone lines. The mobile cart includes the oscillator and mixer circuits as well as a built-in Touch Tone Pad for entering location and patient code information (Figure 1). Telephone lines transmit ECGs to the computer with no clinical distortion, and noise in the lines can be readily filtered out.

Procedure

At the computer center, the analog telephone signal is converted back into its original analog form, then converted into digital form and entered into the computer system for analysis. The computer will then perform an analysis which will: (1) measure all pertinent ECG amplitudes and duration; (2) characterize the wave forms from each of the twelve leads of the scalar electrocardiogram; (3) calculate such factors as rate and electrical axis; and (4) produce an interpretation of the status of the electrical function of the heart based upon these parameters. The resultant interpretation is then teletyped back to the location at which the ECG has been taken, in digital matrix format with a summary set of correspondent interpretive statements (Figure 2).

Reliability

If a computer system has an up-time of 95%, it is considered good. This would imply that over a period of a week, a total of 8 1/2 hours might exist during which a hospital or institution could not send electrocardiograms if the computer center had only one computing system. This would be unacceptable, since hospitals require 24 hour service. To overcome this problem, two completely independent computer systems have been installed.

TELEMED presently utilizes a procedure of acquiring data on one computer and analyzing it on the other. Either computer is capable of acquiring data, so that ECG data can be acquired even if one system fails. Experience to date indicates a failed system is brought up to full operation in under one hour. Therefore, at the outside, ECG analysis would be delayed for no longer than this period of time.

Of particular value in this two-computer approach is that the acquisition system and the analysis system are complimentary. That is, the acquisition system is I/O bound while the analysis is compute bound. The acquisition system is mainly involved with acquiring data from many phone lines simultaneously and in checking the validity of this data. The analysis system is mainly concerned with performing detailed calculations upon this data. They therefore lend themselves ideally to a foreground-background processing situation. The acquisition system can be run as a foreground program operating in real-time, while the analysis system operates in non-real time in a background mode when CPU time is available.

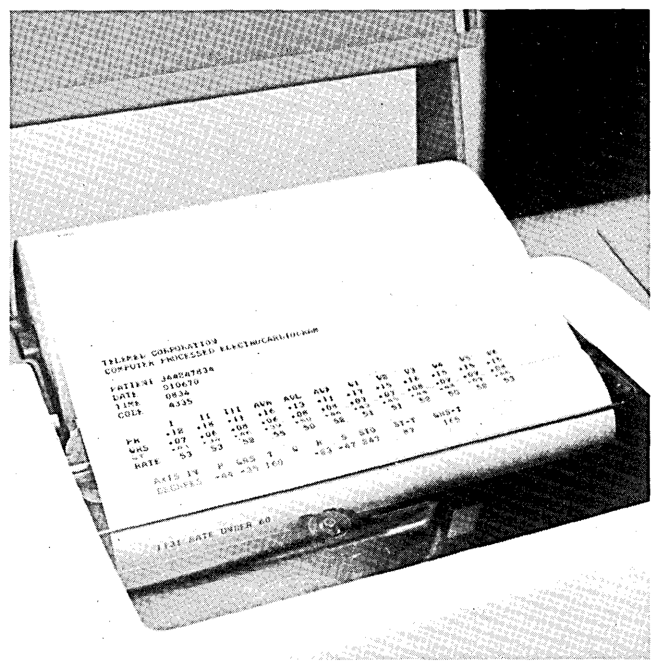

Figure 2

The teletyped computer interpretation of an ECG contains all pertinent electrocardiogram amplitudes and durations, characterization of wave forms from each of the twelve leads, calculation of rate and electrical axis, and written statement of electrical function of the heart based upon these parameters.

Overflow Storage

During busy peaks, the systems can acquire at a faster rate than they can analyze. Therefore, overflow storage is provided on an RAD (random access device similar to a large disk with fixed read/write heads for each track), or on magnetic tape. These areas of storage are continually refreshed with new data, until the load diminishes. Under normal input conditions (3-6 simultaneous ECGs being received) the turnaround time (time from end of call to receiving of analysis output) is under five minutes. For an emergency ECG, the system would bypass any queue and analyze the ECG immediately, thereby providing an interpretation in under five minutes, no matter what the input load.

The Importance of Direct Communication

The most important characteristic of TELEMED'S operation is on-line operation whereby the operator and the computer are in direct communication. From the time the telephone call is received, the computers are monitoring the performance of the operator, cart, telephone line and specifically designed front-end receiving equipment. If the operator inputs a wrong identification number (ID), the computers will recognize it and appropriately inform via a reverse channel (which is a 387 hertz tone placed on the telephone line that lights a light and sounds a buzzer on the transmitting cart). This indicates the ID was received incorrectly and should be resent. This mode of communication between the operator and the computers continues throughout the call. The computers monitor the telephone line looking for noise conditions to determine whether the call should be rejected as being unacceptable. If it is so determined, the computers inform the operator via a reverse channel indicator. The computers perform preliminary analysis upon incoming signals looking for such items as length of time of each lead of the ECG sent, and calibration signals sent with the ECG to determine the rise time and voltage change. If the duration of the pulse or the amplitude is incorrect, the computers will reject the call. The computers have the capability of analyzing calls from a particular cart and determining if a significant number have been rejected. If so, it can be determined if the cart is malfunctioning and in this manner the computer center can determine if a cart has failed and arrange for appropriate service.

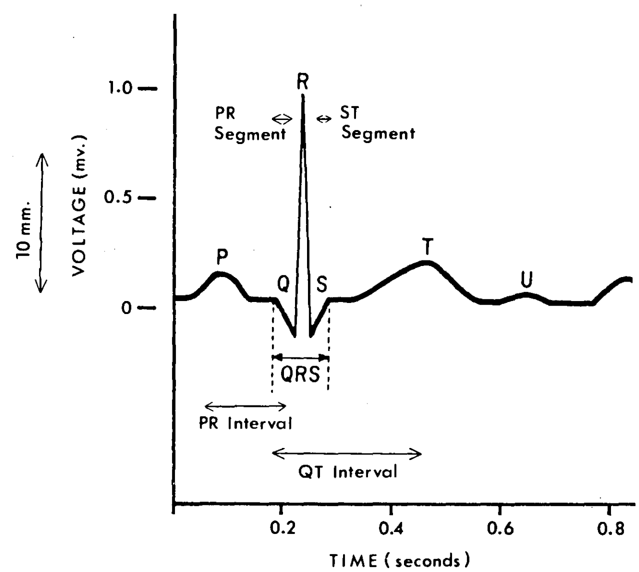

Figure 3

A typical ECG trace showing diagramming complexes, intervals, and segments.

Figure 3 represents a diagram of electrocardiographic complexes, intervals, and segments. This is the type of trace that would be obtained utilizing a standard electrocardiographic cart. It should be noted that the QRS segment can have very sharp slopes. The time duration (QRS interval) can vary from below 30 milliseconds to above 60 milliseconds. The amplitude of this wave can be higher than 2 1/2 volts. Therefore, the slope of the QR segment can be quite large. In general, an electrocardiogram does not contain significant frequencies above 45 hertz. Sampling theory dictates that one should sample every 10 milliseconds to represent a 50 Hz signal. A good rule of thumb is to sample at a rate of 5 times higher than this value in order to easily reconstruct these signals.

The electrocardiogram produced by the patient at the cart is frequency modulated (FM) and transmitted over normal voice-grade telephone lines to the computing center. In addition to FM, some signal characteristics are altered within the cart and reconstructed after demodulation at the computer interface. The FM signal is demodulated and reconstructed as previously indicated and input to the analog to digital (A/D) converter. This analog to digital converter can sample up to 64 multiplexer points in a sequential read mode. The time between samples can be changed if desired; at present it is 10 microseconds. The advantages of transmitting these signals via FM is that amplitude variations due to the phone system and noise on the telephone lines will not interfere with the signal. Also, since the program that analyzes these signals only deals with relative amplitudes, any phase distortion introduced by the voice-grade line will in general have little affect upon the signal, since the phase distortion does not vary rapidly with time.

Phone Lines

It is desirable to keep the number of phone lines servicing the computer system to a minimum. This will in general reduce telephone line and receiver costs. It is important to have enough telephone lines such that during the busiest hour the number of busy signals that callers receive is kept to a minimum. If this number becomes excessive, users will find the system difficult to utilize. A patient that is wired up for an electrocardiogram does not enjoy waiting while an operator places a call a number of times.

The analysis program expects incoming data to be precisely separated. Therefore, it is important that a time skew should not exist in the sampling for the analog to digital converter (A/D). A time skew could exist for any of the following reasons:

1. The monitor control system does not allow the A/D process to be started immediately.
2. The priority scheduling for the A/D is incorrect.
3. I/O conflicts with other devices cause delay in the analog to digital conversion.

Since many different electrocardiograms can be within the system simultaneously, it is important that a sample for a particular ECG be taken in a precise time increment from the previous sample. It is not important that every *ECG* within the system be sampled at exactly the same time, but only for any particular ECG that the samples be spaced precisely apart. Therefore, as long as the previous 3 items are accounted for, sequential automatic reading mode for the A/D will meet this requirement.

At present both a vector and scalar scheme exist for ECG analysis. In general, the scalar scheme is more widely accepted. Both systems involve sending ECG and calibration data. The vector scheme involves a time correlation between a number of simultaneous ECG measurements. These measurements are transmitted on a 3 carrier system (like the scalar) but require that no time skew exist between samples. Therefore, sample and hold registers must be provided on the A/D for simultaneous sampling of all 3 carriers. This measurement must also meet the general scalar requirement of 2 milliseconds between group sampling.

In general, it may be stated that the 12 lead scalar computer analysis approach has generally gained more clinical acceptance than the vector analysis program. It is more easily correlated to the classical, non-computerized ECG trace, thereby offering a simple procedure of usual comparison by the physician. □

A CASE HISTORY: IMPLEMENTATION OF A COMPUTER-BASED PATIENT ACCOUNTING SYSTEM

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"A package should not be considered as a means for circumventing the tasks and problems associated with an installation. Although the package designers attempt to generalize their package for hospitals with many and varied requirements, its design usually reflects the uniqueness of the hospital for which it was developed."

Within the last few years, considerable attention has been devoted to the development of data processing applications for hospitals. Computer manufacturers and software firms have developed a number of application packages designed to meet the requirements of hospital administration.

Of the various applications available to hospital system planners, patient accounting is generally regarded as the most appropriate for initial implementation. This application is important because it typically comprises well over half of the total data processing load of a hospital. In addition, the data collection required for the Medicare and Title XIX Programs have caused this application to be of paramount importance in enabling hospitals to recover charges for patients covered by these programs.

The scope of a patient accounting system generally includes census, patient billing, and accounts receivable. These subsystems are described as follows:

Census – The census provides assistance in Hospital operations by serving as a communications link between the nursing stations and the ancillary departments. The census reports also may be used as a tool for reporting vital signs and other nursing data. In addition, census data frequently serves as a base for statistical reports for Medical Records and are used to keep the medical staff advised of pending Medicare certifications.

Patient Billing – The patient billing programs post charges to the patient's account and prepare the

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patient's bill. Many systems offer an insurance proration feature by which the computer is used to estimate that portion of the patient's bill which is due from third party carriers. The patient billing subsystem also collects and reports utilization data, and provides management-oriented analysis of revenue data.

Accounts Receivable — The accounts receivable reports assist the collection efforts of the hospital's Business Office.

From this brief description, it is apparent that a patient accounting system offers a hospital the capability to automate many administrative tasks. A successful implementation can enable the hospital to reduce outstanding accounts receivable, trim clerical staff costs, and relieve many statistical chores associated with census tabulations and Medicare and Title XIX cost reporting.

The Uniqueness of Packages

The use of a package can reduce the time required to implement patient accounting. A package, however, should not be considered as a means for circumventing the tasks and problems associated with an installation. Most packages were developed at one or two test sites. Although the systems designers attempt to generalize them for hospitals with many and varied requirements, their design usually reflects the uniqueness of the hospital(s) for which they were developed. This uniqueness expresses itself in many ways. Teaching hospitals and larger hospitals, for example, tend to offer a wider range of specialized services than general-practice community or smaller hospitals. Public hospitals tend to have a high volume of clinic and emergency outpatients. Other hospitals accommodate a high volume of referral or one-time out-patients. Some hospitals have several locations. Management styles differ, varying across the spectrum from centralized to decentralized organizations. As a result, a package will often require some tailoring to fit the administrative needs of the particular hospital using it. In addition to the modifications desired to fit the unique characteristics of the using hospital, the generalization of the package tends to make the system inefficient and cumbersome to process. Many packages require changes for efficient processing by a specific user.

In mid-1969, the management of Stanford University Hospital decided to redesign their computer-based patient accounting system. As part of this decision, the IBM Shared Hospital Accounting System (SHAS) was selected for installation on a stand-alone basis. In order to install SHAS with modifications desired to meet its unique needs, Stanford University Hospital entered into a joint effort with Arthur Young & Company for a three-phase installation plan.

PHASE I — PLANNING

The first phase of the installation plan consisted of specifying the system and planning the implementation. There were three objectives for Phase I.

1. Determination of the System Design

The evaluation of SHAS established two classes of modifications for the installation at Stanford. The first involved changes to the system required by the management of the Hospital. Stanford University Hospital is both a teaching and a community facility. It serves as the medical center for Stanford University. In addition, it is the community hospital for the City of Palo Alto, California. Because of this dual role, the Hospital's management required several significant changes to the SHAS system design.

The second class of modifications involved changes to improve the operational characteristics of the system and reduce the run time. Based on the experience of other SHAS users, the expected running time for the System on a stand-alone basis at Stanford was thought to be excessive. The Hospital's long-range plan anticipated the use of the same computer for many additional applications.

We have found that it is desirable to specify and implement efficiency modifications at the time the package is installed. After the System is operating, the users tend to place heavy demands upon data processing personnel for application design changes. These pressures make it difficult to realize savings through improved efficiency modifications after the system is implemented.

2. Determine the Appropriate Hardware Configuration

SHAS is designed to be used with IBM hardware and its disk operating system. Although this restricts the selection of computer equipment, considerable attention was given to the appropriate configuration to be used with the package. Many data processing users waste hardware resources because they tend to over-buy computer equipment.

3. Determine an Installation Plan

The Phase I analysis enabled us to develop a staffing plan required to install the system within the specified time limitation. The analysis also provided a generalized plan for the installation. This plan included a projected implementation date for the three subsystems of the Patient Accounting system.

To accomplish these goals, Arthur Young & Company consultants worked closely with the Data Processing Manager and System Manager of the hospital. Phase I was divided into three tasks:

1. ORGANIZATIONAL ANALYSIS
2. ANALYSIS OF USER REQUIREMENTS AND DETERMINATION OF SPECIFICATIONS
3. HARDWARE/SOFTWARE ANALYSIS

Each of these activities proceeded simultaneously and are described below.

Organizational Analysis

The impact of a new system on the organization structure is frequently overlooked in the implementation process. Implementations of systems are usually undertaken by data processing specialists. They usually do not focus on organizational matters. As a result, compromises are required to force the amalgamation between the system and certain user departments.

Proper analysis of organizational impact can significantly improve the benefits to be derived from a system implementation. In many cases, the organization and procedures of the user departments are not compatible with the requirements of the new system. For example, many hospitals do not prorate charges to determine patient liability while the patient is in the hospital. Some hospitals wait until the insurance companies have paid before attempting to collect from the patient. The availability of an automatic insurance proration and a daily report of patient liability enables the hospital, if it so desires, to advise the patient of his liability at the time of discharge. This feature may require a restructuring of the Business Office. Use of the feature can appreciably increase a hospital's cash flow if the restructuring is planned and accomplished smoothly.

The impact of the new system on the organization of the hospital was determined. Policies and goals for operation under the new environment were defined and formalized. Functional organizational charts and job descriptions were prepared.

Analysis of User Requirements and Determination of Specifications

This step is an integral part of all good systems' implementation efforts. In the case of a package implementation, the analysis of the requirements of the users generally involves the comparison of the characteristics of the package with the requirements of the various users. Both the project team and the appropriate users should work together to reconcile potential differences.

Although this step is generally a part of most systems efforts, it is frequently approached in a haphazard fashion. Unnecessary or improper modifications are a frequent result if appropriate emphasis is not placed on the analysis of the user requirements, if the implementation team attempts to second guess the requirements of the user department, or if a department does not seriously consider its own requirements.

At Stanford, the project team spent a considerable amount of time with the user departments to develop with them the systems specifications. After these specifications were determined, they were documented in reports to management. These specifications then became fixed until the installation was completed. This approach provided the project team with a sound and firm system design, rather than a design which would evolve as the system was being implemented.

Hardware/Software Analysis

A study of the system design of the package should be undertaken. For the Stanford project, this study included running the package in a simulated operating environment using transaction data from Stanford's files. Although a technical study of this magnitude may not be required in other situations, it is advantageous for the user hospital to become knowledgeable about the software design of the package as quickly as possible.

The results of hardware/software analysis at Stanford led to the definition of:

(a) the most appropriate configuration to be used with SHAS,
(b) the use of multitasking to improve SHAS throughput, and
(c) suggested modifications to the structure of SHAS functions and job steps. Although this analysis identified many potential modifications, only those changes which were cost-justified were recommended for implementation.

Results of Phase I

The results of Phase I were documented for the hospital management. This documentation included:

(a) description of the SHAS reports which were to be provided to the hospital,
(b) detail design of the reports not included in the SHAS package, but required by hospital management and operating personnel,
(c) definition of the SHAS modifications required to meet the hospital's operating procedures, and those necessary to improve the operational efficiency of the package, and
(d) definition of the changes to the hospital's operating practices required to meet the requirements and constraints of SHAS.

All technical specifications were documented for all SHAS programs. This documentation conformed to the standards established by the Hospital's Data Processing Department, and was at a level suitable for assignment to programmers.

PHASE II – INSTALLATION

The second phase consisted of the implementation of the system as it was specified in Phase I. The implementation included not only the programming of the package modifications, but also the implementation of the organizational modifications described during Phase I.

To accomplish this phase of the project, an on-site Project Manager was appointed from the staff of Arthur Young & Company to be responsible for the overall guidance and direction of the implementation effort. He reported directly to the Hospital's Associate Director of Finance. In this way, the project manager was able to cross organizational lines to effect the necessary changes required for the system's implementation.

Systems Coordinators

One of the unique aspects of the Stanford installation was the use of two systems coordinators. These coordinators were representatives of user departments who were organizationally transferred to the Data Processing Department. One was from the hospital's Business Office, and the other was a registered nurse from the nursing staff. These coordinators were asked to participate in the design of particular aspects of the SHAS System which affected their departments. They were then assigned to work with their respective user departments to assist with staff training, procedure writing, and other user interface tasks.

The balance of the team included both Arthur Young & Company and Hospital personnel. It consisted of systems analysts with prior experience in the implementation of SHAS, senior-level application programmers, and an administrative specialist responsible for the changes in the user departments.

The first task during Phase II was the development of a detailed work plan for the implementation of the system. At Stanford, a PERT chart was developed to plan the sequencing of the various technical and user interface tasks required for system implementation. This plan took into consideration the number and experience of personnel assigned to the project.

Charting Progress

After the plan was developed, it was summarized on two wall charts. One chart pertained to the technical data processing tasks required for implementation, and the other related to user interface tasks. The data processing chart was hung in a predominant place in the Data Processing Department. The other chart was hung in the Business Office. Progress on the project was charted on both of these charts by the use of overlay sheets.

The PERT chart enabled the project managers to remain closely attuned to the overall progress of the project. In addition, project status was clearly visible to all of the participants. As delays in specific tasks were incurred, it was relatively easy to project the overall impact of these delays.

Another advantage of the PERT technique was its use in developing status reports for hospital management. After the PERT charts were developed, activity lists were summarized for management. These lists indicated the primary tasks required for the implementation of each aspect of the package, and the estimated time period during which these tasks were to be accomplished. Each month, a report was prepared. This report indicated the completion date for the tasks planned for that month. The report also contained a brief narrative documenting the project problems incurred during the month. We found this device useful not only for keeping management abreast of project progress, but also to keep the project team aware of assignment schedules.

POSTAGE STAMPS DESIGNED BY COMPUTER IN THE NETHERLANDS

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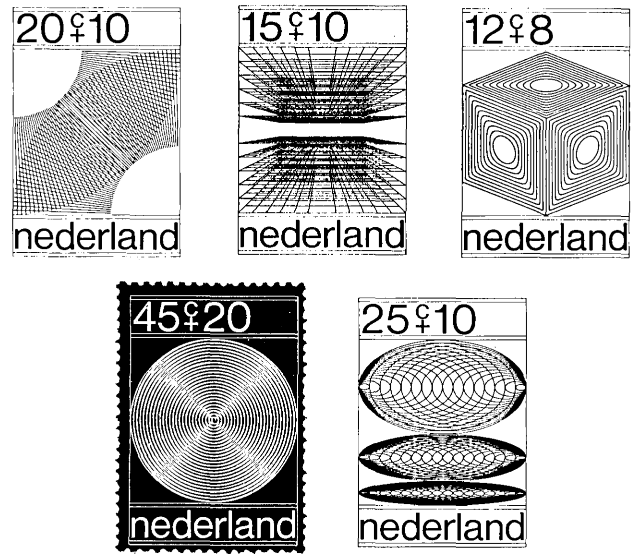
I am at the Computer Science Department at the University of Rotterdam, and we read your magazine with very much interest. Especially the readers service is very useful for us.

I have taken the freedom to act as your correspondent because something interesting happened in The Netherlands. Our G.P.O. (General Post Office) issued a series of stamps designed by a computer, which has never been done before. The artist is R. D. E. Oxenaar, a member of the Department for Numeric Control of the Technical University of Eindhoven. (This is the same university to which the well-known pioneer of modular programming, E. W. Dijkstra, belongs.) □



CORRECTION

The following corrections are for the article by Richard E. Sprague, "The Assassination of President John F. Kennedy: The Application of Computers to the Photographic Evidence", which was published in our May, 1970 issue (page 29).

- p. 5, item 5: Replace page number "30" with "29"
- p. 31, col. 2, line 36: Replace "Flammande" with "Flammonde"
- p. 42, caption for Fig. 7: Replace "3 seconds" with "3.5 seconds"
- p. 43, caption for Fig. 9: Replace "after the first three shots" with "after the first shot"
- p. 47, col. 1, line 23: Replace "Z2313" with "Z313"
- p. 51, Chart 2, 5th horizontal line: Replace "3 sec." with "3.5 sec."
- p. 57, col. 2, line 6: Replace "Table 1" with "Chart 2"
- p. 57, col. 2, line 11: Replace "Table 1" with "Table 3"
- p. 60, col. 2, line 5: Replace "Flammande" with "Flammonde"

We originally projected that six months would be required for systems implementation. Because of certain software problems and staff turnover, delays were incurred. The use of the PERT charts enabled us to anticipate the potential delays and to predict precisely the impact as problems arose. As a result, we were able to limit the delays to a minimum. The system was installed on a production basis in seven months. In addition, the cost to Stanford for the total project remained within budget limitations.

PHASE III – FOLLOW-UP

Too many data processing professionals believe that a system installation is completed once the system is installed. In truth, the user does not really understand a system and its limitations until it is operating on live data. For this reason, a follow-up effort was planned as part of the Stanford implementation. A programmer, a systems analyst, and the systems coordinators were assigned to this task. Essentially, they assisted departments in overcoming minor difficulties which came to light as the users gained experience. They also made modifications to the system which may have been overlooked during the specifications of the systems design.

Although this activity appears to be relatively minor when compared to the tasks required for installation, its importance cannot be understated. The installation of any system, whether involving the use of a package or a system developed in-house, is a complex task. Minor design considerations and user interface problems are going to be overlooked during the specification and implementation phases. Unless an effort is planned to correct these deficiencies after the system is installed, they will be overlooked by data processing personnel who are interested in new and more creative assignments. These problems bring increased costs and unnecessary manual effort to the operating departments, and destroy the credibility of the computer's capability to assist operating personnel.

Conclusions

Many hospitals are beginning to install sophisticated data processing systems. Many of these installations are being undertaken by project teams with little prior exposure to the complexity of hospital operations. Some of the projects are directed by managers with limited exposure to the implementation of large-scale data processing applications. As a result, implementation timetables are frequently overrun and project costs greatly exceed budget estimates.

In this article we have described the approach used to install the SHAS patient accounting system at Stanford University Hospital. Although there were unique aspects to the Stanford implementation, the techniques described in this article can be applied to the implementation of systems in other hospitals.

At Stanford, a team with hospital background and prior SHAS experience participated in the project. The team was guided by project leaders who managed with project control techniques that had been used successfully in other projects. As a result, a highly modified version of SHAS was installed with a minimum of delay and within budget limitations. □

WORLDWIDE

REPORT FROM GREAT BRITAIN

"Steal IBM's top talent and aim for the European market at the very least," Saul Steinberg told a recent public meeting of the Parliamentary Select Committee on Science and Technology which, since early this year, has been investigating the British computer industry.

