computers and people

formerly *Computers and Automation*

June, 1975
Vol. 24, No. 6

COMPUTERIZED STRATEGY FOR POLE VAULTING

The Notebook on
COMMON SENSE, ELEMENTARY AND ADVANCED

is devoted to development, exposition, and illustration of what may be the most important of all fields of knowledge:

WHAT IS GENERALLY TRUE AND IMPORTANT =

COMMON SENSE + WISDOM + JUDGEMENT AND MATURITY + SCIENCE IN GENERAL + TECHNIQUES FOR SOLVING PROBLEMS +

TECHNIQUES FOR AVOIDING MISTAKES + SOME PARTS OF OPERATIONS RESEARCH + SOME PARTS OF SYSTEMS ANALYSIS + AVOIDANCE OF LOGICAL FALLACIES + ...

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- to prevent mistakes before they happen
- to display new paths around old obstacles
- to point out new solutions to old problems
- to stimulate your resourcefulness
- to increase your accomplishments
- to improve your capacities
- to help you solve problems
- to give you more tools to think with
- . . . . .

Topic:
THE SYSTEMATIC PREVENTION OF MISTAKES

Already Published

Preventing Mistakes from:
- Failure to Understand
- Forgetting
- Unforeseen Hazards
- Placidity
- Camouflage

To Come

Preventing Mistakes from:
- Bias
- Interpretation
- Distraction
- Gullibility
- Failure to Observe
- Failure to Inspect
- Prejudice
- . . . .

Topic:
SYSTEMATIC EXAMINATION OF GENERAL CONCEPTS

Already Published

The Concept of:
- Expert
- Rationalizing
- Feedback
- Model
- Black Box
- Evolution
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- Understanding

To Come
- Strategy
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by Edmund C. Berkeley, Author and Anthologist

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Table of Contents

The Fox of Mt. Etna and the Grapes

Once there was a Fox who lived on the lower slopes of Mt. Etna, the great volcano in Sicily. These slopes are extremely fertile; the grapes that grow there may well be the most delicious in the world; and of all the farmers there, Farmer Mario was probably the best. And this Fox longed and longed for some of Farmer Mario's grapes. But they grew very high on arbors, and all the arbors were inside a vineyard with high walls, and the Fox had a problem. Of course, the Fox of Mt Etna had utterly no use for his famous ancestor, who leaping for grapes that he could not reach, called them sour, and went away.

The Fox decided that what he needed was Engineering Technology. So he went to a retired Engineer who lived on the slopes of Mt. Etna, because he liked the balmy climate and the view of the Mediterranean Sea and the excitement of watching his instruments that measured the degree of sleeping or waking of Mt. Etna. The Fox put his problem before the Engineer. . . .

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computers and people

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

IF YOU ARE INTERESTED IN COMPUTER ART, WE INVITE YOUR ENTRIES IN OUR

13TH ANNUAL COMPUTER ART EXPOSITION

— a *special feature* of the August 1975 issue of *Computers and People.*
One of the entries we receive will be selected to appear on the cover of our August issue. More entries will be published inside; other entries will be published in later issues. See our announcement and guidelines for entry on page 12 of this issue.

Front Cover Picture

On his way up, USC Prof. James B. Vernon, age 58, has cleared 11 feet, 1-1/4 inches and holds national AAU and Senior Olympic records for his age group. He is using the school's computer to learn which factors are the most important for success in the sport and believes that a 20-foot vault is within reach of the current generation of athletes. For more informa- information, see p. 32.

ANNOUNCEMENT

A great part of the department
The Profession of Information Engineer and the Pursuit of Truth
which *Computers and People* has published in the past, has now been broken out and published as a separate monthly magazine
PEOPLE AND THE PURSUIT OF TRUTH
The first issue was May 1975.
See the fuller announcement on the back cover.

Key

[A]	–	**Article**
[C]	–	**Monthly Column**
[E]	–	**Editorial**
[F]	–	**Forum**
[N]	–	**Newsletter**
[R]	–	**Reference**

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EDITORIAL

Military Deterrence in History

"This book is a study of military deterrence as it has been used at various times and places throughout 2500 years of history."

That is the first sentence in the preface of an interesting, important, and unusual book.

The authors are Raoul Naroll, Vern L. Bullough, and Frada Naroll; the work is published by the State University of New York Press, 99 Washington Ave., Albany, N.Y. 12210, 416 pages, 1974. The acknowledgements include:

"Our largest debt is owed to Thomas W. Milburn, director of Project Michelson at the Naval Ordnance Test Station, China Lake, California. He suggested the research, proposed the ... conference on our research design, and gave freely of his counsel throughout the project. Through Milburn and Project Michelson, we are indebted to the United States Navy for its support of the entire project. Presumably the naval authorities must have hoped — as we ourselves had hoped — that our findings would have solidly supported the deterrence hypothesis. But when on the contrary we found deterrence an unsuccessful strategy, there was never the slightest hint on the part of anyone concerned that we might hedge our report or shade our findings. In these times when support of social science research by the Department of Defense is frequently challenged, we would like to record our appreciation of the generous funding and a completely free hand in our scientific policies, our interpretations, and our publication of results."

The authors take 20 periods of history and study conflicts between the Conspicuous State and the Conspicuous Rival. The periods and chapter titles include:

Period	Title
China, 125-116 B.C.	The Climax