Key to ICL's Success

Steinberg did not mince his words. He told the politicians that the way in which International Computers was created *a priori* had meant the most serious difficulties for the company's management. In this, Steinberg and Schoeters are at one. I have always said in this column that the one grave factor counter to ICL's success was the requirement laid upon it by Government that besides its own very successful 1900 series — now using logic more advanced and faster than any U.S. machine — it should continue to make and support on software the System-4 equipment from English Electric, very closely akin to RCA's family.

He told the most revolutionary of the socialist members on the Committee that he was against grants. The best thing to do with ICL was to leave the company to work out its own solutions and then provide contracts for the first 25 new machines. "Grants are not necessary — contracts are the answer," he asserted.

But all this is a long way from the guidelines laid down for the investigation by this Committee, which was convened purely and simply to look at Government procurement policies for computers. It has turned into a free-for-all . . . for what has Saul Steinberg really got to contribute on UK Government policies for the purchase of computers? Every facet of the industry is being looked at in sessions now crowding closer and closer together as the threat of an early election looms larger. Even with an October poll, the Committee will be hard pressed to get any kind of report out before the recess. A June poll would simply prevent any report being issued. There is enough evidence already accumulated to provide at least 500 pages of edited text.

No Investigation Needed

To my way of thinking, there should have been no investigation at all. If a Government has taken as a conscious policy decision that an indigenous industry must be fostered and promoted in the face of competition which often steps far outside the bounds of what we in Britain call fair commercial practice, then is there anything wrong in such a Government's buying domestic equipment for standard jobs, knowing that price and performance are right?

The trouble is that so few people in Parliament have even the vaguest idea of what automation and information processing are all about. Moreover, the Tories are for laissez-faire and the bigger the company taking advantage, the better. Labour on the other hand, still tends to take the short-sighted view that once a company comes into a depressed development area, no matter from where, and once it employs a certain number of workers, it is British. The fact that both manufacturing and research policies may be controlled from a centre five thousand miles away, or that most of the components for the final product are being imported, hardly seems to matter.

The hard fact of life that, if present growth continues, computing in every shape and form will account for somewhere between 5 and 6 per cent of the gross national product of all advanced countries by the end of the present decade, just has not sunk in yet.

The Election

Whatever the Select Committee may decide to recommend to the Minister of Technology, the crux will be the outcome of the election. It is most unlikely that Government money will remain in International Computers if Labour loses. This would mean finding some $30m in a hurry. While that would not break the company's back, it might make agreement with several other European computer companies more difficult to achieve. The alternative would be the marriage with CDC which many within ICL favour as against the long hard flog down the road to Europe.

Future Prospects

There is no arguing with the figures. The economic assessment of the market for electronic capital goods for the period to 1972 by the Electronics Economic Development Council — government, unions, industry — shows quite clearly what has been happening on the computer front.

If I give a little table, it will speak volumes:—

All £'000	*1968*	*1969*	*1972*	*% growth 68-72*
Exports	43,712	53,557	110,000 to 137,000	23 to 30
Imports	74,808	97,592	151,000 to 176,000	19 to 24
Re-exports	3,992	3,204	3,000	
Trade balance	(ALL MINUS) 27,174	40,768	41,000 to 39,000 (range) 66,000 to 14,000 (limits)	

Multiply all these figures by 2.5 to give $ and the UK problem is quite clear. The percentage of imports representing IBM equipment is high. IBM makes nothing but the 1130 in the UK, plus a few bits and pieces for the 360 range from France and Germany and the discs for System 3 in Europe. There is nothing here to offset imports of complete computer systems from Europe and the U.S. to meet about half the UK market. So the UK companies had lost half their potential outlets before they even began to assume a shape in which they stood a hope of a chance of competing.

(Please turn to page 62)

COMPUTERS IN THE LABORATORY

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"The main purpose for a computer in the laboratory is 'high quality-control of quantity'. The computer in the laboratory achieves this purpose only after careful analysis of systems and requirements has been made."

Medicine, health, and hospitals have been often pointed out as suitable areas for computers to be applied extensively. Although there are many problems that computers can help to solve, there are many more that computers cannot nor should not be applied to. Hospitals, like every other enterprise, will suffer wastes of time, energy, and money when computers are misapplied.

Forget "Total Systems"

We can propose a theorem or law: "Hospital computer systems have failed in direct proportion to the enthusiasm with which they were launched as 'total systems'." We can also propose the converse theorem: "Those persons who have sought an orderly sequence of well-defined, practical, modular applications, have succeeded and will succeed in applying computers usefully to medicine and health care." In fact, it is desirable that all of us who prepare articles on the use of computers in health and medical care should be placed under the same restrictions that drugs are now under, namely, that we indicate information about contra-indications, warnings, precautions and adverse reactions. The key words to be forgotten and disregarded are "total system". Although this may be admirable as a distant goal, they are disastrous as any near-at-hand task.

The Hospital Is a Business

Computers have been applied to four major areas of hospital activity. First, a hospital is a business. Its product is a service, namely, excellence in patient care. This service depends upon highly skilled, devoted, sensitive people, and upon a continuous program of education, research and renewal. As a business, the hospital has a business and accounting function, not very different from this function in any other business. The differences have been known to drive hospital controllers to distraction; but once the anomalies of the third-party, pre-reimbursement system are comprehended, the hospital business systems can be developed effectively.

As one controller told me, in hospitals, unlike merchandising, you can't get back what you gave the customer (namely, his health) if you discover you didn't charge him enough. But with a mildly philosophical approach and some earnest business judgment, it is possible to produce a computer system that collates charges, totals them, subtracts insurance coverage, and prints the bill.

The most widespread current use of computers in hospitals is for this type of business data processing. It may be attained in a variety of ways — from the time-shared-computer system that Michigan Blue Cross is developing, to small computers being purchased or leased by individual hospitals for application to processing accounts receivable, bills, and payroll.

Information Retrieval

A second, more challenging requirement concerns distribution and retrieval of medical information. Every hospital has basic communication needs that may be aided by computers. For data transmission and display, the particular computer is less important than the peripheral device used for actual display. Almost every third generation, and many second generation computers, are eminently capable of controlling a variety of terminal devices. However, it is vital to select a terminal device that serves the particular requirement: a noisy, if economical teletypewriter, does not belong at a nursing station; a quiet, if expensive CRT display does belong in an intensive-care unit, when it is used for real-time display of physiologic parameters under continuous monitoring and analysis. Many experimental systems are in use at various hospitals and medical centers, for computer-controlled processing and display of medical data. I have visited dozens of these places; but I have yet to see a working, operational system — such as I have observed in use at airports, to place, confirm or purchase airline reservations.

This type of system was inaugurated by American Airlines (and called SABRE) many years ago — and it has been refined, adapted and developed; such a system will work very well and is certainly applicable in a hospital — when and if the detailed analysis of requirements and systems design that preceded SABRE is capable of being accomplished in the hospital.

A major cause for the many failures of these "total" computer-communications systems in health is that one of the important users in the hospital is the doctor. Doctors as a class are rather unprepared for the techniques that computers afford. Although medical school students are learning more about computers, nevertheless there is a substantial gap between doctors and computer people; there is a formidable tendency to adhere to old traditions in the medical profession, to prepare and compile medical data in the same old cumbersome way. Medical records are really composed in a problem-oriented manner; occasionally, they are composed incoherently. However, this is changing; eventually, medical data will be recorded in a fashion that permits establishment of structured data files that in turn permit computer programs to retrieve, summarize, edit and distribute or display.

Management

The third area of application is management. Hospitals have management staffs; many of these managers are well trained and experienced. In addition, the great majority of non-profit hospitals are governed by trustee groups of whose members are industrial, financial, and professional leaders, and who have had considerable management experience with computers and automation.

Thus, in hospitals, the computer can be a management tool — for: financial analysis and forecasting; inventory control; materials management of the thousands of supplies that hospitals order and use; and preventive maintenance scheduling. The computer is an efficacious tool here, as it has proved to be in other service industries, such as airlines, hotels, and franchised food processing.

Medical-Clinical Activity

The fourth area of hospital applications is, the medical-clinical activity: diagnostic, research and educational. Here many notable applications, truly could not function without electronic equipment for diagnosis, therapy, monitoring, and analysis. Particularly the mini-computer may be the control element.

The Clinical Pathology Laboratory

The main purpose for a computer in the clinical laboratory is "high quality-control of quantity". The computer in the laboratory achieves this purpose only after careful analysis of systems and requirements has been made. Therefore, the objectives of the laboratory must be understood, and the capabilities and limitations of technology, resources, and people must be appropriately combined.

Lab Requirements

Let me first briefly explain the functions and requirements of the laboratory. Pathology by textbook definition is that branch of medicine which employs methods and instruments of precision for the examination of secretions and excretions of the human body and its functions, in order to: diagnose disease; follow its course; aid in its treatment; ascertain the cause of death if death occurs; ascertain the result of treatment; and through research help advance the science of medicine.

As applied to medicine, pathology includes the disciplines of gross and microscopic anatomic pathology, and clinical pathology.

Clinical pathology, in which automation and computers figure prominently, consists of the following major areas of study:

Hematology — the qualitative and quantitative study of blood cells;
Bio-chemistry — the study of chemical changes in the body caused by disease;
Bacteriology — the study of disease-bearing bacteria and fungi;
Serology — the study of changes in blood serum produced by disease; and
Blood banks, blood coagulation, and urinalysis.

Of these, hematology and chemistry are primary areas for automation and computerization. In other words, in these two areas, 75 to 85% of all analyses can be performed under automatic control. To varying lesser degrees, analyses can be automated in the other areas.

The general requirements for an acceptable computer-assisted laboratory system, are that it not only benefit the clinical lab, but also, the nursing service, the patient-care physicians, the hospital and above all, the patient.

Functions of the Computer System

A description of the general functions of the system, within the lab, are in order here.

Clerical — Throughout a normal work day, lab technologists expend much of their time in manually writing a variety of lists — such as patient accession lists, wherein the patient is assigned a lab number; work lists, wherein the lab number is listed with particular lab tests that have been ordered; quality control results, which are harvested at intervals during the day and charted; work tally sheets for administrative purposes of lab work load analysis; and charge lists for accounting.

Computational — Many of the laboratory procedures require computations to convert raw data obtained by analytical instruments into meaningful, clinically useful information. Each time a computation is manually or mentally executed by a technologist there are chances for mathematical errors or transcription errors. With computer assistance both kinds of potential error are minimized.

Quality Control — Without computer assistance the technologists must: monitor analytical instruments; make corrections for drift of baseline; interpret and chart repeated analyses of standards; decide when methods are "out of control"; and decide when to repeat an analysis which appears possibly in error. A properly designed computer system can monitor the instruments, analyze the data continuously to provide continuous control of quality, and relay error messages to the technologists in the event that potentially erroneous data is transmitted.

Benefits to the Nursing Service

Benefits to the Nursing Service include:

Requisition Procedures Simplification — Currently, the nursing service manually generates a daily blood drawing list from each ward. In addition, the nursing service transcribes the physicians' requests for laboratory tests to the combination laboratory request-result form. With an optical card reader and a mark-sensing request form, the computer would generate the blood drawing list and direct the printing of specimen tube labels. The nursing service would only need to mark the card in accordance with the physicians' orders.

Charting Procedures — Presently the nursing service places the laboratory result forms in the patient charts in an overlapping shingle fashion. This is a time consuming operation. With a computer, a summary review of serial laboratory results can be published in the form of a single page summary report which is easily placed in the patient charts.

Benefits to the Physician

The Benefits to the Patient-Care Physician include, first of all:

General Benefits — Much of the above discussion affords direct benefits to the physicians. Results with no computational or transcription errors and of better quality and usefully presented in the patient charts are beneficial. By freeing technologists from clerical duties, patient reports are completed up to four hours earlier. Technologist time can then be better utilized to provide laboratory tests not now available. Local performance of these tests provides less delay in patient care decisions than when specimens are shipped to distant laboratories.

Distribution of Laboratory Results — As noted above, completed laboratory reports can be returned to the floors up to four hours earlier. This aids the physician in directing the diagnosis, therapy or decision for discharge of his patients. In addition, those laboratory results which are completed can be given to physicians immediately upon request. This latter aspect is of extreme importance in hospitals like William Beaumont, with an active emergency service, intensive care units and an outpatient service.

Patient Benefits

All of the above benefits directly relate to better patient care, although most of them will not be obvious to the patient. With earlier reporting, physicians can review laboratory data at a time of the day when additional procedures can still be obtained from the laboratory. Furthermore, the decision to discharge can be made early enough in the day so that the patient can leave the hospital that same day, rather than awaiting a review of final laboratory results the next morning. It is estimated that the potential will exist for shortening the hospital stay by 12 to 24 hours in most instances. This benefit will be obvious to the patient.

All of the above constitute direct or indirect benefits for the hospital. Billing for laboratory services is rapidly provided to the hospital accounting department from the laboratory computer. This should result in increased revenue which might otherwise be lost as a result of misplaced billing slips. The need for clerical support within the laboratory will also be decreased.

I do not mean to imply that computerization is necessarily fiscally economical. Hospital benefits, summarized from previous considerations, accrue: (1) through better patient-care services; (2) through a better utilization of laboratory personnel and nursing service time; (3) through a modest increase in revenue from more complete billing; and (4) conceivably through an increased utilization of patient beds. The computerization of laboratories in other institutions has not resulted in any decrease in the need for laboratory technologist support.

Hardware Requirements

The consideration of the general requirements for a computer-assisted laboratory serves to indicate some of the specific requirements for such a system.

In order to put into effect all of the benefits described above, the system must be "on-line in real-time". The computer must be capable of accepting the raw laboratory data as it is generated at the analytical instruments, and be able to process this data immediately. "Processing" includes the computation and quality control. The processed data and the laboratory request file must be readily accessible at all times so that physician inquiries can be satisfied and emergency reports can be immediately available. These requirements define the need for direct interfacing of laboratory instruments, for easily operated devices with rapidity of data input, for disc storage to gain instant access capabilities, and for appropriate programming.

The ability to create blood drawing lists, patient accession files, work lists and incomplete work lists from cards marked by the nursing unit requires an operating optical card reader and a line printer capable of printing at least 300 lines per minute. The printer can also be used for publishing the summary reports for the patient charts.

Input Devices

The necessary hardware includes input devices directly connected to the analytical laboratory instruments. These devices should also be operable in a general purpose mode for the entry of data such as white cell differentials in hematology, which are not subject to instrumental automation. These input devices must be simple to operate and provide for the rapid entry of a patient's accession number, the type of test being reported, the raw data, and an assortment of selected comments (such as "specimen diluted 2:1" or "quantity not sufficient" or "report to follow"). With more sophisticated input devices, the computer can "talk back" to the technologists, particularly to give messages about the improper use of the equipment or probable errors in the data.

Additional interfaced input devices would be desirable for atomic absorption determinations, protein electrophoresis and gas chromatography. Special purpose input devices for entering white cell differentials, erythrocyte morphology, reticulocyte counts, urinalysis results, bacteriology data and blood bank information are necessary for the entry of data from special and "non-automatable" procedures throughout the laboratories.

The Computer

The computer can vary in size when backed up by a central hospital computer for long term storage and retrieval capabilities. Computers dedicated to clinical laboratory functions range from the CDC 3200 like the one at the National Institutes of Health to the PDP-8 or comparable small computers commercially available as "off-the-shelf" systems. The degree of sophistication and potential for expansion relates directly to the combination of "computer power", and the ingenuity and experience of the system designers and programmers.

Output Devices

Output devices vary depending upon the desires and philosophies of the users. Under currently acceptable practices, as prescribed by the Joint Committee on Hospital Accreditation of the A.M.A., the final reports must be printed and subjected to the review of laboratory personnel prior to dissemination to the patient areas. This requirement, along with others noted above, dictates the necessity of a line printer. The A.M.A. restriction would not preclude publishing provisional reports at remote terminals such as the emergency room area, the intensive care units, operating rooms or patient ward areas, if desired.

The Beaumont Hospital System

The William Beaumont Hospital has selected a system that was developed by the Berkeley Scientific Laboratories

PUNCH LINES . . .

Business managers worrying about rising costs during the 70's can count on at least one thing: The cost of their computer systems won't increase over today's levels — despite the fact that they will, on the average, require a five-fold increase in computing power. What will make this static pricing possible is Large Scale Integration (LSI) — an electronics technology that permits batch fabrication of computer memories formerly hand-wired. LSI is to the computer industry what automation was to the auto industry.

— *Robert E. Markle, Vice President*
Cogar Corporation
Herkimer, N.Y. 13350

More than 200 companies are currently in the highly competitive, low-profit margin, time sharing service with most, if not all, companies not making a profit. The largest segment of this market, scientific computation, will continue to grow, although its market share will shrink rapidly and will stagnate by the mid-1970's. **Even now vendors of time-sharing service will have to find other opportunities to broaden their market and even maintain solvency. The shake-out time is here.**

— *"Samson Trends"*
Samson Science Corp.
245 Park Ave.
New York, N.Y. 10003

The "blue collar" computer — the computer that makes things and keeps assembly lines moving — will really come into its own during the next 10 years. **By the end of the decade the smallest industrial plant will be a prime computer user. What is needed, however, is more confidence in computers.** The ghost of automation keeps reappearing, although economists have proven that unemployment is lowest when productivity is highest, and more computers working in factories would mean greater productivity.

— *G. C. Turner, General Manager*
Hagan/Computer Systems Div.
Westinghouse
200 Beta Dr.
Pittsburgh, Pa. 15238

Revolutions in technology can happen, but they're not likely because of the stolid resistance of the hard-to-change habits of human beings. It takes a long time for things to evolve and become universally accepted because of the habit patterns of people. The computer will become more critical than ever to world society during the next decade, but people — perhaps wisely — resist change and only very gradually permit technical innovations to become part of daily life.

— *Erwin Tomash, Pres.*
Data Products Corp.
6219 DeSota Ave.
Woodland Hills, Calif. 91364

Much of the hardware and all of the technology to create a system of automatic pollution monitoring stations using electronic data processing equipment currently exists. The establishment of automatic monitoring stations should naturally evolve out of the growing concern for environmental control. At a moment's notice, those charged with the enforcement of air and water pollution regulations could be advised as to excessive contamination. Remedial action could be swift, and the public interest — and the environment — protected.

— *George Wulfing, President*
Infotec, Inc.
22 Purchase St.
Rye, N.Y. 01580

The staggering cost of paper handling will force businesses and government into the "electronic money age". The effect of "electronic money" on the nation's economy will be somewhat comparable to the impact made by the railroad, automobile, and modern communications systems.

— *William M. Tetrick, President*
Synergistics, Inc.
10 Tech Circle
Natick, Mass. 01760

There are nearly 3000 computer service firms in the country, and there ought to be more like 300. With money getting tighter, and competition growing, we're going to see a considerable weeding out in the field. There's a lot of "me too" type thinking in the computer industry, and not enough searching for new ideas and applications.

— *Mike Fremming, Chairman of the Board*
Financial Technology, Inc.
7501 Carpenter Freeway
Dallas, Tex. 75247

(BSL) for the National Institutes of Health in Bethesda. The Chief of Hematology at Beaumont is the pathologist who helped develop the N.I.H. system during his tenure as Chief of Hematology there. In the BSL concept, the data input consoles are directly interfaced to the lab analytical instruments. They route raw data for processing, storage and retrieval, to the computer. We will use a mini-computer, the Interdata 4, but as BSL has shown, it would be possible to utilize in place of the Interdata, a Control Data 1700 series, the XDS Sigma 2 series, the IBM 1800 series, or equivalent process control systems.

The advanced design and implementation of the system at N.I.H. represents the culmination of roughly 30 man-years of effort by N.I.H. pathologists and computer scientists. The currently operating system was programmed and implemented by the "hardware" and "software" specialists assembled at BSL East for the N.I.H. project. Beaumont's system will differ from the N.I.H. system in the level of sophistication we will have, based on more specialized input devices for the entry of multiple result tests and consequently, more and diverse reports.

The Social Implications of Computers in Medicine

In conclusion, I would wish to add some comments on the social implications of computers in medicine. (1) The mini-computer can be a crucial tool in improving the manner in which health care is accomplished and delivered. (2) Interest and talent can be applied fruitfully in designing computer-based systems for health care. (3) As *Fortune* for January, 1970, asserted: "The institution in medicine of the same degree of efficiency that Americans have reached in other realms (of industry) would probably effect enough saving so that good care could be brought to every American with very little increase in cost." I could alter "would probably" to "might perhaps" — but I hope *Fortune* is right. □

THE HOSPITAL COMPUTER COMES OF AGE

Morton Ruderman, President
A. Neil Pappalardo, Vice President
Medical Information Technology, Inc.
65 Rogers St.
Cambridge, Mass. 02142

"A company offering total computer services to hospitals must provide for the hospital's desire to lease, rent, and even acquire fully operational medical information systems, including the computer and all necessary input/output terminal hardware, and both systems and applications software."

Viewed as the ultimate solution to the information handling crisis being experienced by today's hospitals, computers are just now emerging into all aspects of patient care. Years of work in designing a range of systems capable of handling the bulk of the information collection, storage and retrieval associated with medical care have netted substantial gains in the areas of laboratory automation, on-line patient monitoring, multiphasic screening and in the development of hospital information systems.

The obstacles associated with the development of complete hospital information systems are being overcome. Current technology and effective management techniques are finally being applied to fill the patient care void.

Technology has confronted the hospital with things that are not easily overcome — things like: (1) the necessity for a large initial capital investment for system hardware; (2) inadequate reliability; (3) an inability to attract the necessary support staff; and (4) substantial start-up time before operating systems can be obtained.

Until recently, a hospital or other medical environment desiring to computerize has been required to make a large capital outlay for equipment. This fact alone has prevented all but the most affluent institutions from attempting innovative programs.

In addition to the outlay for hardware, once one leaves the area of accounting and enters the realm of patient care, the requirements for reliability go up to 100 percent. Significant additional expense is necessary to achieve adequate system redundancy.

However, even in those cases where a hospital was able to locate the funds for computer hardware, their ability to attract and maintain an adequate technical staff has proven

Morton E. Ruderman is president of Medical Information Technology, Inc. (MEDITECH). Prior to forming MEDITECH in 1969, Mr. Ruderman was the Biomedical Marketing Manager with Digital Equipment Corporation. He received his Bachelor of Science degree in Electrical Engineering from Northeastern University in 1959, and has taken additional graduate and executive development courses in management.

A. Neil Pappalardo is vice president of systems development and secretary-treasurer of MEDITECH. He was formerly the Assistant Director of the Laboratory of Computer Science and a Research Associate at Massachusetts General Hospital. Mr. Pappalardo received a Bachelor of Science degree in Electrical Engineering from M.I.T. in 1964. He later took graduate courses in computer sciences at M.I.T.

not only expensive, but difficult as well. System development is time consuming. Unlike most turnkey users, medical institutions require a substantial amount of system modification and software development before the benefits of computerization can be realized. Thus, as much as four or five years are necessary to evolve software and techniques which maximize the data storage and handling ability of a computer based operation.

Thus, if this technology is to be spread into a wider range of medical environments, it will require commercial enterprises that are capable of delivering total services in a manner that minimizes start-up costs and the technical staffs required to sustain the system.

Management Criteria

When the focus shifts from hardware to total software services, the issue of system management becomes paramount. Whereas a considerable portion of the problem is technological, the overriding concern is still that of managing the process in which the computer takes over the data management responsibility in a hospital.

Today, hospitals are understaffed and are working under continuous pressures. They are constantly criticized by the community for inadequate services and by government for high medical costs in the delivery of health care. They have little leisure nor the means with which to experiment with new techniques. The computer must, therefore, be brought into the hospital routine so as not to disrupt on-going procedures.

Successful implementation is as much a management problem as a technological one because hospitals require services that are multi-disciplinary. It is becoming increasingly clear that, just as hospitals require computer services that are evolutionary in nature, so too the organizations offering medically-oriented computer services must be willing to maintain these services and evolve new applications programs as the hospital's needs grow.

Testing the Total Service Concept

Organized to support both the management and technological needs of today's hospitals, Medical Information Technology, Inc. (MEDITECH) was established in August of 1969 to deliver continuing medical information system services to a wide variety of medical environments.

The mushrooming demand for effective and economic patient care has sped the development of a computer system capable of automating many of the repetitive and time-consuming tasks found in a hospital. Services have been evolved to integrate medical, scientific and operation skills needed in providing computer-based information services to hospitals, clinics, screening centers, and other such patient care facilities at a low cost – often for no more cost per month than the salary of a medical secretary for total computer service (i.e. 24-hours, seven days per week) including programs, terminal and central computer usage.

Computer programs generated and maintained by MEDITECH are currently in use by many remotely located hospitals. Software for the system includes the company's unique version of the MGH Utility Multi-Programming System (MUMPS) interpreter, originally conceived at the Massachusetts General Hospital. All application programs for the medical environment are written using this interpretive language – allowing use of standard arithmetic and Boolean statements. MUMPS has been made even more suitable to the medical data management function by the addition of an extensive set of instructions to manipulate text strings and data files. These modifications were necessary since much of the data processing activity is in the form of inputting text strings that are analyzed, processed,

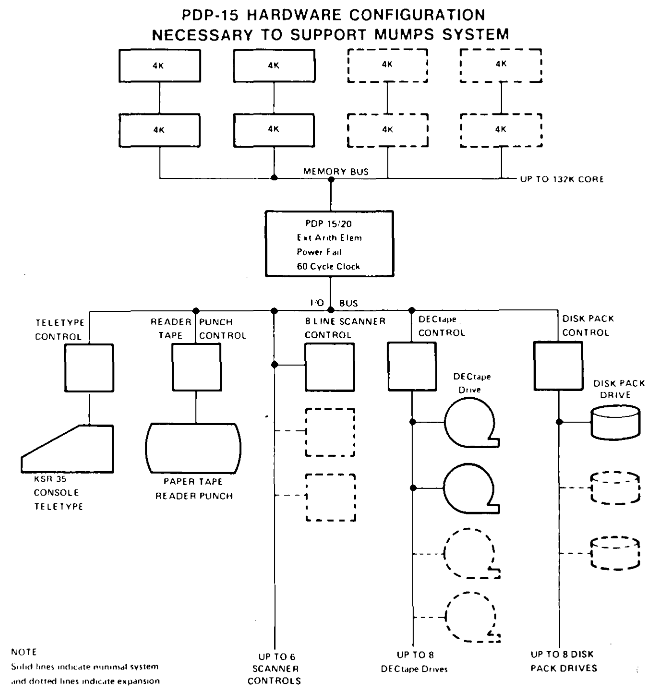

Figure 1

stored, and then retrieved on command by the computer – a Digital Equipment Corporation PDP-9 (Figure 1).

MUMPS – An Interpretive Language

Since the MUMPS interpreter is a high-level language with a particularly powerful set of features tailored to the medical community, applications programs are easily created. Although the ease of programming might also be accomplished by using a compiler language where the source program would be similar to MUMPS, use of an interpretive language has two major advantages.

The first is the elimination of compiling and/or assembling during program development. This feature makes the correction and modification of the programs especially convenient, and allows the programmer to make changes as the programs are running. This ability to modify programs quickly is especially desirable during the trial service operation.

The second and even more overriding benefit of using an interpretive language arises from size considerations. Since the source language version of an interpretive program is very concise, it is possible to have several programs resident in core simultaneously. This feature allows the time-sharing of a medium-scale computer by partitioning of core, rather than by a continuous swapping of programs from the disk. If the program being run is too long to fit into a partition, it may be broken down into several segments. These segments are stored on the disk together with the inactive programs, and are brought into the partition by the interpreter only as they are invoked by the application program.

The Computer Facility

The central computer facility itself is composed of three basic elements:

a.) a medium-scale central processor (PDP-9) with a very fast core storage,
b.) a high-speed disk memory system, and
c.) a set of terminal scanners capable of interfacing to remote teletypewriters or keyboard display scopes, line printers, card readers, optical sense page readers and analog-to-digital converters.

MEDITECH'S second computer facility will be the PDP-15, an evolved version of the PDP-9 with increased capabilities for servicing hospitals.

Shared Computer Resources

The system is designed to meet the requirements for implementation and maintenance of information systems which are concerned with solving the problems created by the burgeoning volume of medical data processing activities. This is being done in such a way that the spiraling costs of medical care can be controlled. The strategy was one of developing time-sharing computers and software in such a way that several medical organizations share a single computer. This multi-user sharing of the computer's hardware and its application packages offers substantial economies to each user of the system. This is especially true since most users of the system have similar needs, as would be expected with hospitals, clinics and laboratories.

However, whenever an individual user requires a specialized program to suit his individual needs and capabilities, a specialized application package is easily and quickly developed for him to facilitate his ability to interact with the system. The goal of this approach is to develop computer capabilities by a stable and evolutionary process tailored to the user's changing needs.

Complete Systems Support Is Needed

As medically-oriented users increase the number and scope of services they can effectively utilize, some find they are able to justify the installation of their own computer system. Yet, many medical organizations do not desire to acquire the skilled computer specialists necessary to design a complete information system — nor to program, operate, maintain and effectively apply this capability to their own changing needs. For this evolutionary process, a different type of complete systems support is needed.

A company offering services in this area must provide for the hospital's desire to lease, rent, and even acquire fully operational medical information systems, including the computer and all necessary input/output terminal hardware, and both systems and applications software.

Thus, a hospital that develops expertise in a time-shared use of a computer system always can convert to a totally dedicated in-house computer installation without the expense of reprogramming, systems checkout or other such transient problems usually encountered in such a conversion. The cost for such a dedicated in-house installation would be in the $100,000 range — remarkably low in a day of million dollar medical information systems.

Specialized Application Packages Are Needed

Today, no service company can claim to offer a totally operational version of a hospital information system. However, several companies are moving in this direction. If one looks at the modular application packages now in use and in the development stages, the progress is quite encouraging.

However, a large part of the problem encountered in designing such a system is the need for handling "literal" terminology with the efficiency that computers regularly handle numbers. The system usable in this environment must be capable of acquiring both literal and analog data.

The Automated Medical History

Several objectives of acquiring literal data can be seen in the use of a computer to acquire a medical history directly from a patient: increased efficiency in caring for patients; creation of legible and fully completed records; and a vehicle for the early detection of disease and for computer-aided diagnosis.

MEDITECH programs for automating the medical history incorporate the branching criteria characteristic of patient-physician interaction, as well as many detailed followup questions.

A self-instructional procedure or a staff member shows the patient how to respond to questions asked by the terminal; then she is essentially free to carry on other responsibilities to the physician. The patient interview is conducted by the computer, which generates multiple-choice questions to which the patient responds by typing in the number of the appropriate response.

The patient chooses the number of the appropriate answer when the question does not warrant a "Y" (yes) or "N" (no) response. Subsequent questions depend on the patient's previous response and each question and answer session is, therefore, configured for the particular patient being interviewed. Patient responses are indicated within boxes.

After each interview, a summary of the patient history is generated for the physician prior to his examining the patient. This patient history summary may be either in narrative form or it may be only a "printout" (list) of positive findings. Chief complaint histories (e.g., a history

```
NAME: GONZALES, MICHAEL          SEX: M

REASON FOR VISIT :  GENERAL CHECKUP

SOCIAL HISTORY:
  PT IS 28 YRS OLD,MARRIED, AND IS EMPLOYED.

FAMILY HISTORY:
  HYPERTENSION, CANCER AND ASTHMA.

GENERAL:
  WEIGHT GAIN OF 22 LBS. ALCOHOLIC CONSUMPTION: OCCASIONAL

HEENT:
  EYE SYMPTOMS: BLURRING EYESIGHT AND EYE PAIN. HISTORY OF
EYE DISEASE. NO DIFFICULTY HEARING. NO TINNITUS. NO EPISTAXIS.
NOTES SINUS TROUBLE, DENIES CHANGE IN VOICE.

RESPIRATORY SYSTEM:
  STOPPED SMOKING 1 YEAR AGO (SMOKED MORE THAN 1Ø YEARS) ONE
TO TWO PACKS A DAY. DENIES COUGH,NOTES NO SHORTNESS OF BREATH.
HISTORY OF NO KNOWN RESPIRATORY AILMENTS.

CARDIOVASCULAR SYSTEM:
  DENIES CHEST PAIN,DENIES PALPITATIONS,NOTES ORTHOPNEA DENIES
PEDAL EDEMA. DENIES LEG PAINS , DENIES PERIPHERAL REACTION TO
COLD. HISTORY OF HEART MURMUR.

GASTROINTESTINAL SYSTEM:
  NOTES ABDOMINAL PAIN,RARELY, DENIES NAUSEA OR VOMITING,DENIES
JAUNDICE,TROUBLED BY CONSTIPATION. HAS BEEN TOLD BY MD OF PRES-
ENCE OF HEMERRHOIDS AND NERVOUS  STOMACH.
```

Figure 2

specifically designed for a patient with chest pain, nausea, etc.) are available (Figure 2).

Patient Examination Report

A Medical Report Routine takes data acquired from the patient interview and enables the user either to enter data for a particular report or to generate a full prose of previously entered data. A Report Form Number is used to specify the kind of report desired (Figure 3). The Examination report is then generated, addressed to the physician indicated (Figure 4).

Hospital Census Operations

Another area where the computer can be readily applied is in providing complete and updated information serving as a record of patient location, as a verification of room assignments for accounting, and as an indication of bed availability. Knowledge of the exact location of all patients,

```
FORM NO:[1]
(11/Ø7/69; HYPERTENSION EVALUATION; DR. GROSSMAN)

OPTION: [E]NTER REPORT

THIS IS REPORT NO.1Ø

REPORT I.D.:[TO DR. KLINE RE PATIENT THOMAS SMITH]

ENTER ITEMS IN ORDER:

> 7 ↑DR. KLINE
> 1Ø↑MR THOMAS SMITH
> 2Ø ↑3 MONTHS
> 21,23 ↑CHRONIC FATIGUE...........
```

Figure 3

```
DEAR DR. KLINE,

THANK YOU FOR REFERRING MR. THOMAS SMITH FOR HYPERTENSION
EVALUATION.

THE PATIENT HAS KNOWN OF THE PROBLEM FOR THE PAST THREE
MONTHS.THERE IS A POSITIVE FAMILY HISTORY OF HYPERTENSION.
THE PATIENT HAS NOTED CHRONIC FATIGUE .................
```

Figure 4

and of space available to care for them, is critical to hospital efficiency and patient care.

Optimal implementation of MEDITECH'S patient census operations requires planning with the client hospital as to the best location of terminals. Terminals located in the admissions office accept the normal types of admission data; i.e., patient name, address, telephone number, illness, unit number, name of private physician, etc. Once this is in the system there is never the need to prepare forms for this information again.

Each morning the admissions office updates the computer with the names of persons admitted during the past night. At this time, a bed availability list is generated for the various divisions and patient care units of the hospital. Once this is done, any census information may be requested

```
HOSPITAL ROUTINE DESIRED :[W]ARD REPORT

WARD:[W1]

:::: WHITE 1 ::::
14 BEDS OCCUPIED, 6 BEDS FREE

 ID     NAME               AGE      SEX    BED
99-7Ø  JONES, JAMES        28        M    W1Ø1A
77-64  SAMUELS, RALPH      --        M    W1Ø1B
73-16  TARLIN, ROBERT      42        M    W1Ø1C
79-14  FORMAN, ROBERT      57 ..............
```

Figure 5

from the computer, including printouts of bed availability in an individual care unit (Figure 5).

Swift admission of a patient to any available bed within a hospital is accomplished using an Admission Routine. The computer requests all the data necessary to admit the patient: i.e., name, address, telephone number, next of kin, birth date, sex, admitting diagnosis, insurance, and bed location (ward and bed). The patient's hospital number is then assigned by the computer and admission is completed.

If the admitting officer is unsure as to which beds are available he merely types a question mark (?) on the teletype. The computer then generates a list of available beds at any particular care unit.

Transfers

To transfer a patient, the computer requests the patient's unit number and asks for a ward or bed to which the patient is being transferred. If the requested bed is available, the transfer is completed immediately. Bed location can be specified merely by ward or room, whereupon the computer will assign the patient any available bed in that ward or room.

Discharging a Patient

Any patient may easily be discharged from the hospital at any time.

On activating the Discharge Routine and entering the patient number, the patient's name and location will be printed out on the teletype along with the question, . . . "DISCHARGE O.K.?" If the user types "Y" (for yes), discharge is made by the computer, which now considers that bed as available for a new patient.

Scheduling Appointments

Computerization enables a hospital to effectively list, make or cancel appointments for any diagnostic or care

```
OPTION:[M]AKE APPOINTMENT

FOR WHAT UNIT? [X]RAY

FOR WHAT DATE:[3/1Ø]

FOR WHAT TIME: [1 PM]

O.K.

OPTION:[L]IST APPOINTMENTS
```

Figure 6

center. Appointments can either be listed by patient number or by particular location such as X-Ray, TB Clinic, etc. (Figure 6).

Ordering Medications and Lab Tests

Using the correct routine and appropriate option within that routine, a physician (or his designate with proper identification) may order or cancel drugs for any patient under his care. The physician may request a list of all drugs currently in use for the patient, along with the name of the doctor who prescribed them and the time at which he did so. (All medication charges are automatically held by the computer for listing on patient bills when the patient's bill is activated.)

The ability to order investigative and diagnostic laboratory tests enables a physician to quickly treat his patient. A laboratory technician may then enter results for laboratory tests previously ordered. As with the Medication Routine, test charges are held by the computer until the patient is billed on leaving the hospital.

The Automated Chemistry Laboratory

Nowhere is the need for computer-based applications packages as critical as in the Chemistry laboratory. During the normal day of operation, the system is required to accept requisition information, print out work sheets, collect test data directly from laboratory instrumentation, generate patient reports, and answer a number of general inquiries for test results.

Many normal procedures in the laboratory are, unfortunately, manual ones which do not lend themselves to automation. Provision is made for entry of results from manual tests into the computer-generated patient reports.

The operation of a typical computer-based laboratory is outlined below. The following sections explain the major functions performed by the existing chemistry laboratory system in use today. However, MEDITECH has personnel available to assist in this evolutionary process.

Log-in: When a sample arrives in the laboratory, it is assigned a specimen number in the normal manner. For each specimen number, the hospital identification number (or any identification number) of the patient to whom it belongs is entered into the computer through a terminal (teletype or display).

If the patient is in the active file, the computer responds to this identification number with the name and patient care unit for verification, after which the typist designates the tests which are to be performed.

If the computer has no prior information on the patient, the typist (technician) must enter the patient's name, sex, hospital number, etc. into the computer — thus creating a patient file.

Test requests arrive in the laboratory throughout the day and can be entered into the computer on a continuing basis.

```
OPTION: LOG-IN

---
PATIENT NUMBER: ØØ-46  (SMITH, THOMAS     W2Ø1G)

TESTS:  NA, K, BUN, GLU, .........

OK? Y

SPECIMEN NO: 1Ø4
```

Figure 7

During peak loads, multiple terminals may be used to enter test data (Figure 7).

Master Worksheet: The Master Worksheet contains essentially the same information that appeared on the Log-In requisitions — but is formatted by the computer so that the technician working with the samples can conveniently use it as a guide for dividing and grouping the

```
OPTION: MASTER WORKSHEET

SN     PATIENT                 TESTS
1Ø1    TATEL,L             CA     K      BUN
1Ø2    LERNER,R            CA     K      NA     P
1Ø3    PETERSON, D         CA     K      SGOT   NA    P    BUN
1Ø4    SMITH, T            GLU    K      NA     BUN
```

Figure 8

specimens according to the tests to be performed (Figure 8).

At specified times during the day (or on request), the computer prints out worksheets for each run of tests to be performed in the laboratory. Each worksheet contains a schedule for each particular test and includes standards, controls, and specimens. The technicians enter their readings on these computer-generated worksheets (Figure 9).

```
ELECTROLYTE  WORK  SHEET                          MARCH 3, 197Ø

CUP  SN    PATIENT            TESTS

1          STAND 1

2          STAND 2

3          STAND 3

4          STAND 4

5          CONTROL

6    1Ø1   TATEL, L                     K           CO2

7    1Ø2   LERNER, R           NA       K     CL    CO2

8    1Ø3   PETERSON, R         NA       K     CL    CO2
```

Figure 9

Test Result Entry: To insure immediate reporting of tests ordered on an emergency basis, test results on specimens marked "STAT" (indicating an emergency situation) are entered into the computer immediately and then automatically reported to the appropriate care center. All test results are, at present, entered manually into the computer. With the installation of analog-to-digital conversion, the computer will collect data directly from laboratory instrumentation on-line. MEDITECH has an A/D converter that can presently transmit through regular communications systems. This capability eliminates the transcription of test results while monitoring all instrumentation for quality control. The computer is programmed to permit considerable flexibility in entering test results which are not in a defined order, and can generate any desired report of test results for procedures done in the laboratory.

Cumulative Reports

Test results are compiled by the computer for each patient. The report issued for the use of the medical staff is cumulative, containing all the laboratory findings for a

```
SMITH, THOMAS     ØØ-46        WHITE 2Ø1G        MAR 3,197Ø

COLLECTION DATE       Ø3/Ø2    Ø3/Ø3

---ELECTROLYTES---

SODIUM                          14Ø
(L36-L45 MEQ/L)

POTASSIUM                       *5.5
(3.5-5  MEQ/L)

---BLOOD SERUM METABOLITES---

BUN                             PEND
(8-25 MG/1ØØ ML)

BLOOD SUGAR                     8Ø
(7Ø-1ØØ MG/1ØØ ML)
```

Figure 10

patient during the past week. Test results outside of normal range findings are marked (*) for easy identification on all output (Figure 10).

Preparing the Patient's Bill

The computer can compile all applicable charges against any patient number requested. Last minute additions to the list of charges are requested by the computer before

```
HOSPITAL ROUTINE DESIRED: BILLING

---
PATIENT NUMBER: ØØ-46 (SMITH,THOMAS    W2Ø6G)
ANY ITEMS TO ADD TO BILL? NO

ROOM CHARGES:

Ø3/Ø3    WHITE 2Ø6G                          74.ØØ
                               SUBTOTAL      74.ØØ

MEDICATION CHARGES:

Ø3/Ø3    PLACIDYL                             9.ØØ
                               SUBTOTAL       9.ØØ

LAB CHARGES:

Ø3/Ø3    GLUCOSE                              6.ØØ
Ø3/Ø3    POTASSIUM                            4.ØØ
Ø3/Ø3    SODIUM                               4.ØØ
Ø3/Ø3    UREA NITROGEN                       15.ØØ
                               SUBTOTAL      29.ØØ

                                  TOTAL     112.ØØ
```

Figure 11

compiling the total bill for the patient. The computer then prepares the reconciliation for the patient account (Figure 11).

Future Developments

Many people believe that full utilization of computer services by hospitals may be as far as a decade away. Our present experience contradicts this view — though we recognize that the process is still evolutionary in nature. During the last two years, developments in system integration and in software have laid the groundwork for rapid development of the modular components from which a total hospital information system can be assembled.

In the short term, we expect to see many hospitals working with the individual service components they deem as most critical. Later, their desire to expand will be matched by further refinements in technology, and they will be able to fill in computer-based services to supplement their existing capability.

Growth, then, will be evolutionary. It will also be a steady and continual process, assisted by private organizations who can provide the technical expertise to refine the process. □

THE ROLE OF ADMINISTRATORS AND PHYSICIANS IN THE DEVELOPMENT OF HOSPITAL INFORMATION SYSTEMS

Geoffrey G. Jackson
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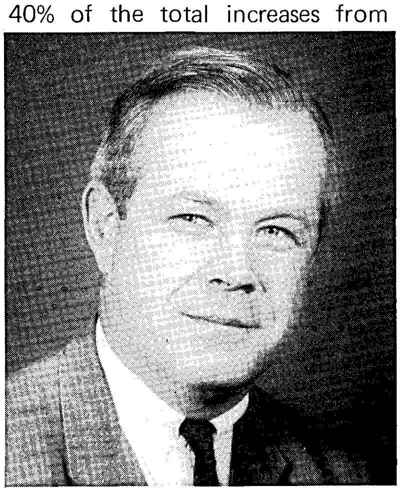
"We can no longer administer a complex medical institution by 'the seat of our pants' any more than the physician can continue to practice advanced medicine without computer assistance."

This is an age of rapidly escalating medical care costs, and much has been said about rising salary levels and increased costs for medical products. As an index of growth, suppose we take short-term general community hospitals. There has been an increase of some 13% between 1963 and 1968 in the number of people required to render service. Combining this with a 35% increase in average annual salary over the same period of time, there has been an annual increase in costs of over $2 billion. This represents over 40% of the total increases from all causes. Personnel cost is rising at a faster rate than other cost factors.



Geoffrey G. Jackson is the Associate Director of the Peter Bent Brigham Hospital in Boston, Mass. He holds a B.A. from Amherst College, and an M.S. in Administrative Medicine from Columbia University. His administrative residency, required for his M.S., was done at Massachusetts General Hospital. He was formerly with General Electric Co. as manager of market research and development for MEDINET, and was the assistant director of the University Hospital at the Boston University Medical Center.

The Flood of Information

With the above in mind, what logical approaches can be considered for controlling these costs, or at least bringing the rate of increase into line with the rate of increase in the national economy? There are no easy answers; the increasing complexity of rendering patient care in the hospital environment is one of the major factors causing the rise of costs. Automated devices (electronic and electro-mechanical) are proliferating in every area of the hospital. Chemistry and hematology laboratories are being automated. Countless patient monitoring devices and systems have come into use. Patient menu selections are being broadened by pre-prepared, portion-controlled, food systems. These automated devices and systems are expanding the capability of areas affected, which in turn generates an increased utilization of the facility. It is, to some degree, a "vicious cycle" where increased capability produces increased demand, and vice versa. In addition, these automated systems are generating a vast flood of information.

How many people are involved with this ever-increasing tide of information? No accurate figures really exist, probably because it is difficult to identify the time consumed by any individual performing his portion of the information-handling activity related to a given sub-system, such as a laboratory. But doubtless many hours are involved.

Satisfactory measurements can hardly be made until accurate information is available defining the path of the information sub-system. Few hospitals can exhibit accurate flow charts of their many information sub-systems. Even if we cannot measure accurately the times or costs, we should at least diagram the sub-systems and identify the number of people involved. In this way we can indicate the magnitude of the problems which ensue when some portion of an information sub-system fails to perform as it should.

Categories of Information Are Not Clear Cut

The great majority of hospital information sub-systems contain essentially two categories of information: medical information; and administrative information. This categorical subdivision is, however, not sharp. For example, the typical laboratory requisition and reporting document is a multipart form with the names of procedures or tests to be performed, and a blank space which is subsequently filled in with the result. One carbon copy of the form contains charge-code numbers (if the hospital has automated patient billing) to be used by the accounting department. In addition, patient identification information including name, patient number, location, etc. is on all copies. Of course, the test result data is basically medical information. But when this same information is collected over a certain time period and analyzed for quality control, the information becomes an administrative tool. Alternatively, charge code information collected over a certain time, and summarized statistically, to indicate test frequency and trends, has medical implications.

This type of interrelationship exists in all hospital ancillary service areas including pharmacy, laboratories, radiology, and dietary. A significant number of hospitals that have electronic data processing installations fail to recognize this interrelationship. That failure frequently results in considerable unnecessary duplication. Thus many hospital EDP billing systems are designed to suit the needs of the accounting department only. In some instances, operating departments such as laboratories are not even aware that useful statistical fallout from the billing system is available.

Physician Interaction

Physicians interact with the information sub-systems at various levels. In many instances sub-systems have evolved directly as a result of physician requirements, either for medical reasons or for convenience. For example, the elapsed time between a sample collected for a laboratory test, and the reported result may be specified by the physician. Physicians tend to request immediate results for a far higher percentage of the total tests than is generally acknowledged to be medically essential. A high rate of these "rush" orders compounds the problem of total throughput in a laboratory. Most laboratories (such as chemistry and hematology) use sophisticated automated equipment, and set up "batch runs". Once these runs are in process, they cannot be interrupted; thus most responses to "rush" orders must be determined manually rather than via automated equipment. This is not only more costly, but interferes with the regular "flow process". When the number of these orders becomes inordinate, the entire testing cycle is slowed down.

Patient Identification

In the typical requisition for ancillary service (such as radiology, etc.) the most vital part of the information is identifying of the patient. Illegibility can cause significant problems; up to this point they have not been well measured. Most hospitals utilize some form of metal-plate ink imprinter to identify patients. These devices are often not properly operated and some portion of the information is illegible. Typically, if the originating department can read the patient's name, they assume that this is adequate. But although his name may be clear, the patient's number and his location may be partially obscured. When the requisition is then received in the ancillary department, they are not able to read the location, and they call "information" or the admitting office to determine the location of the patient, in order to transmit the ancillary department's result to the correct place. A second part of this form goes to the accounting department; they also can't read the patient number, by means of which they organize their billing accounts. Another telephone call and some more wasted effort is needed to fill in another bit of essential information for the same transaction. Any significant amount of illegibility can cause inordinate delays in transmitting important information.

The Level of Understanding

A level of understanding of various hospital information sub-systems both by administration and the physicians is urgently needed. Neither the hospital administrator nor the physician need be a systems analyst, but they do need a general understanding of hospital systems and procedures to work effectively together. Naturally, there is a tendency on the part of anyone to want to solve his own pressing problems without due regard to the effect of the solution on others. This approach to problem solving is evident in many hospitals. Over the past ten years, it has produced "information systems" which can best be described as "patchwork quilts" and which function, in many cases, only on the knowledge and inherent idiosyncracies of several key clerical employees.

The Results of Uncoordination

This example of the results of a self-centered approach to problem solving occurred in a hospital recently. The director of one of the clinical laboratories in this hospital engaged a commercial time-sharing computer firm to provide a system which would (1) accept information pertaining to orders for clinical tests organized by patient; and (2) produce work lists organized by procedure — thus "automating" a somewhat time consuming and tedious manual task. Originally, this new system was to be used on a trial basis for two months only. But because the laboratory personnel readily accepted it, the system quickly became an integral part of the overall computer system of the hospital.

When the hospital systems staff were then brought up to date on the new system in the lab, they quickly determined another use for it. By adding six digits to the input of each patient requisition, the system could produce, as a by-product, a machine-readable tape which could be used for billing. This application of the system eliminated manual keypunching of some 1000 cards per day — and the time saved in the billing activity turned out to be greater than the time saved in the lab itself.

Why was this second use for this system not planned from the start? The commercial firm installing the system should have recognized the potential of the proposed activity; but the laboratory director made the mistake of solving his own problem without considering the other operating parts of the hospital.

Responsibilities of Equipment Manufacturers

The attitudes and responsibilities assumed by the manufacturers of automated equipment can also affect the success of a system. For example, one firm producing an automated hematology device provides with the device a "black book" to be used to convert the analog signal to a printed digital result. There was no provision made by this company for acquiring these digital results in machine-readable form. Thus numbers had to be re-keyed before they could be introduced into the in-house computer system.

Equipment manufacturers have made some progress in automating clinical tests, but not enough progress has been

C.a

PROBLEM CORNER

Walter Penney, CDP
Problem Editor
Computers and Automation

PROBLEM 706: RESTORATION COMPLETED

"Had a little trouble with our printer today," Joe said as Pete entered the computer room.

"What was that?"

"Well, at first we thought there was something wrong with our decimal to binary conversion routine. By coincidence, at the time the bug developed, we happened to be using a number containing only 1's and 0's. You can imagine our surprise when we got the same number for the equivalent in binary."

"You pulling my leg or something?" Pete asked. "Only 1 and 0 are the same in decimal and binary."

"Right! But this was a 6-digit number. Of course, as soon as we tried another number we realized what the trouble was. The machine for some reason was printing out only the left-most six bits."

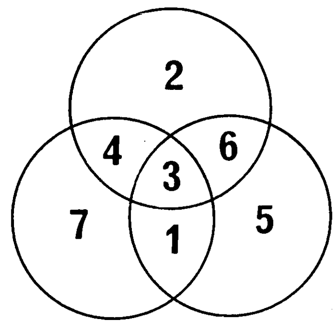
"Everything O.K. now?"

"Oh, yes," Joe said. "And my faith in the conversion routine was restored."

What was the number?

Solution to Problem 705: Al's 3-Ring Problem

The numbers 2, 5 and 7 were in the outer areas and 6, 1 and 4, respectively, were in the overlapped portions; or, equivalently, 6, 1 and 4 in the outer areas and 5, 7 and 2, respectively, in the overlapped portions.



Readers are invited to submit problems (and their solutions) for publication in this column to: Problem Editor, Computers and Automation, 815 Washington St., Newtonville, Mass. 02160.

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made in speeding up reports of the results of these tests. The fact that the lab can conduct tests more rapidly is of little value to the practicing physician, unless he can obtain the results reasonably quickly.

Personnel Shortage

The hospital/medical field needs capable systems people. To say that these people are in short supply is an understatement. Hopefully the unique challenge of the medical field will attract more capable people.

I do firmly believe that hospitals need to be automated. We can no longer administer a complex medical institution by "the seat of our pants", any more than the physician can continue to practice advanced medicine without computer assistance. There is no reason, however, for well-planned, automated systems to "de-humanize" hospitals.

Lessons from Industry

Many of the criticisms leveled at our "so-called" health delivery system are justified, I think (see ***Fortune*** magazine, January, 1970). Management of hospital and health delivery systems has been less than outstanding, and doctors, administrators, and boards of trustees must share the blame.

Probably the area in which they have been most negligent is in the utilization of the systems and techniques that have been developed and used by industry for almost two decades now. Perhaps one cannot directly compare the manufacturing process with the sickness-to-health process, yet a lab system is in many ways similar to a process control system. While there are few manufacturing industries that today do not rely on process control systems, the number of hospitals with totally automated laboratory systems is quite small.

We are rapidly becoming buried in a sea of millions of words handwritten on paper documents. These words must be reduced, formatted and stored in machine-readable form soon, or the volume will make access to the documents virtually impossible within any reasonable time frame. The problems created by the volume of medical records in my hospital are staggering. Industries could not make a profit without solving these kinds of problems. If airline scheduling were not computer-assisted, the airline companies could not handle the volume of business they do economically. Inpatient and outpatient admissions in a hospital share some of the problems of airline scheduling, yet there are few inpatient/outpatient scheduling and admissions systems.

The Commercial Vendor

We must be wary of the commercial vendor's ability to solve complex systems problems. Much of what appears in advertisements and brochures is in the imagination of the marketing section of a company. A demonstration model can be a long way from the reality of actually operating a system. Attempts to apply industrial techniques to hospitals will only succeed in an environment of mutual understanding. A lack of understanding can have undesirable, if not disastrous results.

Neither hospital administrators nor physicians are capable of functioning effectively in an environment of too stringent systems controls. But the total lack of control over automated systems is no longer tolerable. We can no longer cling to our paper documents and a prodigious memory. Administrators and doctors alike must shed the familiar past and delve into the realities of today — and without question, this means automation wherever feasible. □

In the Year 2001: SURGERY BY COMPUTER

Dr. Robert Fondiller
Management Consultants
200 W. 58th St.
New York, N.Y. 10019

"The kidney transplant operation proceeds at lightning speed – without a human surgeon! The computer-controlled robot, whom the staff has affectionately named 'Dr. Sawbones', is efficiently operating at a speed that is almost too fast for the human eye to follow."

A.D. 2001. Mr. Star Bright is lying naked in the environmentally-controlled operating room of Compu Hospital. He is in the midst of a kidney transplant.

The only other human being in the operating room is Miss Digit, a computer operator with a specialty in nursing. Her only attire is an aseptic spray-on coverall. When she goes off duty, her coverall will wash off instantly in the shower, and she will spray on another attire, appropriate to her after-work activity, by merely pushing the appropriate buttons of the spray-on machine for a riding outfit, evening dress, or whatever is her whim of the moment.

Dr. Robert Fondiller is a licensed Professional Engineer with degrees from Columbia University and Stevens Institute of Technology. He is also a licensed Psychologist; his Doctorate Thesis was on "Creative Problem-Solving." Dr. Fondiller is on the faculties of New York University and Columbia University's School of Engineering and Applied Science. In addition to his teaching responsibilities and consulting assignments, he is also a frequent speaker for the American Management Association, the Association for Computing Machinery, and a number of other professional societies.

Miss Digit is paying no attention to Mr. Star Bright. She is programming the computer for the next patient, a heart transplant, whose operation will begin in 2 minutes and 46 seconds. Organs are no longer repaired, nor taken from other human beings. The man-made article is now far superior, free from disease or breakdown, and "guaranteed for a lifetime."

Mr. Bright's operation is proceeding at lightning speed – without a human surgeon! The computer-controlled robot, whom the staff affectionately call "Dr. Sawbones", is efficiently operating at a speed that is almost too fast for the human eye to follow.

Admission Procedures

When Mr. Bright arrived in the unattended reception room of Compu Hospital, there was no tiresome waiting, interviewing, and filling out of forms – with the patient "dropping dead" on his feet. Instead, Mr. Bright walked up to the brightly illuminated sign, "NEW PATIENTS PRESS THIS BUTTON". He pressed the button, and a recorded voice immediately welcomed him in warm, soothing tones: "Welcome to Compu Hospital. You will be out again – healthier than ever – in less than fifteen minutes. Your friends and family can wait for you at the Exit Door, at the back of the hospital. Will the patient please lie down on the couch, with the head toward the wall. That is all."

Mr. Bright followed the instructions. Lying down, with his head toward the wall, he discovered that the "couch" was the beginning of a ride on an endless conveyor belt. His weight actuated the drive motor and he began travelling toward the operating room. Soft, warm air and lighting soothed him. A gentle voice cooed, "Please shut your eyes." As the conveyor belt carried Mr. Bright along, his spray-on clothing was evaporated off, his skin was laved by a warm, antiseptic mist that did not lower his body temperature.

The pea-size transmitter that had been implanted in Mr. Bright's body at birth broadcast his identification number, so that the computer could retrieve all his vital information from the Personal Data Bank, without Mr. Bright having to say a word. No need to recall the date of birth when you are too ill to remember. No need for blood typing, etc., etc.

Routine Tests

Routine tests were conducted almost without Mr. Bright's knowing about them. For instance, he thought that he felt a slight tingling at one of his fingertips – but before he could really identify the sensation, it had gone away. Actually, his fingertip had been sprayed with a local anesthesia, a needle had extracted a micro-sample of blood from a capillary, and a light touch of a laser beam had cauterized the spot – all in less than one second.

Mr. Bright was in a state of euphoria. The first zone through which the conveyor belt passed contained a heady gaseous relaxant and analgesic (an agent for producing insensibility to pain). Mr. Bright began to feel that the world was a very happy, healthy, painless place in which to live. Therefore, when the sub-liminal (below the level of conscious awareness) command to "deliver a urine sample" was given by the robot and collected by the robot, Mr. Bright unknowingly complied. (In contrast to the old procedures of the Dark Ages of 1970, when the patient was too frightened to relax sufficiently to deliver a sample of urine for analysis.)

Identifying Illness

Mr. Bright then passed through a hoop of extremely delicate thermal sensors, whose function was to identify and diagnose any illness anywhere in his body. Whenever any part of the body is in stress or difficulty, blood rushes to that area to help repair and heal the area. This causes a local concentration of higher heat than the rest of the body, which the thermal sensors detect. The body-scanning of the thermal sensors is computer-plotted by X and Y axes to pinpoint any aberrations from health. The aberrations are then fed into the computer for diagnosis, and choice of therapy – which is then carried out by injection of long-lasting (several years, if necessary) prescriptions – or, – if indicated, – surgical procedures by Dr. Sawbones.

In Mr. Bright's case, the computer calculated Mr. Bright's survival chances ***without*** an operation versus his survival chances ***while undergoing*** an operation versus his survival chances as a result of ***having had*** the operation, – and mathematically selected his best statistical survival chance as having the operation now.

A Failing Kidney

Once Mr. Bright's trouble was found to be a failing kidney, he was injected with a dye that colored his kidney ***only.*** Later, in the operating room, a curve-tracing computer program would control Dr. Sawbones' laser in cutting out his old kidney.

In the meantime, the size of the artificial kidney that Mr. Bright would require was calculated by a computer program based on these input data:

1. His weight – as determined when the conveyor belt went over an in-line scale.
2. His body volume – determined by an array of photosensors ***beneath*** the transparent conveyor belt and ***alongside*** the conveyor belt. (Very much like the photosensors that keep elevator doors open when a passenger is in front of the photosensor, either entering or leaving the elevator.) The computer completed all the intricate calculations to arrive at Mr. Bright's body volume and density, including taking account of such possibilities as edema (abnormal accumulation of serous fluid in the connective tissue).

By the time that Mr. Bright arrived in the operating room the computer had:

1. Computer-admitted him to the hospital.
2. Computer-interviewed him.
3. Computer-received him – and undressed, washed, and given him a relaxant.
4. Computer-lab tested him.
5. Computer-diagnosed him.
6. Computer-prepared him for the operation.
7. Computer-administered his analgesia.
8. Computer-calculated operating room procedure for him.
9. Computer-programmed the operating robot.

Finally, Mr. Bright passed through the hypnotic section of the conveyor belt, immediately prior to entering the operating room. The hypnotic section:

1. Hypnotized the patient by a combination of visual stimuli (flashing and whirling lights, visible through closed eyelids) and a soft, suggestive recorded voice.
2. Gave him all his instructions for behavior during the operation, such as "feel no pain, remain motionless, obey instructions."
3. Gave him all his post-operative instructions as post-hypnotic suggestion, including a list of do's and dont's, possible post-operative symptoms and what to do in response to each, when to return for a check-up, etc. (Under hypnosis, long and detailed instructions are easily remembered and obeyed.)

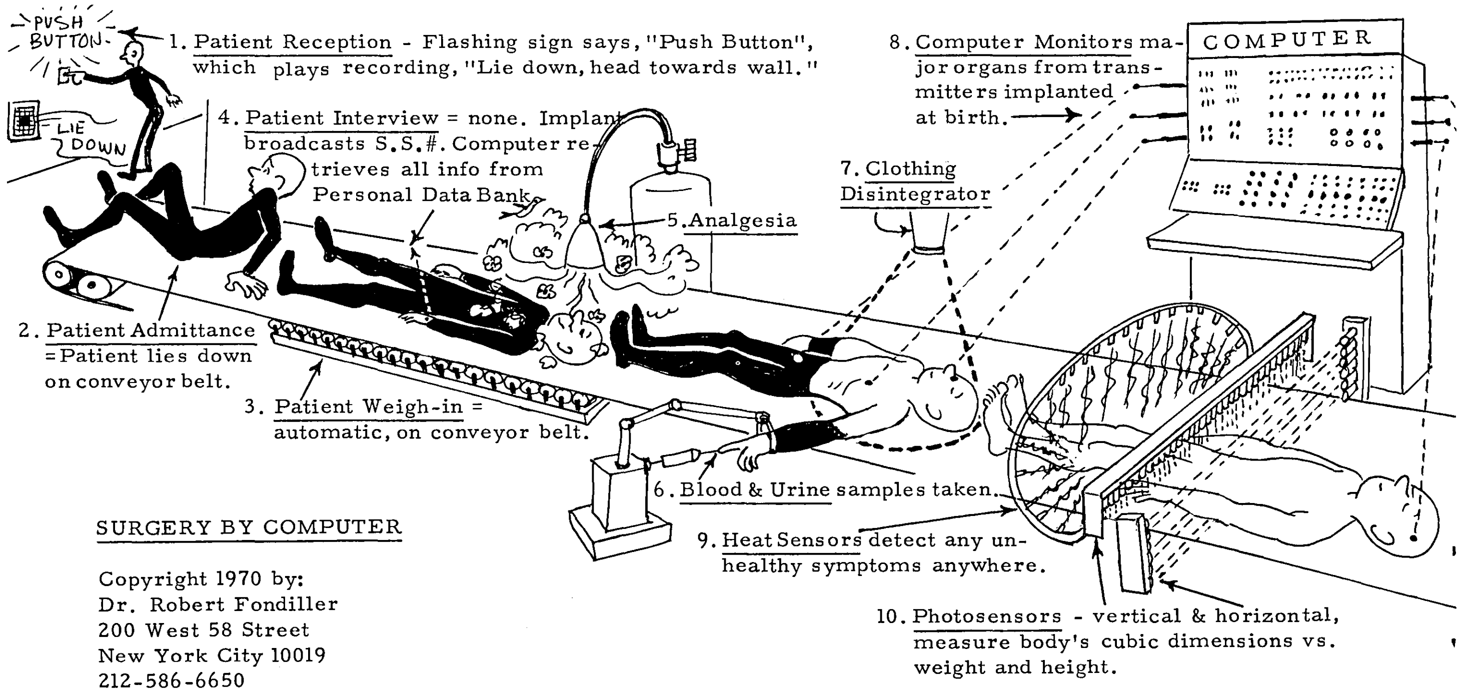
Now, Mr. Bright arrives in the operating room, delivered by the conveyor belt. His computer-selected artificial kidney has been automatically delivered to Dr. Sawbones. His body is relaxed. It is simply a matter of taking out the old, defective kidney and replacing it with the new artificial one.

The Transplant

Dr. Sawbones' many robot hands go into action ***simultaneously,*** as computer-programmed (from his data bank of previous kidney transplant operations, which has been personally tailored to Mr. Bright's specific case as it was diagnosed and analyzed during his brief, quick trip along the conveyor belt). Dr. Sawbones operates alone. He needs no surgical assistants, with whom he needs to speak, and then wait for them to understand and execute his orders.

While Dr. Sawbones is making a laser incision in "the most perfect spot" (bearing in mind the location of the kidney, the musculature of the abdomen, and the esthetics of the slight, thin white line of scar tissue that will remain), other pairs of "paws" of Dr. Sawbones' are testing the elasticity of Mr. Bright's abdominal skin – to mathematically compute the optimum length and direction of the incision to ***just*** clear the removal of the old kidney and the insertion of the new.

As the incision is made, the laser cauterizes the tissue against blood flow and infection, and the "paws" continually test the size of opening that is necessary by pulling the incision open ***as it is being cut!*** A feedback loop through the computer continuously monitors and calculates the length and direction of incision required and the results of the calculations control the motion, and the length of motion, of Dr. Sawbones' laser beam.



SURGERY BY COMPUTER

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While the incision is widening, others of Dr. Sawbones' "fingers" are spreading the muscle layers apart, while still others are positioning themselves to pinch off the important blood vessels leading to the kidney, prior to their being severed by the laser beam (in a cutting by evaporation, but not cauterizing, mode).

At the time of the removal of the old kidney, some twenty or thirty of Dr. Sawbones' "fingers" will be pinching off blood vessels, holding back muscles, lifting out the old kidney, inserting the new kidney, etc. The whole operation is programmed to take place in less than three minutes.

Timed Recovery

At the end of 180 seconds, Mr. Bright has a freshly-tested, newly-installed, artificial kidney that will outlast him, and he is passing on the conveyor belt out to the back door, where his timed recovery will enable him to get a post-hypnotic cue to "Sit up! You are all better again — and healthier and happier for your visit to Compu Hospital." And so, Mrs. Bright accompanies him home in their car, less than five minutes from the time that Mr. Bright walked in the front door of Compu Hospital, an ailing man, in need of a serious operation!

"MAY DAY!"

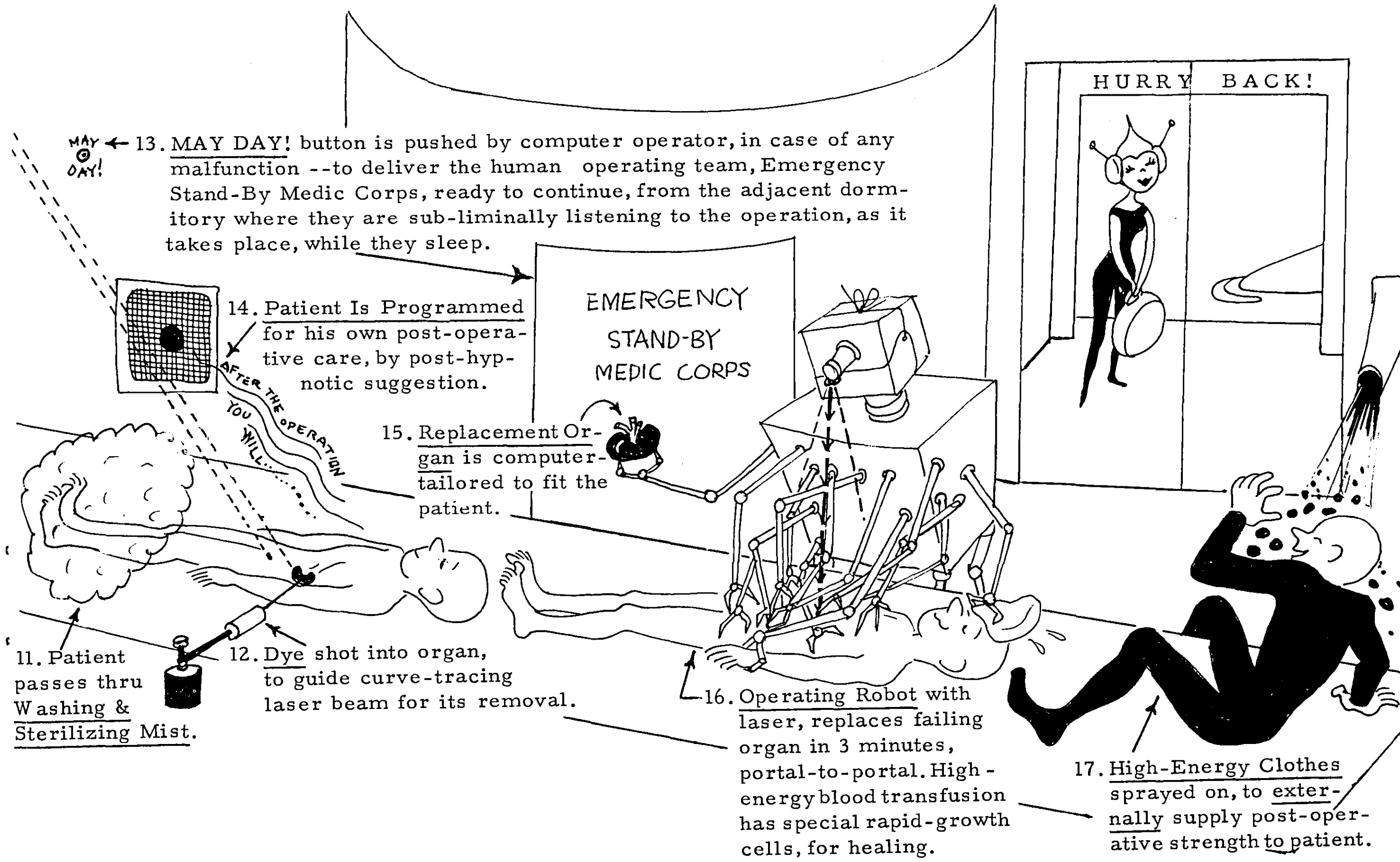
Miss Digit has been watching Dr. Sawbones operating on Mr. Bright out of the corner of her eye, as she went about her computer-tending duties. If there had been the slightest difficulty of any kind, she would have immediately hit one of the "MAY DAY!" buttons, strategically placed within arm's length from any point in the operating room. The "MAY DAY!" button would:

1. Immediately immobilize Dr. Sawbones.
2. Actuate a high-speed, 5-second computer print-out of:
   a. The patient's diagnosis.
   b. The PERT diagram of the step-by-step procedure for the operation.
   c. The post-operative procedures.
   d. The point at which the operation was stopped.
   e. The reason why the operation was stopped.
   f. The PERT diagram of what should be done, step-by-step, ***right now.***

Alongside the operating room is a dormitory containing a complete ***human*** operating room team, antiseptically prepared, dressed, ready for immediate action, and fast ***asleep.*** While sleeping, this team has been receiving a sub-liminal report of all the information in the above print-out. If the operation had concluded successfully, they would have received a suggestion to "Forget all about this operation." On the other hand, if anything goes wrong, the dormitory room is immediately revolved to open into the operating room and the operating team awakened. They are all ready to go into instant action, because they have been completely in touch with every detail of the operation while asleep. Their last sleeping suggestion would have been, "You will remember everything about this operation when you wake up NOW!" The operating team would then take over from Dr. Sawbones, as best they could, being only humans (with such very human limitations as only two hands apiece, and being able to think with a brain whose internal speed is only 50 miles per second vis-a-vis the computer's internal electrical speed approaching light's velocity of 186,000 miles per second).

Alternatives to Transplant Surgery

The foregoing description of an organ transplant operation 31 years hence was unimaginative, because organ



transplant surgery may no longer be necessary then. Instead, miniature transmitters will probably be placed throughout the body at birth, each about the size of a fly speck, or broadcast ***only*** when the strategic location in the body (which the transmitter is monitoring) becomes unhealthy. In effect, many "Little Brothers watching you" will safeguard your health.

Diseased organs will be injected by a gun aimed and shot (to the proper depth inside the body) from outside the body, with specific, trained bacteria to fight the specific illness. Or, general purpose cells with a high growth rate (like a controllable healthy cancer) will be used to consume the unhealthy cells and rapidly replace them. Or, chemotherapy will be employed, where the chemical unbalance (either living or inert) that causes malfunction in organs will have been so accurately analyzed, that countervailing chemicals can be introduced to restore the proper balance within the organ. Or, a hypodermic needle could be inserted into the ailing organ, disintegrate it into dust-sized particles, suck the particles out, and re-inject ***another*** dehydrated, collapsed, string-shaped ***new organ,*** that would then be wetted and blown up in its proper place into a full-size, "instant" replacement organ.

The description of Mr. Bright walking into Compu Hospital was also an old-fashioned, rutty idea. Actually, since everybody would be computer-monitored, if something serious occurred, an ambulance would be computer-dispatched to pick up the patient, drive into the hospital itself, and unload him directly onto the conveyor belt.

Costs

Of course, costs will go up due to the inflationary pressures of the working-class unions. But these will be more than off-set by the cost-savings of the thinking class's innovations. As a result, a three-minute operation may cost $20.00 per minute of computer and peripheral (Dr. Sawbones') time, or a total of $60.00 for an organ transplant. In a checkless society, the computer would simply deduct the cost of the operation from Mr. Bright's account – with no paper work, no signatures.

Mr. Bright's temperature, pulse, blood pressure, and respiration rate are all computer-monitored on the conveyor belt, and in the operating room, as they are 24-hours of every day of his life.

Monitoring and Decoding Brain Waves

There is a very, very remote possibility that by A.D. 2001, a computer may be able to decode Mr. Bright's brain waves (as measured by electro-encephalogram-electrodes on the skull) into actual words and sentences. If so, it will be possible to computer-interrogate Mr. Bright for his symptoms, and receive his answers without Mr. Bright having to speak. If not, the interview by the computer can take place in the hypnotic trance, with the computer decoding human speech into computer language of "0's" and "1's".

The Here and Now Reality

Implantable Transmitters for sounds (such as a phonocardiogram), for temperature, and for pressure are ***now*** manufactured by American Electronic Laboratories, Inc. of Lansdale, Pennsylvania. AEL even has a Phonocatheter that is passed into the kidney, for recording the renal arterial pulse for the urologist.

Mr. George S. Springsteen, Vice President of Management Concepts, Inc. of Philadelphia, Pennsylvania, is a leading expert on medical data systems – such as the cardiac arrest and the anaesthesiology systems of Albert Einstein College of Medicine in New York City, the obstetrics and gynaecology system at Walter Reed General Hospital in Washington, D.C., the radiation therapy data system at Johns Hopkins Hospital in Baltimore, Maryland, and many others. The biggest problem that Mr. Springsteen has encountered in creating the systems that help a doctor to get an immediate computer read-out of how similar cases have been handled by other doctors — with what dosages of what curative agents, with what percentages of success, and what survival rates — has been the resistance of physicians to the thought that anyone else practicing their speciality might have useful information that they, themselves, do not already know.

Norman W. Rubinson, formerly the Director of the Rockland County Health Complex, has introduced computerized multi-phasic testing, laboratory automation, hospital administration, and epidemiological (relating to epidemics) research. Presently, Mr. Rubinson is Chairman of the Board of Cambridge Computer Corporation in New York City, which is putting these computerized applications into a rapidly broadening number of institutions.

FerroFluidics Corporation of Burlington, Massachusetts, has developed specialized magnetic liquids that will assist in the non-surgical removal of cancerous tissue by selective absorption of laser energy.

The diametric opposite of our forecast of the year 2001 is in actual use now. The University of Southern California and Aerojet-General-Corp. have developed a computer-controlled medical manikin, Sim One, that substitutes for human patients in training student doctors. Sim One has just gotten a new right arm and a new computer that will have "muscle", "nerves", "bone", and "pulse." Internal instrumentation will identify and measure the quantity of three different simulated drug injections, and will detect and report contact with bone and nerve areas. The "arm" will even jerk to signify discomfort. This is just the opposite of Dr. Sawbones operating on Mr. Bright. "Turnabout is fair play." □

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c.a

NUMBLES

NUMBER PUZZLES FOR NIMBLE MINDS —AND COMPUTERS

Neil Macdonald
Assistant Editor
Computers and Automation

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 is otherwise irregular, to discourage cryptanalytic methods of deciphering.

We invite our readers to send us solutions, together with human programs or computer programs, which will produce the solutions. This month's Numble was contributed by:

Stuart Freudberg
Newton High School
Newton, Mass.

NUMBLE 706

```
            A G O O D
            x W O R D
          L K R E Y E
        K E Y O A L
      G W W E N I
    K L D D L W
  = G A K S G R L E E

    88004   26139   7298
```

GNY = KRI

Solution to Numble 704

In Numble 704 in the April issue, the digits 0 through 9 are represented by letters as follows:

H = 0	O = 5
U = 1	K = 6
G,N = 2	S = 7
E = 3	R = 8
A,I = 4	T,F,P = 9

The full message is: "Rogues speak of their honor."

Solution to Numble 705

In Numble 705 in the May issue, the digits 0 through 9 are represented by letters as follows:

H = 0	L = 5
O = 1	S = 6
B,W,Y = 2	E = 7
R = 3	P,T = 8
A = 4	C,M = 9

The full message is: "May all peoples welcome each other as brothers."

Our thanks to the following individuals for submitting their solutions to **Numble 704:** C. L. Agrawal, Claymont, Del.; A. Sanford Brown, Dallas, Tex.; Murray A. Chayet, Tucson, Ariz.; T. Paul Finn, Indianapolis, Ind.; Barry L. Gingrich, Endicott, N.Y.; George Gluck, Boulder, Colo.; Philip R. Hollenbeck, San Leandro, Calif.; Kenneth S. Johnson, Neptune, N.J.; B. Kruel, Cypress, Calif.; Wm. Lasher, Greenbelt, Md.; Jud Gilbert, Tallahassee, Fla.; Lambert J. Simon, Irving, Tex.· and Robert R. Weden, Edina, Minn. **Numble 703:** T. A. Peters, Nacogdoches, Tex. **Numble 702:** H. J. Baitsch, Rostock, Germany.

"The House is on Fire" — THE PROFESSION OF INFORMATION ENGINEER

Computers and Automation 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 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, this department of *Computers and Automation* will publish from time to time, articles and other information related to socially useful input and output data systems in a broad sense. To this end we shall seek to publish here 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.

In this issue, we are publishing an article which contains a quantitative analysis of nine crisis problems — and a call for the large-scale mobilization of scientists to implement proposed solutions.

What We Must Do

John Platt
Research Biophysicist and Associate Director
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University of Michigan
Ann Arbor, Mich. 48104

There is only one crisis in the world. It is the crisis of transformation. The trouble is that it is now coming upon us as a storm of crisis problems from every direction. But if we look quantitatively at the course of our changes in this century, we can see immediately why the problems are building up so rapidly at this time, and we will see that it has now become urgent for us to mobilize all our intelligence to solve these problems if we are to keep from killing ourselves in the next few years.

The essence of the matter is that the human race is on a steeply rising "S-curve" of change. We are undergoing a great historical transition to new levels of technological power all over the world. We all know about these changes, but we do not often stop to realize how large they are in orders of magnitude, or how rapid and enormous compared to all previous changes in history. In the last century, we have increased our speeds of communication by a factor of 10^7; our speeds of travel by 10^2; our speeds of data handling by 10^6; our energy resources by 10^3; our power of weapons by 10^6; our ability to control diseases by something like 10^2; and our rate of population growth to 10^3 times what it was a few thousand years ago.

Could anyone suppose that human relations around the world would not be affected to their very roots by such changes? Within the last 25 years, the Western world has moved into an age of jet planes, missiles and satellites, nuclear power and nuclear terror. We have acquired computers and automation, a service and leisure economy, superhighways, superagriculture, supermedicine, mass higher education, universal TV, oral contraceptives, environmental pollution, and urban crises. The rest of the world is also moving rapidly and may catch up with all these powers and problems within a very short time. It is hardly surprising that young people under 30, who have grown up familiar with these things from childhood, have developed very different expectations and concerns from the older generation that grew up in another world.

What many people do not realize is that many of these technological changes are now approaching certain natural limits. The "S-curve" is beginning to level off. We may never have faster communications or more TV or larger weapons or a higher level of danger than we have now. This means that if we could learn how to manage these new powers and problems in the next few years without killing ourselves by our obsolete structures and behavior, we might be able to create new and more effective social structures that would last for many generations. We might be able to move into that new world of abundance and diversity and well-being for all mankind which technology has now made possible.

The trouble is that we may not survive these next few years. The human race today is like a rocket on a launching pad. We have been building up to this moment of takeoff for a long time, and if we can get safely through the takeoff period, we may fly on a new and exciting course for a long time to come. But at this moment, as the powerful new engines are fired, their thrust and roar shakes and stresses every part of the ship and may cause the whole thing to blow up before we can steer it on its way. Our problem today is to harness and direct these tremendous new forces through this dangerous transition period to the new world instead of to destruction. But unless we can do this, the rapidly increasing strains and crises of the next decade may kill us all. They will make the last 20 years look like a peaceful interlude.

Several types of crisis may reach the point of explosion in the next 10 years: nuclear escalation, famine, participatory crises, racial crises, and what have been called the crises of administrative legitimacy. It is worth singling out two or three of these to see how imminent and dangerous they are, so that we can fully realize how very little time we have for preventing or controlling them.

Take the problem of nuclear war, for example. A few years ago, Leo Szilard estimated the "half-life" of the human race with respect to nuclear escalation as being between 10 and 20 years. His reasoning then is still valid now. As long as we continue to have no adequate stabilizing peace-keeping structures for the world, we continue to live under the daily threat not only of local wars but of nuclear escalation with overkill and megatonnage enough to destroy all life on earth. Every year or two there is a confrontation between nuclear powers—Korea, Laos, Berlin, Suez, Quemoy, Cuba, Vietnam, and the rest. MacArthur wanted to use nuclear weapons in Korea; and in the Cuban missile crisis, John Kennedy is said to have estimated the probability of a nuclear exchange as about 25 percent.

The danger is not so much that of the unexpected, such as a radar error or even a new nuclear dictator, as it is that our present systems will work exactly as planned!—from border testing, strategic gambles, threat and counter-threat, all the way up to that "second-strike capability" that is already aimed, armed, and triggered to wipe out hundreds of millions of people in a 3-hour duel!

What is the probability of this in the average incident? 10 percent? 5 percent? There is no average incident. But it is easy to see that five or ten more such confrontations in this game of "nuclear roulette" might indeed give us only a 50-50 chance of living until 1980 or 1990. This is a shorter life expectancy than people have ever had in the world before. All our medical increases in length of life are meaningless, as long as our nuclear lifetime is so short.

Many agricultural experts also think that within this next decade the great famines will begin, with deaths that may reach 100 million people in densely populated countries like India and China. Some contradict this, claiming that the remarkable new grains and new agricultural methods introduced in the last 3 years in Southeast Asia may now be able to keep the food supply ahead of population growth. But others think that the reeducation of farmers and consumers to use the new grains cannot proceed fast enough to make a difference.

But if famine does come, it is clear that it will be catastrophic. Besides the direct human suffering, it will further increase our international instabilities, with food riots, troops called out, governments falling, and international interventions that will change the whole political map of the world. It could make Vietnam look like a popgun.

In addition, the next decade is likely to see continued crises of legitimacy of all our overloaded administrations, from universities and unions to cities and national governments. Everywhere there is protest and refusal to accept the solutions handed down by some central elite. The student revolutions circle the globe. Suburbs protest as well as ghettoes, Right as well as Left. There are many new sources of collision and protest, but it is clear that the general problem is in large part structural rather than political. Our traditional methods of election and management no longer give administrations the skill and capacity they need to handle their complex new burdens and decisions. They become swollen, unresponsive—and repudiated. Every day now some distinguished administrator is pressured out of office by protesting constituents.

In spite of the violence of some of these confrontations, this may seem like a trivial problem compared to war or famine—until we realize the dangerous effects of these instabilities on the stability of the whole system. In a nuclear crisis or in any of our other crises today, administrators or negotiators may often work out some basis of agreement between conflicting groups or nations, only to find themselves rejected by their people on one or both sides, who are then left with no mechanism except to escalate their battles further.

The Crisis of Crises

What finally makes all of our crises still more dangerous is that they are now coming on top of each other. Most administrations are able to endure or even enjoy an occasional crisis, with everyone working late together and getting a new sense of importance and unity. What they are not prepared to deal with are multiple crises, a crisis of crises all at one time. This is what happened in New York City in 1968 when the Ocean Hill-Brownsville teacher and race strike was combined with a police strike, on top of a garbage strike, on top of a longshoremen's strike, all within a few days of each other.

When something like this happens, the staffs get jumpy with smoke and coffee and alcohol, the mediators become exhausted, and the administrators find themselves running two crises behind. Every problem may escalate because those involved no longer have time to think straight. What would have happened in the Cuban missile crisis if the East Coast power blackout had occurred by accident that same day? Or if the "hot line" between Washington and Moscow had gone dead? There might have been hours of misinterpretation, and some fatally different decisions.

I think this multiplication of domestic and international crises today will shorten that short half-life. In the continued absence of better ways of heading off these multiple crises, our half-life may no longer be 10 or 20 years, but more like 5 to 10 years, or less. We may have even less than a 50-50 chance of living until 1980.

This statement may seem uncertain and excessively dramatic. But is there any scientist who would make a much more optimistic estimate after considering all the different sources of danger and how they are increasing? The shortness of the time is due to the exponential and multiplying character of our problems and not to what particular numbers or guesses we put in. Anyone who feels more hopeful about getting past the nightmares of the 1970's has only to look beyond them to the monsters of pollution and population rising up in the 1980's and 1990's. Whether we have 10 years or more like 20 or 30, unless we systematically find new large-scale solutions, we are in the gravest danger of destroying our society, our world, and ourselves in any of a number of different ways well before the end of this century. Many futurologists who have predicted what the world will be like in the year 2000 have neglected to tell us that.

Nevertheless the real reason for trying to make rational estimates of these deadlines is not because of their shock value but because they give us at least a rough idea of how much time we may have for finding and mounting some large-scale solutions. The time is short but, as we shall see, it is not too short to give us a chance that something can be done, if we begin immediately.

From this point, there is no place to go but up. Human predictions are always conditional. The future always depends on what we do and can be made worse or better by stupid or intelligent action. To change our earlier analogy, today we are like men coming out of a coal mine who suddenly begin to hear the rock rumbling, but who have also begun to see a little square of light at the end of the tunnel. Against this background, I am an optimist—in that I want to insist that there is a square of light and that it is worth trying to get to. I think what we must do is to start running as fast as possible toward that light, working to increase the probability of our survival through the next decade by some measurable amount.

For the light at the end of the tunnel is very bright indeed. If we can only devise new mechanisms to help us survive this round of terrible crises, we have a chance of moving into a new world of incredible potentialities for all mankind. But if we cannot get through this next decade, we may never reach it.

Task Forces for Social Research and Development

What can we do? I think that nothing less than the application of the full intelligence of our society is likely to be adequate. These problems will require the humane and constructive efforts of everyone involved. But I think they will also require something very similar to the mobilization of scientists for solving crisis problems in wartime. I believe we are going to need large numbers of scientists forming something like research teams or task forces for social research and development. We need full-time interdisciplinary teams combining men of different specialties, natural scientists, social scientists, doctors, engineers, teachers, lawyers, and many other trained and inventive minds, who can put together our stores of knowledge and powerful new ideas into improved technical methods, organizational designs, or "social inventions" that have a chance of being adopted soon enough and widely enough to be effective. Even a great mobilization of scientists may not be enough. There is no guarantee that these problems can be solved, or solved in time, no matter what we do. But for problems of this scale and urgency, this kind of focusing of our brains and knowledge may be the only chance we have.

Scientists, of course, are not the only ones who can make contributions. Millions of citizens, business and labor leaders, city and government officials, and workers in existing agencies, are already doing all they can to solve these problems. No scientific innovation will be effective without extensive advice and help from all these groups.

But it is the new science and technology that have made our problems so immense and intractable. Technology did not create human conflicts and inequities, but it has made them unendurable. And where science and technology have expanded the problems in this way, it may be only more scientific understanding and better technology that can carry us past them. The cure for the pollution of the rivers by detergents is the use of nonpolluting detergents. The cure for bad management designs is better management designs.

Also, in many of these areas, there are few people outside the research community who have the basic knowledge necessary for radically new solutions. In our great biological problems, it is the new ideas from cell biology and ecology that may be crucial. In our social-organizational problems, it may be the new theories of organization and management and behavior theory and game theory that offer the only hope. Scientific research and development groups of some kind may be the only effective mechanism by which many of these new ideas can be converted into practical invention and action.

The time scale on which such task forces would have to operate is very different from what is usual in science. In the past, most scientists have tended to work on something like a 30-year time scale, hoping that their careful studies would fit into some great intellectual synthesis that might be years away. Of course when they become politically concerned, they begin to work on something more like a 3-month time scale, collecting signatures or trying to persuade the government to start or stop some program.

But 30 years is too long, and 3 months is too short, to cope with the major crises that might destroy us in the next 10 years. Our urgent problems now are more like wartime problems, where we need to work as rapidly as is consistent with large-scale effectiveness. We need to think rather in terms of a 3-year time scale—or more broadly, a 1- to 5-year time scale. In World War II, the ten thousand scientists who were mobilized for war research knew they did not have 30 years, or even 10 years, to come up with answers. But they did have time for the new research, design, and construction that brought sonar and radar and atomic energy to operational effectiveness within 1 to 4 years. Today we need the same large-scale mobilization for innovation and action and the same sense of constructive urgency.

Priorities: A Crisis Intensity Chart

In any such enterprise, it is most important to be clear about which problems are the real priority problems. To get this straight, it is valuable to try to separate the different problem areas according to some measures of their magnitude and urgency. A possible classification of this kind is shown in Tables 1 and 2. In these tables, I have tried to rank a number of present or potential problems or crises, vertically, according to an estimate of their order of intensity or "seriousness," and horizontally, by a rough estimate of their time to reach climactic importance. Table 1 is such a classification for the United States for the next 1 to 5 years, the next 5 to 20 years, and the next 20 to 50 years. Table 2 is a similar classification for world problems and crises.

The successive rows indicate something like order-of-magnitude differences in the intensity of the crises, as estimated by a rough product of the size of population that might be hurt or affected, multiplied by some estimated average effect in the disruption of their lives. Thus the first row corresponds to total or near-total annihilation; the second row, to great destruction or change affecting everybody; the third row, to a lower tension affecting a smaller part of the population or a smaller part of everyone's life, and so on.

Informed men might easily disagree about one row up or down in intensity, or one column left or right in the time scales, but these order-of-magnitude differences are already so great that it would be surprising to find much larger disagreements. Clearly, an important initial step in any serious problem study would be to refine such estimates.

In both tables, the one crisis that must be ranked at the top in total danger and imminence is, of course, the danger of large-scale or total annihilation by nuclear escalation or by radiological-chemical-biological-warfare (RCBW). This kind of crisis will continue through both the 1- to 5-year time period and the 5- to 20-year period as Crisis Number 1, unless and until we get a safer peace-keeping arrangement. But in the 20- to 50-year column, following the reasoning already given, I think we must simply put a big "✠" at this level, on the grounds that the peace-keeping stabilization problem will either be solved by that time or we will probably be dead.

At the second level, the 1- to 5-year

period may not be a period of great destruction (except nuclear) in either the United States or the world. But the problems at this level are building up, and within the 5- to 20-year period, many scientists fear the destruction of our whole biological and ecological balance in the United States by mismanagement or pollution. Others fear political catastrophe within this period, as a result of participatory confrontations or backlash or even dictatorship, if our divisive social and structural problems are not solved before that time.

On a world scale in this period, famine and ecological catastrophe head the list of destructive problems. We will come back later to the items in the 20- to 50-year column.

The third level of crisis problems in the United States includes those that are already upon us: administrative management of communities and cities, slums, participatory democracy, and racial conflict. In the 5- to 20-year period, the problems of pollution and poverty or major failures of law and justice could escalate to this level of tension if they are not solved. The last column is left blank because secondary events and second-order effects will interfere seriously with any attempt to make longer-range predictions at these lower levels.

The items in the lower part of the tables are not intended to be exhaustive. Some are common headline problems which are included simply to show how they might rank quantitatively in this kind of comparison. Anyone concerned with any of them will find it a useful exercise to estimate for himself their order of seriousness, in terms of the number of people they actually affect and the average distress they cause. Transportation problems and neighborhood ugliness, for example, are listed as grade 4 problems in the United States because they depress the lives of tens of millions for 1 or 2 hours every day. Violent crime may affect a corresponding number every year or two. These evils are not negligible, and they are worth the efforts of enormous numbers of people to cure them and to keep them cured—but on the other hand, they will not destroy our society.

The grade 5 crises are those where the hue and cry has been raised and where responsive changes of some kind are already under way. Cancer goes here, along with problems like auto safety and an adequate water supply. This is not to say that we have solved the problem of cancer, but rather that good people are working on it and are making as much progress as we could expect from anyone. (At this level of social intensity, it should be kept in mind that there are also positive opportunities for research, such as the automation of clinical biochemistry or the invention of new channels of personal communication, which might affect the 20-year future as greatly as the new drugs and solid state devices of 20 years ago have begun to affect the present.)

Table 1. Classification of problems and crises by estimated time and intensity (United States).

Grade	Estimated crisis intensity (number affected × degree of effect)		Estimated time to crisis* 1 to 5 years	5 to 20 years	20 to 50 years
1.		Total annihilation	Nuclear or RCBW escalation	Nuclear or RCBW escalation	✠ (Solved or dead)
2.	10^8	Great destruction or change (physical, biological, or political)	(Too soon)	Participatory democracy Ecological balance	Political theory and economic structure Population planning Patterns of living Education Communications Integrative philosophy
3.	10^7	Widespread almost unbearable tension	Administrative management Slums Participatory democracy Racial conflict	Pollution Poverty Law and justice	?
4.	10^6	Large-scale distress	Transportation Neighborhood ugliness Crime	Communications gap	?
5.	10^5	Tension producing responsive change	Cancer and heart Smoking and drugs Artificial organs Accidents Sonic boom Water supply Marine resources Privacy on computers	Educational inadequacy	?
6.		Other problems—important, but adequately researched	Military R & D New educational methods Mental illness Fusion power	Military R & D	
7.		Exaggerated dangers and hopes	Mind control Heart transplants Definition of death	Sperm banks Freezing bodies Unemployment from automation	Eugenics
8.		Noncrisis problems being "overstudied"	Man in space Most basic science		

* If no major effort is made at anticipatory solution.

Where the Scientists Are

Below grade 5, three less quantitative categories are listed, where the scientists begin to outnumber the problems. Grade 6 consists of problems that many people believe to be important but that are adequately researched at the present time. Military R & D belongs in this category. Our huge military establishment creates many social problems, both of national priority and international stability, but even in its own terms, war research, which engrosses hundreds of thousands of scientists and engineers, is being taken care of generously. Likewise, fusion power is being studied at the $100-million level, though even if we had it tomorrow, it would scarcely change our rates of application of nuclear energy in generating more electric power for the world.

Grade 7 contains the exaggerated problems which are being talked about or worked on out of all proportion to their true importance, such as heart transplants, which can never affect more than a few thousands of people out of the billions in the world. It is sad to note that the symposia on "social implications of science" at many national scientific meetings are often on the problems of grade 7.

In the last category, grade 8, are two subjects which I am sorry to say I must call "overstudied," at least with respect to the real crisis problems today. The Man in Space flights to the moon and back are the most beautiful technical achievements of man, but they are not urgent except for national display, and they absorb tens of thousands of our most ingenious technical brains.

And in the "overstudied" list I have begun to think we must now put most of our basic science. This is a hard conclusion, because all of science is so important in the long run and because it is still so small compared, say, to advertising or the tobacco industry. But basic scientific thinking is a scarce resource. In a national emergency, we would suddenly find that a host of our scientific problems could be postponed for several years in favor of more urgent research. Should not our total human emergency make the same claims? Long-range science is useless unless we survive to use it. Tens of thousands of our best trained minds may now be needed for something more important than "science as usual."

The arrows at level 2 in the tables are intended to indicate that problems may escalate to a higher level of crisis in the next time period if they are not solved. The arrows toward level 2 in the last columns of both tables show the escalation of all our problems upward to some general reconstruction in the 20- to 50-year time period, if we survive. Probably no human institution will continue unchanged for another 50 years, because they will all be changed by the crises if they are not changed in advance to prevent them. There will surely be widespread rearrangements in all our ways of life everywhere, from our pat-

Table 2. Classification of problems and crises by estimated time and intensity (World).

Grade	Estimated crisis intensity (number affected × degree of effect)		Estimated time to crisis* 1 to 5 years	5 to 20 years	20 to 50 years
1.	10^{10}	Total annihilation	Nuclear or RCBW escalation	Nuclear or RCBW escalation	✠ (Solved or dead)
2.	10^{9}	Great destruction or change (physical, biological, or political)	(Too soon)	Famines Ecological balance Development failures Local wars Rich-poor gap ↑	Economic structure and political theory Population and ecological balance Patterns of living Universal education Communications-integration ↑ Management of world Integrative philosophy
3.	10^{8}	Widespread almost unbearable tension	Administrative management Need for participation Group and racial conflict Poverty–rising expectations Environmental degradation	Poverty Pollution Racial wars Political rigidity Strong dictatorships	?
4.	10^{7}	Large-scale distress	Transportation Diseases Loss of old cultures	Housing Education Independence of big powers Communications gap	?
5.	10^{6}	Tension producing responsive change	Regional organization Water supplies	?	?
6.		Other problems—important, but adequately researched	Technical development design Intelligent monetary design		
7.		Exaggerated dangers and hopes			Eugenics Melting of ice caps
8.		Noncrisis problems being "overstudied"	Man in space Most basic science		

* If no major effort is made at anticipatory solution.

terns of society to our whole philosophy of man. Will they be more humane, or less? Will the world come to resemble a diverse and open humanist democracy? Or Orwell's *1984*? Or a postnuclear desert with its scientists hanged? It is our acts of commitment and leadership in the next few months and years that will decide.

Mobilizing Scientists

It is a unique experience for us to have peacetime problems, or technical problems which are not industrial problems, on such a scale. We do not know quite where to start, and there is no mechanism yet for generating ideas systematically or paying teams to turn them into successful solutions.

But the comparison with wartime research and development may not be inappropriate. Perhaps the antisubmarine warfare work or the atomic energy project of the 1940's provide the closest parallels to what we must do in terms of the novelty, scale, and urgency of the problems, the initiative needed, and the kind of large success that has to be achieved. In the antisubmarine campaign, Blackett assembled a few scientists and other ingenious minds in his "back room," and within a few months they had worked out the "operations analysis" that made an order-of-magnitude difference in the success of the campaign. In the atomic energy work, scientists started off with extracurricular research, formed a central committee to channel their secret communications, and then studied the possible solutions for some time before they went to the government for large-scale support for the great development laboratories and production plants.

Fortunately, work on our crisis problems today would not require secrecy. Our great problems today are all beginning to be world problems, and scientists from many countries would have important insights to contribute.

Probably the first step in crisis studies now should be the organization of intense technical discussion and education groups in every laboratory. Promising lines of interest could then lead to the setting up of part-time or full-time studies and teams and coordinating committees. Administrators and boards of directors might find active crisis research important to their own organizations in many cases. Several foundations and federal agencies already have in-house research and make outside grants in many of these crisis areas, and they would be important initial sources of support.

But the step that will probably be required in a short time is the creation of whole new centers, perhaps comparable to Los Alamos or the RAND Corporation, where interdisciplinary groups can be assembled to work full-time on solutions to these crisis problems. Many different kinds of centers will eventually be necessary, including research centers, development centers, training centers, and even production centers for new sociotechnical inventions. The problems of our time—the \$100-billion food problem or the \$100-billion arms control problem—are no smaller than World War II in scale and importance, and it would be absurd to think that a few academic research teams or a few agency laboratories could do the job.

Social Inventions

The thing that discourages many scientists—even social scientists—from thinking in these research-and-development terms is their failure to realize that there are such things as social inventions and that they can have large-scale effects in a surprisingly short time. A recent study with Karl Deutsch has examined some 40 of the great achievements in social science in this century, to see where they were made and by whom and how long they took to become effective. They include developments such as the following:

- Keynesian economics
- Opinion polls and statistical sampling
- Input-output economics
- Operations analysis
- Information theory and feedback theory
- Theory of games and economic behavior
- Operant conditioning and programmed learning
- Planned programming and budgeting (PPB)
- Non–zero-sum game theory

Many of these have made remarkable differences within just a few years in our ability to handle social problems or management problems. The opinion poll became a national necessity within a single election period. The theory of games, published in 1946, had become an important component of American strategic thinking by RAND and the Defense Department by 1953, in spite of the limitation of the theory at that time to zero-sum games, with their dangerous bluffing and "brinksmanship." Today, within less than a decade, the PPB management technique is sweeping through every large organization.

This list is particularly interesting because it shows how much can be done outside official government agencies when inventive men put their brains together. Most of the achievements were the work of teams of two or more men, almost all of them located in intellectual centers such as Princeton or the two Cambridges.

The list might be extended by adding commercial social inventions with rapid and widespread effects, like credit cards. And sociotechnical inventions, like computers and automation or like oral contraceptives, which were in widespread use within 10 years after they were developed. In addition, there are political innovations like the New Deal, which made great changes in our economic life within 4 years, and the pay-as-you-go income tax, which transformed federal taxing power within 2 years.

On the international scene, the Peace Corps, the "hot line," the Test-Ban Treaty, the Antarctic Treaty, and the Nonproliferation Treaty were all implemented within 2 to 10 years after their initial proposal. These are only small contributions, a tiny patchwork part of the basic international stabilization system that is needed, but they show that the time to adopt new structural designs may be surprisingly short. Our cliches about "social lag" are very misleading. Over half of the major social innovations since 1940 were adopted or had widespread social effects within less than 12 years—a time as short as, or shorter than, the average time for adoption of technological innovations.

Areas for Task Forces

Is it possible to create more of these social inventions systematically to deal with our present crisis problems? I think it is. It may be worth listing a few specific areas where new task forces might start.

1) *Peace-keeping mechanisms and feedback stabilization.* Our various nuclear treaties are a beginning. But how about a technical group that sits down and thinks about the whole range of possible and impossible stabilization and peace-keeping mechanisms? Stabiliza-

tion feedback-design might be a complex modern counterpart of the "checks and balances" used in designing the constitutional structure of the United States 200 years ago. With our new knowledge today about feedbacks, group behavior, and game theory, it ought to be possible to design more complex and even more successful structures.

Some peace-keeping mechanisms that might be hard to adopt today could still be worked out and tested and publicized, awaiting a more favorable moment. Sometimes the very existence of new possibilities can change the atmosphere. Sometimes, in a crisis, men may finally be willing to try out new ways and may find some previously prepared plan of enormous help.

2) *Biotechnology*. Humanity must feed and care for the children who are already in the world, even while we try to level off the further population explosion that makes this so difficult. Some novel proposals, such as food from coal, or genetic copying of champion animals, or still simpler contraceptive methods, could possibly have large-scale effects on human welfare within 10 to 15 years. New chemical, statistical, and management methods for measuring and maintaining the ecological balance could be of very great importance.

3) *Game theory*. As we have seen, zero-sum game theory has not been too academic to be used for national strategy and policy analysis. Unfortunately, in zero-sum games, what I win, you lose, and what you win, I lose. This may be the way poker works, but it is not the way the world works. We are collectively in a non–zero-sum game in which we will all lose together in nuclear holocaust or race conflict or economic nationalism, or all win together in survival and prosperity. Some of the many variations of non–zero-sum game theory, applied to group conflict and cooperation, might show us profitable new approaches to replace our sterile and dangerous confrontation strategies.

4) *Psychological and social theories*. Many teams are needed to explore in detail and in practice how the powerful new ideas of behavior theory and the new ideas of responsive living might be used to improve family life or community and management structures. New ideas of information handling and management theory need to be turned into practical recipes for reducing the daily frustrations of small businesses, schools, hospitals, churches, and town meetings. New economic inventions are needed, such as urban development corporations. A deeper systems analysis is urgently needed to see if there is not some practical way to separate full employment from inflation. Inflation pinches the poor, increases labor-management disputes, and multiplies all our domestic conflicts and our sense of despair.

5) *Social indicators*. We need new social indicators, like the cost-of-living index, for measuring a thousand social goods and evils. Good indicators can have great "multiplier effects" in helping to maximize our welfare and minimize our ills. Engineers and physical scientists working with social scientists might come up with ingenious new methods of measuring many of these important but elusive parameters.

6) *Channels of effectiveness*. Detailed case studies of the reasons for success or failure of various social inventions could also have a large multiplier effect. Handbooks showing what channels or methods are now most effective for different small-scale and large-scale social problems would be of immense value.

The list could go on and on. In fact, each study group will have its own pet projects. Why not? Society is at least as complex as, say, an automobile with its several thousand parts. It will probably require as many research-and-development teams as the auto industry in order to explore all the inventions it needs to solve its problems. But it is clear that there are many areas of great potential crying out for brilliant minds and brilliant teams to get to work on them.

Future Satisfactions and Present Solutions

This is an enormous program. But there is nothing impossible about mounting and financing it, if we, as concerned men, go into it with commitment and leadership. Yes, there will be a need for money and power to overcome organizational difficulties and vested interests. But it is worth remembering that the only real source of power in the world is the gap between what is and what might be. Why else do men work and save and plan? If there is some future increase in human satisfaction that we can point to and realistically anticipate, men will be willing to pay something for it and invest in it in the hope of that return. In economics, they pay with money; in politics, with their votes and time and sometimes with their jail sentences and their lives.

Social change, peaceful or turbulent, is powered by "what might be." This means that for peaceful change, to get over some impossible barrier of unresponsiveness or complexity or group conflict, what is needed is an inventive man or group—a "social entrepreneur" —who can connect the pieces and show how to turn the advantage of "what might be" into some present advantage for every participating party. To get toll roads, when highways were hopeless, a legislative-corporation mechanism was invented that turned the future need into present profits for construction workers and bondholders and continuing profitability for the state and all the drivers.

This principle of broad-payoff anticipatory design has guided many successful social plans. Regular task forces using systems analysis to find payoffs over the barriers might give us such successful solutions much more often. The new world that could lie ahead, with its blocks and malfunctions removed, would be fantastically wealthy. It seems almost certain that there must be many systematic ways for intelligence to convert that large payoff into the profitable solution of our present problems.

The only possible conclusion is a call to action. Who will commit himself to this kind of search for more ingenious and fundamental solutions? Who will begin to assemble the research teams and the funds? Who will begin to create those full-time interdisciplinary centers that will be necessary for testing detailed designs and turning them into effective applications?

The task is clear. The task is huge. The time is horribly short. In the past, we have had science for intellectual pleasure, and science for the control of nature. We have had science for war. But today, the whole human experiment may hang on the question of how fast we now press the development of science for survival.

ACROSS THE EDITOR'S DESK

Computing and Data Processing Newsletter

Table of Contents

APPLICATIONS

Computer Simulates Workings of Inner Ear 49
IBM Computer Helps Texas Improve Care for Mentally Ill and Retarded 49
Two Isaiahs Proved by Computer 49
Histories of Cook County Land Tracts Analyzed by Computer 50
Library Computer Quietly Changes Tradition 50
"Instant Insanity" Fails to Frustrate Computer 50

EDUCATION NEWS

Educational Film — "Man's Most Magnificent Machine" — Available from DPMA 50

NEW PRODUCTS

Digital

SPC-16 Computer — General Automation, Inc. 51
MAC Jr. Computer — Data Products Division of Lockheed Electronics 51
MD708 Minicomputer — Monitor Data Corp. 51
XDS Sigma 6 Computer — Xerox Data Systems 51
Raytheon 704 Minicomputer — Raytheon Co. 51
Two New Computers, Model 5 and Model 1 — Interdata, Inc. 51

Special Purpose Systems

"The Manufacturing Man's Computer" — Texas Instruments 52
Honeywell Banking System — Honeywell EDP 52
Professional Information Processor — Medelco Inc. 52

Teaching Devices

COMP-U-KIT Computer Logic Lab — Scientific Measurements, Inc. 52
Compu-kee Model 40 Trainer — Kee, Inc. 52

Memories

PDM-8, Point-Designed Memory System — Dataram Corp. 55
5000 Series Disc Memory System Controllers — Information Data Systems, Inc. 55
Disc Memory for Varian 620 Minicomputers — Data Disc Inc. 55
Computer Memory Systems, Low-Cost and Expandable — RCA, Memory Products Div. 55

Software

BASE (Brokerage Accounting System Elements) — IBM Corporation 55
Construction Company Cost System — International Computer Corp. 55
N/C Lathe Package — Fordax Corp. 55
On-Line Management Information and Accounting System — Computing Corporation International, Inc. 55
System '70 — Western Operations, Inc. 55

Peripheral Equipment

PortaCom Terminal — Data Products Corp. 56
Printer Output Microfilm System — Advanced Terminals Inc. 56
Data Entry Equipment, System 480 — Entrex, Inc. 56
Data-kap 882 Machine-Source Digital Recorder — Electronic Laboratories, Inc. 56
Numerical Readout Displays — Oppenheimer, Inc. 56
Optical Character Readers — VIATRON Computer Systems Corp. 56

Data Processing Accessories

Data Interface Test Set — Pulse Communications, Inc. 56
Table-Top Magnetic Tape Tester-Cleaner — Kybe Corp. 57
Disk Pack Certifier — Interscan, Inc. 57

COMPUTER-RELATED SERVICES

Medical Information System, MIS-1 To Be Available Nationwide 57

NEW LITERATURE

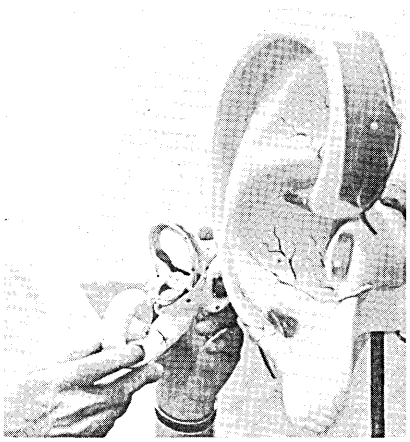
Careers, Computers and You 57
Guide to Data Education Films 57
How to Buy Proprietary Software Products 57

APPLICATIONS

COMPUTER SIMULATES WORKINGS OF INNER EAR

Dr. Alfred Inselberg, a mathematician at IBM's Los Angeles Scientific Center, has programmed a computer to simulate the intricate workings of a portion of the human ear. A native of Athens, Greece, he has been working on the project since graduate school (eleven years). Dr. Inselberg has created a mathematical model of the inner ear that may help specialists learn more about how it works, and might suggest remedies for certain types of hearing loss. The simulation has involved hundreds of thousands of calculations on an IBM 360/75.

The inner ear (cochlea) is a delicate area and one that is almost totally inaccessible. Yet the physical structure is well-known. Using



— A model of the inner ear used in anatomy classes at the UCLA medical school

the known structure and other available evidence, Dr. Inselberg built a program based on a mathematical model of the inch-long, hair-thin basilar membrane, key part of the cochlea.

Sound waves set the eardrum in motion. This motion is transmitted by the middle ear to the snail-shaped cochlea. When the cochlea's basilar membrane starts to oscillate, the motion of the membrane is picked up by the auditory nerve and transmitted to the brain. "For years the workings of the cochlea were not well understood," Dr. Inselberg said. "By simulating its activity in the computer, we were able to draw some preliminary conclusions."

One conclusion demonstrated that two separate types of wave motions — called standing and traveling waves — are present in the membrane. Physiologists have disagreed for decades as to which type of wave occurs in the inner ear. The model also showed that the ear's high-frequency threshold is governed by membrane properties such as stiffness, mass distribution and the viscosity of the surrounding fluid; the low-frequency threshold was only affected by changes in the membrane's length.

"We must always remember that a mathematical model can't be as precise as the inner ear itself," Dr. Inselberg cautioned. Still, our model seems to be a reasonable approximation." With more sophisticated techniques, Dr. Inselberg foresees still better model building in the future.

IBM COMPUTER HELPS TEXAS IMPROVE CARE FOR MENTALLY ILL AND RETARDED

The Texas Department of Mental Health and Mental Retardation is using an IBM System/360 Model 50 to help speed up and improve treatment for Texas' mentally ill and retarded at 20 state institutions. The agency has almost 12,000 retardates in its special schools and admits more than 17,000 mental patients to its state hospitals each year. It also supervises the programs at 27 locally operated community MH/MR centers throughout the state. John Kinross-Wright, M.D., commissioner of the department, said, "We are just beginning to understand and utilize the very significant potential of the computer in mental health."

Psychiatrists now receive rapid patient information that helps them diagnose illnesses and prescribe and maintain programs of treatment. Psychologists receive far greater information than ever before about the number, types and needs of mental retardates in the state's special schools. Soon, the IBM system will follow each patient from admission until discharge, recording each step in his treatment program and through the recovery process. In the past, those at the community level were often unaware of a patient's release unless he reported for needed follow-up care on his own. In the future, when a patient is ready to go home, his records automatically will be sent to his local health center or a community case worker.

Additionally, the computer system compiles and analyzes a central list of retardates on a growing waiting list for admission to state schools, allowing administrators to make placements according to greatest need. Findings about the numbers of applicants from geographic areas are being used to help select the locations of special schools still to be built. Lists of patients and students with specialized problems, such as visual impairment, are provided to other state agencies that provide services to meet these needs.

TWO ISAIAHS PROVED BY COMPUTER

Over the last 150 years there has been a learned dispute among scholars as to the existence of one or two Biblical Isaiahs. A Hebrew University doctoral thesis has put a halt to the dispute, proving two Isaiahs by means of electronic computer tests. It is believed to be the first major study to be completed with computer programming in the field of Biblical research.

Dr. Yehuda Radday (in charge of Bible teaching in the Department of General Studies at the Israel Institute of Technology) recently obtained his Ph.D. degree at the Hebrew University of Jerusalem for a thesis on research on the unity of the Biblical book of Isaiah. Prof. Chaim Rabin, Professor of Hebrew Language, and Prof. Shemaryahu Talmon Assoc. Professor of Bible, supervised the research, which lasted two years.

Abraham Ibn-Bzra, the medieval Hebrew scholar (d. 1167, Spain), already had recognized that the chapters 40-66 of Isaiah might have been written by other than the prophet Isaiah. An extensive international discussion has existed among scholars during the last 150 years as to whether or not these chapters were written by a later prophet than the original Isaiah. The dispute was derived mainly from historical arguments, but also concerned the author's style and language. As there was no objective test, no conclusion could be drawn. The doctoral thesis ending the dispute, upsets theories which are the result of the life-long work of several scholars.

Since 1940, a new element was added by the development of a scientific study of stylistic features, which ascertained that certain minor statistical features such as sentence length are typical for a person and can serve as a hallmark for his authorship. Yehuda Radday set out on his research project convinced that there was only one Isaiah. He added a completely new dimension to his pure humanistic approach as a Bible and language teacher by acquiring a wide mathematical knowledge while working on his thesis.

His approach was entirely new, applying 19 of the most modern and sophisticated tests to the question of the two Isaiahs. He divided each of the assumed two Isaiahs into three parts for a total of six units, submitting each of them to a series of tests. These included length of words and sentences, frequency and sequence of parts of speech, as well as entropy (the degree of orderliness in the arrangement of various linguistic features). Among the tests was one invention by the doctoral candidate himself — the percentage of words taken from different fields of life such as war, nature, family, religion, etc.

All these tests were programmed for (1) the Hebrew University's large CDC 6400 computer; (2) a computer in Haifa; and (3) for one in Achen in Germany. At the latter place, two German physicists advised Dr. Radday on advanced parts of his study.

The result, according to Prof. Rabin, is "very highly fool-proof". On every test, chapter 40 onwards proved to be a sample of writing by an entirely different person than chapters 1-40. Although some tests were more significant than others, a final summary of all tests by advanced statistical methods shows that the probability of the 1st Isaiah also having written the chapters attributed to the 2nd Isaiah is 1:100,000.

The 2nd Isaiah, a contemporary of King Cyrus, is believed to have lived in the year 530 B.C. and to have witnessed the restoration of the Temple. The first Isaiah probably lived about 200 years earlier.

HISTORIES OF COOK COUNTY LAND TRACTS ANALYZED BY COMPUTER

Chicago Title and Trust Company, Chicago, Ill., is using a computer system to analyze the histories of 1.3 million parcels of land in Cook County. The system researches vast reference files and processes new data affecting title status to keep the files current; the files store tax, special assessment, court judgement and other data which could affect title to land. The system also prints portions of title insurance policies.

IBM 2260 visual display terminals are linked to one of two IBM System/360 Model 40 computers which retrieves reference information from storage on magnetic strips in a large-capacity data cell. CRT operators enter the information through the terminal's keyboard and edit the data on the 2260's display screen before transmitting it to the computer.

Under the computer-based approach, data is reproduced as needed for title examination and policy printout. The new system not only has adapted to but also has helped improve the concept of individual examining units, each operating as a "little title company" for specific groups of customers. A typical examining unit includes a staff of ten plus three display terminals. Seven such units now are operating.

LIBRARY COMPUTER QUIETLY CHANGES TRADITION

Ohio's third largest library, the Columbus Public Library, has a computer that is quietly changing tradition there. In a small room on the second floor, surrounded by some of the library's 900,000 volumes, an IBM System/360 Model 20 controls circulation of 2.8 million books per year. The computer helps provide same-day return to the shelves of turned-in reading materials — a task which previously took two or three days.

The system tracks the 70,000 volumes borrowed each week from the library, saving more than 1,500 man-hours weekly. Heavy circulation, especially in the 17 branches and five bookmobiles throughout Franklin County, meant personnel spent most of their time at this clerical task. Most of the timesaving is accomplished through elimination of the old "book-slipping" process, which involved hand-filing predated transaction cards. Now when a book is returned, a sequentially-numbered card is taken from the book and the book is returned to the shelf for further use — on the same day. The data processing department sorts and re-dates the cards.

— Virginia Geus checks a computer print-out that lists the 900,000 volumes on hand

In addition, the library also uses the system for ordering books from publishers, preparing overdue notices and registering patrons. Use of the computer has freed personnel all over the system to provide better, more individual service to patrons.

"INSTANT INSANITY" FAILS TO FRUSTRATE COMPUTER

A computer has overcome the frustrations of "Instant Insanity," a popular puzzle that requires the player to arrange four cubes in a particular order. Each of the cubes has red, white, blue and green sides. The colors are arranged so that no two blocks are identical. To determine there are 256 ways of arriving at one or more unique solutions to the puzzle, a UNIVAC 1108 computer performed 1,207,959,552 calculations — and printed them on paper — in six minutes and 17 seconds. James E. Renouf, systems programming manager for Univac's Data Processing division office in Oakbrook, Ill., noted that it takes some people "hours to complete just one solution".

Mr. Renouf, who arrived at the solution method with the help of two co-workers, explained that each cube has 64 possible combinations of sides. He said there are a total of 16,777,216 combinations for the sides. A number was arbitrarily assigned to each side of the cube. "In effect," he said, "we mathematically simulated the problem (played the game) in the computer.

"Instant Insanity" is manufactured by Parker Brothers, Inc., Salem, Mass. "We'll be happy to solve any other puzzles they have," Mr. Renouf said. "All they have to do is send them to us."

EDUCATION NEWS

EDUCATIONAL FILM — "MAN'S MOST MAGNIFICENT MACHINE" — AVAILABLE FROM DPMA

A 16mm color-sound educational film about the computer and the information processing industry, entitled "Man's Most Magnificent Machine", has been produced and is being distributed by Data Processing Management Association (DPMA). The professionally produced 20-minute film is intended for a general, non-technical audience to further knowledge and appreciation of the computer and the EDP industry.

It traces the development of the computer to its present, diverse and expanding applications. It explains in simple language what the computer is, tells about the people who operate it and discusses the computer's growing influence on American life. Among the areas covered in the film are job opportunities in the EDP field and the computer's role of increasing importance in industry, schools, medicine, finance, transportation, the professions and many other fields.

Prints of the film have been distributed to regional DPMA division vice presidents, from whom it can be obtained free of charge for viewing by local chapter membership and by others interested in the subject (schools, civic, professional, educational, youth and other organizations).

Prints also are available at $95 to DPMA chapters, members and member companies, and $105 to non-members, payable in U.S. funds or equivalent. There is a $5 review handling charge which is deductible from purchase price of film. Write to DPMA International Headquarters, 505 Busse Highway, Park Ridge, Illinois 60068.

NEW PRODUCTS

Digital

SPC-16 COMPUTER / General Automation, Inc.

The SPC-16 computer, introduced at the 1970 Spring Joint Computer Conference last month, is a compact, economical 16-bit machine. Designed as a dedicated automation computer for manufacturing and production environments, the GA SPC-16 also optimizes laboratory and scientific data acquisition, data communications, and process and control automation projects.

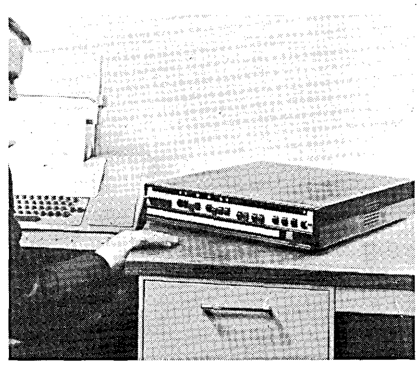
The SPC-16 provides both on-line and off-line operation, with up to 64 hardware priority interrupts. The computer uses completely interchangeable Read Only and Read/Write memories, as well as 16 general-purpose registers. A basic 4K core memory is field expandable to 32K in 4K increments, with 960 nanosecond access time to entire 32K core memory. ROM, with 480 nanosecond access time, may be expanded in 512, 1024, or 2048 word increments. (For more information, circle #41 on the Reader Service Card.)

MAC JR. COMPUTER / Data Products Division of Lockheed Electronics

The second of the MAC 16 family of minicomputers, the "MAC Jr." computer, was announced at the Spring Joint Computer Conference in Atlantic City; it also will be shown to the June IEEE Computer Group in Washington, D.C., June 16-18. The Lockheed MAC Jr. has a maximum of 8K 16-bit words of one microsecond memory and 16 hardware priority interrupts. The basic system includes 4K words of memory, four hardware priority interrupts and integral power supply. MAC Jr. inherits an extensive library of proven software and a broad range of peripheral devices from the MAC 16 (November 1968) small-scale computer. The new minicomputer retains most of the multi-application features of the original, making the two computers completely compatible. MAC Jr. is designed for smaller system environments providing cost economies attractive to the quantity OEM user.
(For more information, circle #42 on the Reader Service Card.)

MD708 MINICOMPUTER / Monitor Data Corp.

Monitor Data's first computer, the MD708, an 8-bit, 1.6 microsecond general purpose computer, is intended for use as a communications controller, translator, peripheral controller, and other usage requiring low-cost, programmable computing power. It includes the CPU, a 1024 8-bit core memory (expandable to 65K words), power supply, control panel, and a desk or rack cabinet.



The minicomputer weighs 25 lbs., occupies 3½" of rack space, and requires only 170 watts of power. I/O interfacing and all standard peripherals are available.

David Green, President of Monitor Data, in announcing their first computer, stated the MD708 will be the lowest priced general-purpose minicomputer available today. It is designed and priced for the large volume user or original equipment manufacturer. The complete MD708 will sell for less than $3,000 in quantities of 25.
(For more information, circle #43 on the Reader Service Card.)

XDS SIGMA 6 COMPUTER / Xerox Data Systems

The new computer, XDS Sigma 6, is designed for business applications. Sigma 6 is a medium-size multi-use computer which will be capable of handling batch, remote batch, on-line and time-sharing activities concurrently; it will be supported by a number of business-oriented programs including the new XDS Data Management System (DMS).

Primary hardware characteristics of the Sigma 6 include an input/output processor capable of handling up to 48 channels of data concurrently, a memory map for efficient core utilization, byte-string decimal arithmetic including floating point, and a communication subsystem to which a variety of remotely-located terminals can be attached.

The computer has a dual-access memory expandable from 131,072 bytes (32,768 words) to 524,288 bytes (131,072 words). Memory cycle time is 300 nanoseconds per byte (1.2 microseconds per word). The computer and its supporting programs are scheduled for delivery to customers in the fourth quarter of 1970.
(For more information, circle #44 on the Reader Service Card.)

RAYTHEON 704 MINICOMPUTER / Raytheon Co.

An improved version of Raytheon's 704 minicomputer was shown last month at the Spring Joint Computer Conference held in Atlantic City. Both cycle time and memory capacity of the computer have been improved. The new cycle time is 1.0 microsecond, down from the original cycle time of 1.5 microseconds. The memory of the 704 now is expandable to 32,000 words, double the previous upper limit.

The new 704 is fully compatible with Raytheon Computer's more than 400 programs and subroutines. Capability of the computer includes 74 instructions, word and byte manipulation, a real-time automatic priority interrupt system, direct input and output to the central processing unit, and four addressable hardware registers. The 704 also includes real-time clock, hardware multiply and divide, high-speed direct memory access, and other options.
(For more information, circle #45 on the Reader Service Card.)

TWO NEW COMPUTERS, MODEL 5 AND MODEL 1 / Interdata, Inc.

The new Model 5 is a third generation general purpose Foreground-Background computer, according to Ronald A. Paterson, Vice President Marketing, for Interdata, "which produces more real-time programming power per dollar than any other computer available today". It is the most powerful Interdata computer made, he added. Privileged instructions separate the supervising modes, and protect an unbugged background program from destroying an operating foreground. Model 5 will be offered in four configurations with memory from 8KB of core for the Model 5/1 to 32KB with the 5/4. A complete line of peripheral equipment is available.

The Model 1 is designed for specific applications such as industrial and process control functions. Memory for the Model 1 is expandable in blocks of 2K x 8 bits, to a maximum of 16K bytes. The Model 1 includes 43 basic instructions plus Auto Indexing features; built-in test and skip options, 4 direct memory access channel capability, and built-in 1.0 millisecond real-time clock. A replaceable Read-Only-Memory is available as an option; a magnetic tape cartridge and other plug-compatible peripheral equipment is offered.
(For more information, circle #46 on the Reader Service Card.)

Special Purpose Systems

"THE MANUFACTURING MAN'S COMPUTER" / Texas Instruments

A new process control computer has been designed specifically for manufacturing applications. Described as "The Manufacturing Man's Computer", the new Texas Instruments system (designated Model 960) utilizes a new, single-bit addressing capability which requires less memory than standard arithmetic computers. Among the applications for which the 960 was designed are discrete control of machine tools and assembly machines, instrument and system control, supervision and monitoring of discrete event and continuous-flow operations.

The "Communications Register Unit", or "CRU", is the key to the computer's flexibility. CRU provides the most economical interface to accommodate a wide variety of application-oriented devices. As many as 4096 input and 4096 output lines may be handled by a single 960 computer. Each I/O line may be addressed independently, or up to 16 lines may be addressed together as a conventional channel.

Fundamentally, the 960 computer is a processor designed to manipulate bits, fields, and words. The core memory has a one microsecond microsecond memory cycle time, 400 nanosecond access time, and a capacity from 4096 to 65,536 words of 16 bits. Inexpensive interfacing is accomplished through plug-in, CRU printed circuit cards.
(For more information, circle #47 on the Reader Service Card.)

HONEYWELL BANKING SYSTEM / Honeywell EDP

This low-cost, disk-oriented system has been designed especially for commercial banks with deposits of $25 million to $100-million. The new banking system includes the Model 115 central processor, Type 172 disk drives and a full complement of disk-oriented applications packages for demand deposit accounting, MICR entry, savings accounting, installment loan accounting, and proof and transit.

The Honeywell banking system not only handles the regular banking routines, but also can be used for general accounting work. Monthly rental cost of the computer includes software, applications packages, systems support and bank employee training under Honeywell's package pricing policy; expansion to the larger Series 200 computers to keep pace with bank growth is easily accomplished.
(For more information, circle #48 on the Reader Service Card.)

PROFESSIONAL INFORMATION PROCESSOR / Medelco Inc.

The new programmed-format computer, the Professional Information Processor (P.I.P.), is designed to utilize the data input and output devices of Medelco's Total Hospital Information System (T.H.I.S.); but unlike T.H.I.S., which functions as an administrative tool, P.I.P. deals with medical information.

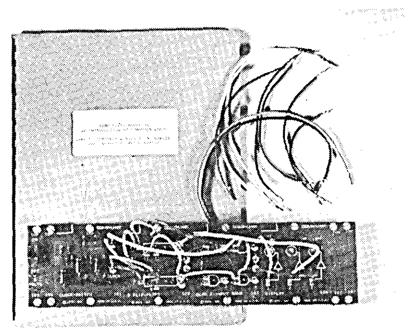
P.I.P. stores patient medical information, quickly retrieves that information on demand, and reminds hospital personnel to perform certain procedures pertaining to the patients. Two advantages of the P.I.P. over stand-alone computers are: (1) it is automatic; there is no need to prepare data for input. Orders sent through T.H.I.S. terminals are routed to P.I.P. instantly and automatically. Results from automatic test equipment also are fed automatically to P.I.P. (2) It utilizes the output devices of T.H.I.S. to send messages instantly and automatically to any point in the hospital where they are needed.

The device can trigger controls on standing orders, such as providing automatic notification in pharmacy of when to prepare unit-dose medication for a specific patient at a specific hour. It also can automatically order the start or stop of any patient routine such as placing a patient on a soft diet at a specific time, or canceling an equipment rental.
(For more information, circle #49 on the Reader Service Card.)

Teaching Devices

COMP-U-KIT COMPUTER LOGIC LAB / Scientific Measurements, Inc.

In COMP-U-KIT, a new Computer Logic Laboratory, all connections are made by patching between points on actual logic diagrams. The lab, built around 7400-series integrated circuits, is modular and expands indefinitely. A book entitled 'An



Introduction to Computer Logic' (written specifically for COMP-U-KIT) provides thorough coverage of computer logic by leading the user through a series of learning-oriented experiments. Advanced books also will be available. The product is suitable for use in high school, college, or industry, and can be used individually, for informal training, or for formal classes.
(For more information, circle #50 on the Reader Service Card.)

COMPU-KEE MODEL 40 TRAINER / Kee, Inc.

A basic trainer for multi access computer terminal operations, the Compu-kee Model 40 simulates all the major functions of a computer terminal. This new training system enables a company to train employees in keyboard and procedural skills with no tie-up of on-line equipment. The system is completely self-administered and self-paced by the student; requires little supervision; no professional instruction; and is easily programmed for any multi access computer system.

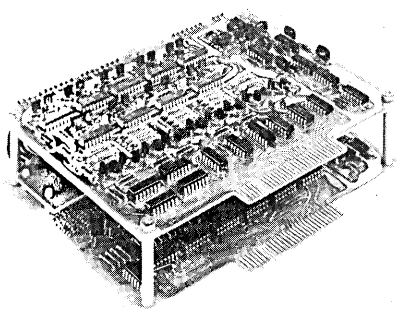
Components of the Model 40 include a program console with lighted display panel, an integrated punched tape reader and corresponding keyboard unit. The console and keyboard configurations are changeable. In addition to serving as a training

tool for computer terminal training, the wide variety of available keyboard configurations also make it useful in teaching keyboard skills in teletype, keypunch, typing, calculating machines, etc.
(For more information, circle #51 on the Reader Service Card.)

Memories

PDM-8, POINT-DESIGNED MEMORY SYSTEM / Dataram Corp.

Another standard core memory system, the PDM-8©, has been added to Dataram's proprietary line of Point Designed Memory systems. The newest system has an eight microsecond cycle and a capacity of 180 x 18 bit words. It is specifically for use as a low-cost buffer memory in keypunch-to-tape and high-speed printer applications. The



entire system is plugged into two standard (6 3/8" x 8" overall) stacked PC boards for integral equipment mounting and wiring. Two models are offered: the PDM-8/A is for decimal address; and, the PDM-8/B is for binary address.
(For more information, circle #52 on the Reader Service Card.)

5000 SERIES DISC MEMORY SYSTEM CONTROLLERS / Information Data Systems, Inc.

The 5000 Series Disc Memory System Controllers is available in two models: one for use with the Interdata Model 3, and one for the Data General Nova Computer. The controller systems utilize IDS, Inc.'s standard 7000 Series Disc Memory units, which offer capacities up to 2.4 million bits with an average access time of 16.5 milliseconds.

The controller for the Interdata machines stores up to 256K, 8 bit words expandable in groups of 32K words, with a word transfer rate of 150K words per second. The systems for the Nova computers store up to 128K, 16 bit words expandable in groups of 16K words, with a word transfer rate of 75K words per second. Also available as optional equipment are write lockout switches which inhibits writing to blocks of 8 tracks and an inert gas atmosphere for industrial environments.
(For more information, circle #53 on the Reader Service Card.)

DISC MEMORY FOR VARIAN 620 MINICOMPUTERS / Data Disc Inc.

The Model 1703 Disc-Memory System was developed exclusively for Varian minicomputers. The memory system is available in four capacities from 32,768 words to 262,144 words. Low capacity systems can easily be field-expanded without danger of data loss. The new disc-memory systems may be used instead of additional core memory in many applications. The 1703 plugs directly into the computer.
(For more information, circle #54 on the Reader Service Card.)

COMPUTER MEMORY SYSTEMS, LOW-COST AND EXPANDABLE / RCA, Memory Products Div.

A new line of low-cost, expandable computer memory systems from RCA are designed for use as main memory or expansion memory units for minicomputers, data buffering devices, and for specialized industrial processor applications. The new systems have planar construction utilizing large PC boards. The basic unit is of modular construction, expandable in 4K increments from 4K to 32K with word lengths from 8 to 18 bits and a cycle time of one microsecond. Other features of the new RCA memory line are 7400 series T^2L logic interface, standard operating modes of clear/write, read/regenerate and read/modify/write plus "byte" operation.
(For more information, circle #55 on the Reader Service Card.)

Software

BASE (Brokerage Accounting System Elements) / IBM Corporation, White Plains, N.Y. / a group of computer programs designed to help brokerage houses' solve back-office paperwork problems; the programs can generate up to 75 timely reports that reflect the status of purchases, sales, stock records, dividends, transfers, customer statements and "fails". The system can be used with System/360 Model 30 or larger with a minimum of 64,000 bytes of core storage and operating under the Disk Operating System. It is scheduled to be available under a license agreement the second quarter of 1971 at a monthly charge of $800.
(For more information, circle #56 on the Reader Service Card.)

CONSTRUCTION COMPANY COST SYSTEM / International Computer Corporation, Washington, D.C. / a series of integrated modules designed to maintain all financial information required for construction firms. The system can easily be adapted by any of the building trades. Customer may lease any or all of the modules of the system. Originally designed for a small Honeywell 200 Series Computer, the system now is available also for the IBM System/360 Model 30.
(For more information, circle # 57 on the Reader Service Card.)

N/C LATHE PACKAGE / Fordax Corp., Long Beach, Calif. / a general lathe package said to be the first available on a minicomputer. Designed to prepare numerical control tapes for lathes, the package consists of a series of commands for inputting dimensional information to the computer, specifying cutter path and controlling operation of the program. Control commands and machine tool control commands allow the programmer to control program operation and tailor the part program to a specific machine tool.
(For more information, circle #58 on the Reader Service Card.)

ON-LINE MANAGEMENT INFORMATION AND ACCOUNTING SYSTEM / Computing Corporation International, Inc., Englewood, Colo. / provides on-line management information and accounting in a conversational manner. Management may inquire into the system from a Teletype or CRT terminal to retrieve information and generate up-to-date reports. The package is designed for a wide variety of on-line computer systems such as the IBM 360/50, the PDP-10, the GE 400 and 600 series, etc. The price, including complete installation and setup, is $60,000.
(For more information, circle #59 on the Reader Service Card.)

SYSTEM '70 / Western Operations, Inc., San Francisco, Calif. / a mutual fund shareholder accounting system which provides complete integration of all areas of shareholder accounting, support personnel and compute operations. There are extensive controls and audits through all phases; clerical procedures are simple and easy-to-learn. Written primarily in COBOL, it can be processed on an IBM System/360-40 with 128,000 bytes of core storage, (3) 2311 disk drives, and (5) tape drives.
(For more information, circle #60 on the Reader Service Card.)

Peripheral Equipment

PORTACOM TERMINAL / Data Products Corp.

A portable computer-communications terminal has been developed for the medical community. The new interactive terminal, called PortaCom, can be hand carried in an attache case anywhere — from physicians office to office, hospital to hospital. Some typical PortaCom applications include gathering clinical statistics during surveys, computer-assisted medical records-keeping at mobile nursing stations, and on-the-spot inventories of drugs and medical supplies in hospital annexes.

PortaCom produces full-page computer printout with up to three carbon copies. For instant computer access, it has its own built-in acoustic coupler. It needs only a standard power outlet and a telephone to begin operating. PortaCom has a standard ASCII keyboard and is Teletype compatible.
(For more information, circle #61 on the Reader Service Card.)

PRINTER OUTPUT MICROFILM SYSTEM / Advanced Terminals Inc.

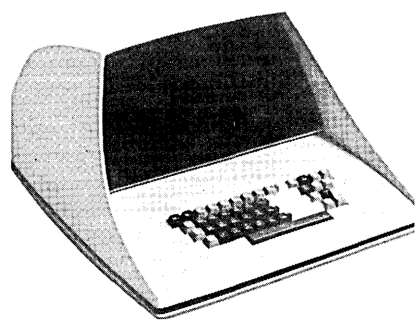
A new output microfilm system (a forms copier that automatically transfers computer printer output data from continuous fan fold forms onto microfilm) offers computer users a way to get into high-speed microfilming without commiting tens of thousands of dollars. The system is not as sophisticated as COM (Computer Output Microfilm), but it goes far beyong slow, tedious hand filming. The ATI system represents a concept that the company calls POM, or Printer Output Microfilm.

The POM system, designated ATI Formscopier Model 1000, consists essentially of an input tray for stacking fan fold forms, a sprocket drive for carrying forms through the copier, a rotary camera with dual lens, and a receiving output tray for collecting copied forms. The operator places printed forms on the input tray, threads the lead sheet through the copier, and stands by while forms are microfilmed. Copied forms stack automatically in the receiving tray.

The Formscopier handles printer hard copy output data at a rate adjustable between 15 and 56 inches per second with automatic exposure control. The top speed corresponds to a photo rate of 20,000 lines per minute (assuming six printed lines to the inch) and may be considered competitive with many COM systems. The lower speed allows easy stacking of forms at the beginning of a run, followed by higher speeds to maximize throughput for a given form. The variable speed allows the copier to handle all types of forms.
(For more information, circle #62 on the Reader Service Card.)

DATA ENTRY EQUIPMENT, SYSTEM 480 / Entrex, Inc.

System 480 is primarily for preparing computer input, and is designed to replace existing keypunch and key-to-tape methods. The major difference between the new system and other methods is the simplicity of operation. Intended to eliminate the user's problems, System 480 is operator-oriented — the equipment "... not only talks to computers at electronic speeds, but also talks to its operators in their language by displaying information in English on television-like screens."



System 480 has it's own computer and disk; it controls up to 64 Data/Scope keystations. The Data/Scope has a 480 character display. Input preparation applications for the System 480 include insurance companies, banks, hospitals, government agencies, and many others.
(For more information, circle #63 on the Reader Service Card.)

DATA-KAP 882 MACHINE-SOURCE DIGITAL RECORDER / Electronic Laboratories, Inc.

The data-kap® Recorder records numeric data directly from cash registers, calculators, and other business machines which have an electro-mechanical matrix. The 882 recorder may be free-standing, or mounted directly to cash registers and large office machines via a universal mounting plate. Data input is directly from the office machine through a plug-in connector to the machine.

Data is recorded in BCD, EBCDIC, or ASCII format, 32 characters per inch, even parity, on standard computer-grade 150-mil 4-track magnetic tape cassette. Cassette capacity is up to 200,000 numeric characters. The recorder weighs only 10 pounds and measures 9" x 10" x 4½".
(For more information, circle #64 on the Reader Service Card.)

NUMERICAL READOUT DISPLAYS / Oppenheimer, Inc.

A new incandescent display offers small size (0.02 sq. in.) and high visibility, even in sunlight. The display can be directly driven from I.C. logic circuitry, or an optional B.C.D. decoder may be used. The decoder also permits varying the display brightness. Because of the availability of standard and custom configurations, the display can be adapted to many different applications, including O.E.M. uses. Applications include navigational systems displays, DME systems, test equipment and computer products.
(For more information, circle #65 on the Reader Service Card.)

OPTICAL CHARACTER READERS / VIATRON Computer Systems Corp.

VIATRON's new line of low priced optical character readers makes optical character reading (OCR) available to even the smallest business or professional organization. The new readers (priced at least 10 times less than OCR devices now available) recognize a proprietary new character set which can be typed by any standard office typewriter or printer. According to Dr. Edward M. Bennett, President of VIATRON, this new character set, which he referred to as VIAFONT, is expected to become the standard of the industry within five years because of its overwhelming economic advantages.

The new readers all interface with VIATRON's System 21, Model 2111 data terminal through a standard data channel. Data read by the OCR can be recorded on VIATAPE cartridges or converted directly to punched cards or computer compatible tape. One OCR model reads typed data from paper documents as small as a credit card or as large as an 11" business form. Another reads typed data from any one of six lines on a standard punch card. Lowest cost VIATRON OCR, the OCR-6101, reads information typed on standard one inch paper tape.
(For more information, circle #66 on the Reader Service Card.)

Data Processing Accessories

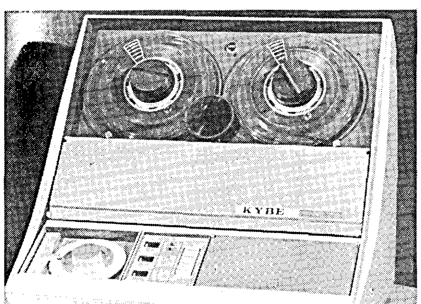
DATA INTERFACE TEST SET / Pulse Communications, Inc.

Model 505 Data Interface Test Set allows data terminal users to sectionalize trouble between the terminal and its associated modem (data set). This test set provides both access and control at all the leads of the RS-232 Interface Connector which is the demarcation line between the data set and the terminal equipment. With this test set any connector lead can be opened or closed, and any control signal such as carrier on, data set ready or request-to-send can be simulated. Indicator lamps, on the test set, provide signal station information.

The Test Set's simplicity allows users of limited technical skill to correctly isolate faults to either the data set or the terminal. The equipment also can be a very useful tool to even highly skilled maintenance personnel.
(For more information, circle #67 on the Reader Service Card.)

TABLE-TOP MAGNETIC TAPE TESTER-CLEANER / Kybe Corp.

The TMS-70 (for Tape Management System), a table-top device, combines the functions of computer magnetic tape testing, cleaning and precision rewinding. TMS-70 is designed primarily for users of small and medium-sized tape-oriented computer systems. The low-cost device



can process a 2,400-foot reel of magnetic tape in less than five minutes. First shipments are expected this month.
(For more information, circle #68 on the Reader Service Card.)

DISK PACK CERTIFIER / Interscan, Inc.

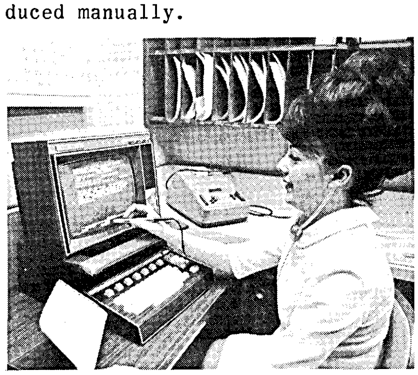
Series 1100 Disk Pack Certifier has been designed to assure computer operators that memory information magnetically stored on their 6 and 11 inch high disk packs can be relied upon to be accurate. This third generation certifier can distinguish between "soft" (marginal) and "hard" (minimum acceptable) errors. The user may adjust the certifier to his own standards or to the critical standards of Interim Federal Specification W.D. 0001489 GSA-FSS dated December 1, 1969.

The Certifier distinguishes between the various types of errors — missing bits, shifted bits, and extra bits. A light comes on to identify missing bits or extra bits on a pack while Nixie tubes show actual track error location. A complete disk pack profile may be printed out on an optional printer to give the operator the exact condition of a particular disk pack.
(For more information, circle #69 on the Reader Service Card.)

COMPUTER-RELATED SERVICES

MEDICAL INFORMATION SYSTEM, MIS-1 TO BE AVAILABLE NATIONWIDE

A computerized system to improve communication and reduce manual information handling in hospitals was demonstrated recently at El Camino Hospital in Mountain View, Calif. Developed by Lockheed Information Systems (a part of Lockheed Missiles & Space Co.), Sunnyvale, Calif., the Medical Information System, called MIS-1, enables nurses, other hospital personnel and physicians to communicate directly with computers. MIS-1 accumulates, processes and displays, on request, medical information related to a patient's hospital stay (starting at the admissions office and continuing until the patient's discharge). The system automatically handles medical orders, reports, charges, requisitions, nurses notes, patient care plans and other information required — information now produced manually.



The picture shows a radiology technician at El Camino Hospital listening to a doctor's tape recording of X-ray results which she feeds into a video terminal for immediate transmission to the attending physician. In MIS-1, two basic communication devices are used by the medical professionals. One is the video terminal consisting of a conventional television screen, a light pen and a typewriter keyboard; the other is a silent, ink-jet printer. The Lockheed system, soon to be available nationwide, is being offered initially to hospitals in the San Francisco Bay area. The northern California systems will be served by a Lockheed computer complex located in Mountain View, the same center that presently supports the MIS-1 prototype at El Camino.
(For more information, circle #70 on the Reader Service Card.)

NEW LITERATURE

CAREERS, COMPUTERS AND YOU, a new 12-page booklet prepared by the National Better Business Bureau (NBBB) and the American Federation of Information Processing Societies (AFIPS). One section is devoted to major job categories — the duties of each position, educational or training requirements, and any special skills needed. Other sections cover the growth of the computer field, a basic description of data processing, methods for self-evaluation of interest and aptitude, general salary information, sources of education and training, and a list of ten recommended guidelines for evaluating private schools. A copy of "Careers, Computers and You" may be obtained by sending twenty-five cents (25¢) to the National Better Business Bureau, 230 Park Avenue, New York, N.Y., 10017. The booklet also is available in bulk quantities.

GUIDE TO DATA EDUCATION FILMS, a 64-page, 8½ x 11, paper-covered reference volume, has been compiled by Dr. Mary Robek of Eastern Michigan University and is published by the Society of Data Educators. The volume contains detailed descriptions of 550 films, including where each can be rented or purchased, rental fee if any, running time, and recommended level of usage. Films were selected on the basis of their value in classroom and training situations; most have been released since 1960.
(For more information, circle #71 on the Reader Service Card.)

HOW TO BUY PROPRIETARY SOFTWARE PRODUCTS, a 63-page booklet published by International Computer Programs, Inc. The subject matter covers: the present status of the software industry, guidelines (and a checklist) for evaluating a software package, the accounting and tax implications of software, and, legal aspects of purchasable software. The booklet is priced at $4.50 per copy; bulk rates are available.
(For more information, circle #72 on the Reader Service Card.)

NEW CONTRACTS

TO	FROM	FOR	AMOUNT
Lear Siegler, Inc., Instrument Div., Grand Rapids, Mich.	Data Input Devices, Derry, N.H.	Manufacture of digital encoders	$9.7 million
Honeywell Data Systems Div., Minneapolis, Minn.	Department of Defense	Digital communications systems to link Defense Contract Administration Service (DCAS) headquarters and selected Contract Administration Offices in computer net to speed defense contract data	$8,084,716
Control Data Corp., Minneapolis, Minn.	Mass. Institute of Technology, Lincoln Laboratory, Lexington, Mass.	Dual CDC 6600 systems; one system will be installed at the Lincoln Labs; the other, at the Kwajalein Missile Range in the Marshall Islands where it will be connected to radar systems	$7 million (approximate)
Informatics, Inc., Sherman Oaks, Calif.	National Aeronautics & Space Administration (NASA)	A one year continuation of the operation of NASA Scientific and Technical Information Facility in College Park, Md.	$5,035,000
Computing and Software, Inc., Los Angeles, Calif.		Continuation of data processing services at Goddard Space Flight Center, Greenbelt, Md.	$4.9+ million
Sanders Associates, Inc. Nashua, N.H.	U.S. Navy, Naval Electronic Supply Office	Classified electronic components	$4,229,488
Infoton, Inc., Burlington, Mass.	National Semiconductor Co., Inc.	Components for cathode ray tube display terminals	$3.2 million
General Instrument Corp., Electronic Systems Div., Hicksville, N.Y.	U.S. Army	Continued production of the TT558/G High Speed Page Printer which is used in conjunction with military communication systems	$2.5+ million
Computer Dimensions, Inc., Dallas, Texas	Budget Industries, Inc., Los Angeles, Calif.	Handling entire data processing operation currently maintained by Budget Industries	$2.1 million
Ferranti-Packard Ltd., Electronics Div., Toronto, Ontario, Canada	Spiegel Inc., Chicago, Ill.	Development and prototype production of computer peripheral equipment for use in a pilot order processing system	$2+ million
General Instrument Corp., Electronic Systems Div., Hicksville, N.Y.	U.S. Navy, Naval Electronic Systems Command	To build and test twenty high-reliability units of the AN/PPS-( ) Battlefield Surveillance Radar	$1.5 million (approximate)
Control Data Corp., Minneapolis, Minn.	The Royal Turf of Thailand	Control Data 3100/3300 system to process racetrack betting information and calculate dividends on winning tickets	$1.5 million (approximate)
Ampex Corp., Culver City, Calif.	Nixdorf Computer AG West Germany	Core memory stacks to be used in new Nixdorf 800 and 900 series computers	$1.4 million (approximate)
	Marconi Elliott Computer Systems Ltd., Great Britain	Core memories to be used in Marconi Elliott 900 series computers	$1.3 million
Motorola Inc., Franklin Park, Ill.	Viatron Computer Systems Corp., Bedford, Mass.	Solid state video display units for use in Viatron's System 21	$1.25 million
Computer Sciences Corp., Los Angeles, Calif.	Defense Communications Agency	Technical assistance in support of the National Military Command System	$1.1 million
Ampex Corp., Culver City, Calif.	Friden Division of the Singer Co., San Leandro, Calif.	Digital tape drives for the new Singer System Ten business computer	$1.1 million
Hazeltine Corp., Little Neck, N.Y.	Department of the Navy	Spare parts in support of the AN/APX-76 Identification Friend-or-Foe (IFF) Interrogator Set	$1,093,000
Ampex Corp., Culver City, Calif.	Data General Corp., Southboro, Mass.	Core memory stacks to be incorporated in Data General's Nova and SuperNova computers	$1+ million
Honeywell Data Products Div.	U.S. Bureau of Census	One-hundred Keytape devices for preparation of some 3.5 million agricultural census forms for computer processing	$1 million (approximate)
Racal-Milgo Ltd., England	Lufthansa	High-speed modems to provide the data transmission links for the airline's international seat reservation system	$750,000+
Tri-Data Corp., Mountain View, Calif.	Teradyne, Inc., Boston, Mass.	CartriFile magnetic tape units	$750,000
General Instrument Corp., Electronic Systems Div., Hicksville, N.Y.	NASA	Building thirty BIP (Balloon Interrogation Package) Systems, a key element in NIMBUS D/IRLS Global Weather Forecasting System	$700,000+
Data Products Corp., Woodland Hills, Calif.	Hewlett-Packard Co., Cupertino, Calif.	Model 2000 Series mini-printers to be used in conjunction with HP's digital computers	$600,000+
Raytheon Co., Submarine Signal Div., Portsmouth, R.I.	Lockheed Electronic's Data Products Div., Los Angeles, Calif.	CR-95 military memory systems for a submarine sonar program	$500,000+
Middle Atlantic Educational and Research Center (MERC), Lancaster, Pa.	Independence Foundation of Philadelphia	A grant for meeting first-year operational expenses of the non-profit computer utility	$102,500
International Computaprint Corp., Fort Washington, Pa.	U.S. Dept. of Commerce	Preparation of a Full Text Computer Data Base for the U.S. Patent Office which plans to use the data base for the direct support of internal Patent Office operations	—
Shipping Research Services A/S (Ltd.), Oslo Norway	Chantiers Navals de la Ciotat	Delivery and installation of AUTOKON, a computer program system for design and construction purposes in shipbuilding industry	—
Applied Dynamics Computer Systems, Ann Arbor, Mich.	Reed Institute, Portland, Ore.	AD/FIVE analog/hybrid computer system; will be interfaced with Nova computer for use in teaching liberal arts students basic math, chemistry and physics	—

NEW INSTALLATIONS

OF	AT	FOR
Burroughs B500 system	Zondervan Publishing Co., Grand Rapids, Mich.	Order processing, accounts receivable and payable, payroll and mailings (system valued at over $340,000)
Burroughs B3500 system	American Data Services, Inc., Portland, Ore.	Expanding computer services; initial use for processing general service bureau work
	Pennsylvania National Mutual Casualty Insurance Co., Harrisburg, Pa.	General ledger and cost accounting systems, external and internal statistical requirements, and policy writing and rating
Control Data 3300 system	Lurgi, Frankfurt, Germany	Solving engineering problems; facilitating design and construction of plants and equipment worldwide
	Shearson, Hammill & Co., Inc. New York, N.Y.	A Brokerage Control System; provides order matching and confirmation of stock market transactions (system valued at almost $2.5 million)
Control Data 3500 system	Secretaria de Hacienda, Mexico City, Mexico (2 systems)	Handling budgetary functions of the Mexican government
Control Data 6400 system	Bell Telephone Company of Canada, Ltd., Montreal, Quebec	Use in forecasting future telephone network needs, communications research projects and analysis (system valued at nearly $2 million)
Control Data 6600 system	Centre National d'Etudes Spatiales (CNES), Bratigny, France	All scientific and administrative computing needs of CNES (the French counterpart of NASA) (system valued at $5.7 million)
Digital Equipment PDP-10	Bowdoin College, Brunswick, Me.	Administrative, research, and instructional needs; also contract computing services to area schools
	Manchester University, Reading, Berkshire, England	Control of 3 analog computers, computer-aided design, general-purpose time sharing, and computation in school's control systems center (system valued at $400,000)
GE-115 system	Chicago Specialty Mfg. Co., Skokie, Ill.	Initial use in order processing and invoicing; will add sales forecasting and analysis later
Honeywell Model 125 system	Metropolitan Pathology Laboratories Inc., Hackensack, N.J.	Use with 2 AGA autochemists to print reports, collate and separate normal from abnormal results (an autochemist machine performs 21 chemical tests on blood samples)
IBM System/3	Bon Voyage Travel Agency, Evanston, Ill.	Accounting jobs for 10 area offices, processing air lines' reports on tickets, and for large commercial accounts
	Century Products, Inc., Cleveland, Ohio	Inventory control, payroll, accounts receivable and payable, commission statements, sales analyses
	Hollingsworth Solderless Terminal Co., Phoenixville, Pa.	Data processing chores previously handled by accounting machines
	Jacob Levy & Bros., Inc., Louisville, Ky.	Computerizing entire accounting operation
	Lingo Lumber Co., Dallas, Texas	Long range sales forecasting, sales analyses, and a variety of accounting tasks
IBM System/360 Model 65	Atar Computer Systems, Inc., Canoga Park, Calif.	Travel agent common automated reservation system; will give selling agents automated access to reservations systems of participating domestic and foreign airlines, hotels and car rental firms. When communications computer (July) and second IBM 360/65 (fall) are installed Atar will have real-time, on-line capability with complete backup (system valued at $2.5 million)
IBM System/360 Model 85	McDonnell Automation Co., St. Louis, Mo.	Commercial data processing services; data sent to it over nationwide telecommunications network from 68 smaller computers and data transmission devices (system valued at nearly $12 million)
NCR Century 100 system	Berger Langmoen A/S, Brumunddal, Norway	Computerizing accounting operation of firm's parquet plant; timber accounting and production control for remaining divisions will be added later
RCA Spectra 70/55 system	Carte Blanche, Los Angeles, Calif.	Billing and credit card accounting; replaces two second generation computers (system valued at $1.6 million)
UNIVAC 9200 system	Bush Brothers & Co., Dandridge, Tenn.	Sales analysis, payroll preparation, general accounting
	Friends Univ., Wichita, Kans.	Administrative and business applications as well as student training
	McArthur Dairy, Florida	Route/driver settlement, wholesale billing, ice cream inventory, marketing reports, payroll, etc.
	Retail Store Employee's Union, Local 782, Kansas City, Mo.	Dues billing, master record maintenance and mailing list
UNIVAC 9300 system	Maruei Dept. Store, Nagoya, Japan	Merchandise control and billing
	State of Rio de Janeiro, Computer Center, Niteroi, Brazil (3 systems)	A number of state government departments; applications include: banking; processing of property, school and turnover taxes; payroll preparation for all of the state employees (systems valued at about $1.5 million)
UNIVAC 9400 system	(1 system)	
XDS Sigma 7 system	Datalogics, Inc., Cleveland, Ohio	Expansion of computer services; will enable firm to offer remote batch-processing and will also permit expanding throughout Southern Ohio and several bordering states

MONTHLY COMPUTER CENSUS

Neil Macdonald
Survey Editor
COMPUTERS AND AUTOMATION

The following is a summary made by COMPUTERS AND AUTOMATION of reports and estimates of the number of general purpose electronic digital computers manufactured and installed, or to be manufactured and on order. These figures are mailed to individual computer manufacturers from time to time 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. Several important manufacturers refuse to give out, confirm, or comment on any figures.

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

Part I of the Monthly Computer Census contains reports for United States manufacturers. Part II contains reports for manufacturers outside of the United States. The two parts are published in alternate months.

The following abbreviations apply:

(A) -- authoritative figures, derived essentially from information sent by the manufacturer directly to COMPUTERS AND AUTOMATION
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 AUTOMATION
(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

SUMMARY AS OF MAY 15, 1970

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 II. Manufacturers Outside United States							
A/S Norsk Data Elektronikk	NORD 1	8/68	2.0	0	20	20	10
Oslo, Norway	NORD 2	8/69	4.0 (S)	0	2	2	3
(A) (Jan. 1970)							
A/S Regnecentralen	GIER	12/60	2.3-7.5	0	39	39	1
Copenhagen, Denmark	RC 4000	6/67	3.0-20.0	0	8	8	6
(A) (Jan. 1970)							
Elbit Computers Ltd.	Elbit-100	10/67	4.9 (S)	-	-	120	75
Haifa, Israel							
(A) (Jan. 1970)							
GEC-AEI Automation Ltd.	Series 90-2/10/20						
New Parks, Leicester, England	25/30/40/300	1/66	-	-	-	13	X
(R)	S-Two	3/68	-	-	-	1	X
(Jan. 1969)	130	12/64	-	-	-	2	X
	330	3/64	-	-	-	9	X
	959	-/65	-	-	-	1	X
	1010	12/61	-	-	-	8	X
	1040	7/63	-	-	-	1	X
	CON/PAC 4020	-	-	-	-	0	X
	CON/PAC 4040	5/66	-	-	-	9	-
	CON/PAC 4060	12/66	-	-	-	5	-
International Computers, Ltd. (ICL)	Atlas 1 & 2	1/62	65.0	0	6	6	X
London, England	Deuce	4/55	-	0	7	7	X
(A)	KDF 6 - 10	9/61	10-36	0	58	58	X
(March 1970)	KDN 2	4/63	-	0	1	1	X
	Leo 1, 2, 3	-/53	10-24	0	59	59	X
	Mercury	-/57	-	0	13	13	X
	Orion 1 & 2	1/63	20.0	0	17	17	X
	Pegasus	4/55	-	0	30	30	X
	Sirius	-/61	-	0	22	22	X
	503	-/64	-	0	16	16	X
	803 A, B, C	12/60	-	0	83	83	X
	1100/1	-/60	5.0	0	22	22	X
	1200/1/2	-/55	0.9	0	68	68	X
	1300/1/2	-/62	4.0	0	196	196	X
	1500	7/62	6.0	0	110	110	X
	2400	12/61	23.0	0	4	4	X
	1900-1909	12/64	3-54	0	1233	1289	C
	Elliott 4120/4130	10/65	2.4-11.4	0	151	142	C
	System 4-30 to 4-75	10/67	5.2-54	0	105	115	C
							Total: 564
Japanese Mfrs.	Various models	-	-	-	-	4136 E	800 E
(N) (March 1970)-							
Marconi Co., Ltd.	Myriad I	3/66	£36.0-£66.0 (S)	0	37	37	9
Chelmsford, Essex, England	Myriad II	10/67	£22.0-£42.5 (S)	0	17	17	12
(A) (Jan. 1970)							
Saab Aktiebolag	D21	12/62	7.6	0	37	37	-
Linkoping, Sweden	D22	5/68	13.4	0	15	15	10
(A) (Jan. 1970)	D220	4/69	9.8	0	1	1	10
Siemens	301	11/68	0.75	-	-	20	C
Munich, Germany	302	9/67	1.3	-	-	24	C
(A)	303	4/65	2.0	-	-	69	C
(March 1970)	304	5/68	2.8	-	-	43	C
	305	11/67	4.5	-	-	51	C
	306	-	6.5	-	-	-	C
	2002	6/59	13.5	-	-	41	C
	3003	12/63	13.0	-	-	38	C
	4004S	-	4.0	-	-	1	C
	4004/15/16	10/65	5.0	-	-	89	C
	4004/25/26	1/66	8.3	-	-	34	C
	4004/35	2/67	11.8	-	-	147	C

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
Siemens (cont'd)	4004/45	7/66	19.8	-	-	130	C
	4004/46	4/69	34.0	-	-	3	C
	4004/55	12/66	25.8	-	-	14	C
							Total: 230
USSR	BESM 4	-	-	-	-	C	C
(N)	BESM 6	-	-	-	-	C	C
(May 1969)	MINSK 2	-	-	-	-	C	C
	MINSK 22	-	-	-	-	C	C
	MIR	-	-	-	-	C	C
	NAIR 1	-	-	-	-	C	C
	ONEGA 1	-	-	-	-	C	C
	ONEGA 2	-	-	-	-	C	C
	URAL 11/14/16	-	-	-	-	C	C
	and others	-	-	-	-	C	C
						Total: 6000 E	Total: 2000 E

CALENDAR OF COMING EVENTS

June 8-9, 1970: CAP Spring Membership Meeting, Computer Users Group of Honeywell's Computer Control Div., Statler Hilton Hotel, Washington, D.C. / contact: Ted Nelson, Sanders Associates, Inc., 95 Canal St., Nashua, N.H. 03060

June 8-10, 1970: International Conference on Communications (IEEE), San Francisco Hilton Hotel, San Francisco, Calif. / contact: A. M. Peterson, Stanford Research Institute, Menlo Park, Calif. 94025

June 9-10, 1970: Grenoble Workshop on Microprogramming, Mathematiques Appliquees, CEDEX 53, 38 — Grenoble-Gare, France / contact: Guy G. Boulaye and Jean P. Mermet, Mathematiques Appliquees, CEDEX 53, 38 — Grenoble-Gare, France

June 10-12, 1970: 1970 Summer Computer Simulation Conference, Denver Hilton Hotel, Denver, Colo. / contact: Donald Lusty, 1970 SCSC Registration Chairman, c/o Electronic Associates Inc., 2120 So. Ash St., Denver, Colo. 80222

June 15-16, 1970: Conference on Solid State in Industry, (IEEE), Statler-Hilton Hotel, Cleveland, Ohio / contact: A. J. Humphrey, Technical Program Chairman, The Reliance Electric & Engrg. Co., 24701 Euclid Ave., Cleveland, Ohio 44117

June 16-18, 1970: Computer Group Conference and Exposition (IEEE), Washington Hilton Hotel, Washington, D.C. / contact: Bob O. Evans or Donald E. Doll, IBM Federal Systems Div., 18100 Frederick Pike, Gaithersburg, Md. 20760

June 16-18, 1970: Conference on Computers in the Undergraduate Curricula, The Univ. of Iowa, Iowa City, Iowa / contact: Brooks Booker, Center for Conferences and Institutes, The Univ. of Iowa, Iowa City, Iowa 52240

June 18, 1970: Ninth Annual Technical Symposium, Washington, D.C. Chapter ACM, National Bureau of Standards, Gaithersburg, Md. / contact: General Chairman, 1970 Symposium Committee, Washington, D.C. Chapter ACM, P.O. Box 6228, Washington, D.C. 20015

June 18-19, 1970: 29th Management Conference of ADAPSO, Washington Hilton Hotel, Washington, D.C. / contact: ADAPSO, 551 Fifth Ave., New York, N.Y. 10017

June 20-24, 1970: RCA Computer User's Association, Atlantic City, N.J. / contact: RCA Information Systems Div., Route 38, Cherry Hill, N.J. 08034

June 22-23, 1970: Eighth Annual Conference, ACM Special Interest Group for Computer Personnel Research, Center for Continuing Education, Univ. of Maryland, College Park, Md. / contact: Robert A. Dickmann, The Johns Hopkins Univ., Applied Physics Lab., 8621 Georgia Ave., Silver Spring, Md. 20910

June 22-24, 1970: Data Processing Supplies Association, Spring General Meeting, The Olympic Hotel, Seattle, Wash. / contact: Data Processing Supplies Association, 1116 Summer St., P.O. Box 1333, Stamford, Conn. 06904

June 23-26, 1970: DPMA International Data Processing Conference and Business Exposition, Olympic and Washington Plaza (co-headquarter hotels), seminars and exposition at Seattle Center, Seattle, Wash. / contact: Data Processing Management Association, 505 Busse Hwy., Park Ridge, Ill. 60068

June 24-26, 1970: 11th Joint Automatic Control Conference (JACC), Georgia Institute of Technology, Atlanta, Ga. / contact: Prof. Eugene Harrison, Dept. of Mechanical Engineering, Clemson University, Clemson, S.C. 29631

June 29-30, 1970: Conference on Optimisation Techniques in Circuit and Control Applications, Institution of Electrical Engineers, Savoy Place, London, WC2, England / contact: Manager, Conference Department, IEE, Savoy Place, London, WC2, England

June 29-July 1, 1970: SIAM 1970 National Meeting, Univ. of Denver, Denver, Colo. / contact: Society for Industrial and Applied Mathematics, 33 South 17th St., Philadelphia, Pa. 19103

July 15-17, 1970: Primer Congreso Argentino de Instruccion Programada, Pedagogia Universitaria, Buenos Aires, Argentina / contact: Professora Luisa Kohen, Viamonte 430, piso 1°, Buenos Aires, Argentina

Aug. 18-21, 1970: International Conference on Microelectronics, Circuits & Systems Theory, Univ. of New South Wales, Kensington, Sydney, Australia / contact: Jt. Conf. Secretariat, IREE, Australia, Box 3120, GPO, Sydney, 2001 Australia

Aug. 24-28, 1970: IFIP World Conference on Computer Education, Amsterdam, Netherlands / contact: A. A. M. Veenhuis, Secretary-General, IFIP Conference Computer Education 1970, 6, Stadhouderskade Amsterdam 13, Netherlands

Aug. 25-28, 1970: Western Electronic Show & Convention (WESCON), Biltmore Hotel, Sports Arena, Los Angeles, Calif. / contact: WESCON, 3600 Wilshire Blvd., Los Angeles, Calif. 90005

Aug. 31, 1970: Fifth Annual ACM Urban Symposium, New York Hilton Hotel, New York, N.Y. / contact: Paul R. DeCicco, ACM Urban Symposium Chairman, Polytechnic Institute of Brooklyn, 333 Jay St., New York, N.Y. 11201

Aug. 31-Sept. 2, 1970: American Society of Civil Engineers, Fifth Conference on Electronic Computation, Purdue University, Lafayette, Ind. / contact: Robert E. Fulton, Mail Stop 188-C Structures Research Division, NASA Langley Research Center, Hampton, Va. 23365

Sept. 1-3, 1970: 25th National Conference, Association for Computing Machinery, New York Hilton, New York, N.Y. / contact: Sam Matsa, ACM '70 General Chairman, IBM Corp., 410 E. 62nd St., New York, N.Y. 10021

Sept. 2-4, 1970: The Institution of Electrical Engineers (IEE) Conference on Man-Computer Interaction, UK National Physical Laboratory, Teddington, Middlesex, England / contact: Roger Dence, IEE Press Office, Savoy Place, London WC2, England

Sept. 14-24, 1970: 1970 FID (International Federation for Documentation) Conference and International Congress on Scientific Information, Buenos Aires, Argentina / contact: U.S. National Committee for FID, National Academy of Sciences, 2101 Constitution Ave., Washington, D.C. 20418

Sept. 17-18, 1970: Computer Science and Statistics Symposium, sponsored by the Los Angeles Chapter of the ACM, University of California, Irvine, Calif. / contact: Dr. Mitchell O. Locks, C-E-I-R Professional Services Div., Control Data Corp., 6060 W. Manchester, Los Angeles, Calif. 90045; or Dr. Michael E. Tarter, Assoc. Prof., Dept. of Mathematics and Dept. of Medicine, University of California, Irvine, Calif. 92664

Sept. 22-24, 1970: The Computers and Communications Conference (IEEE), The Beeches, Rome, N.Y. / contact: Jerold T. McClure, Conference Chairman, P.O. Box 182, Rome, N.Y. 13440

Sept. 22-24, 1970: Univac Users Association Fall Conference, Roosevelt Hotel, New Orleans, La. / contact: User Group Relations, Univac Division, Sperry Rand Corp., P.O. Box 500, Blue Bell, Pa. 19422

Oct. 5-9, 1970: Computer 70—International Computer Exhibition, Olympia, London, England / contact: M. F. Webster, Leedex Limited, 100 Whitechapel Road, London, E.1., England

Oct. 7-9, 1970: American Production and Inventory Control Society 13th Annual International Conference, Ohio Convention Exposition Center, Cincinnati, Ohio / contact: APICS National Office, Suite 504, Watergate Bldg., 2600 Virginia Ave., N.W., Washington, D.C. 20037

Oct. 11-15, 1970: 33rd Annual Meeting of the American Society for Information Science (ASIS), Sheraton Hotel, Philadelphia, Pa. / contact: ASIS 1970 Convention Chairman, Dr. Eugene Garfield, Institute for Scientific Information, 325 Chestnut St., Philadelphia, Pa. 19106

Oct. 12-13, 1970: Sixth National Data Processing Conference of the Information Processing Association of Israel, Tel Aviv Hilton Hotel, Tel Aviv, Israel / contact: S. Shalish, Chmn., Information Processing Association of Israel, P.O.B. 3009, Jerusalem, Israel □

ADVERTISING INDEX

Camwil Products, Inc., 835 Keeaumoku, Honolulu, HI 96814 / Page 62 / Richard T. Clarke Co.

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Computer Signal Processors, Inc., 209 Middlesex Turnpike, Burlington, MA 01893 / Page 2 / Ingalls Associates, Inc.

Computers and Automation, 815 Washington St., Newtonville, MA 02160 / Pages 3 and 63 / —

REPORT FROM GREAT BRITAIN

(Continued from page 23)

Competitive Pressure

Add to that the fact that launch in the UK simultaneously with anything new in the U.S. is becoming automatic and there you have the whole problem — ICL is just big enough to start holding its own in Europe, but commands only half its own home market and has to face up to sharp competition from every other manufacturer except RCA and Philips.

It is hard to imagine an American company at home faced with similar problems.

Indeed, the above figures do not reveal the true seriousness of the situation, black as they are. The proportion of domestic-made equipment supplied to the home market is likely to go on falling till 1972, at which time half the installations of any type of computing equipment put into UK users' premises will be brought in from overseas. Pundits at the Ministry of Technology say that from then on the position will improve because the Scottish plants of Burroughs will be turning out disc systems for Europe while NCR's Century line, also in Scotland, will be in full operation for destinations outside North America.

The position will improve, all things being equal. But if ICL goes under as a result of the immense competitive pressures on it, then the position will turn into a complete disaster for a fumbling, bumbling Government policy.

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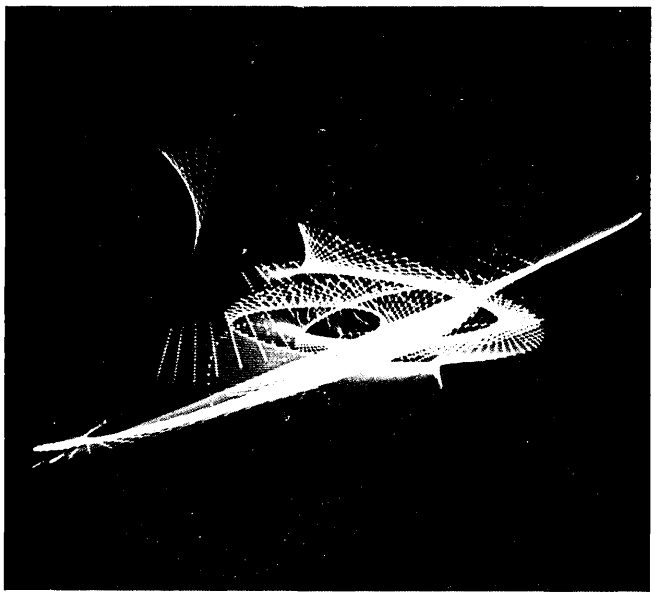

CIRCUS
— Tom Childs

The winning entry will appear on the cover of our August issue — more than 25 entries will be published inside. The 1969 first prize winner, "Circus", is shown here at the left.

GUIDELINES FOR ENTRY

1. Any interesting and artistic drawing, design or sketch made by a computer (analog or digital) may be entered.

2. Entries should be submitted on white paper in black ink for best reproduction. Color entries are acceptable, but they may be published in black and white.

3. Entries should be limited in size to $12\frac{1}{2}$" by 17".

4. Each entry should be accompanied by an explanation in three or four sentences of how the drawing was programmed for a computer, the type of computer used, and how the art was produced by the computer.

There are no formal entry blanks; any letter submitting and describing the entry is acceptable. We cannot undertake to return artwork, and we ask that you not send originals.

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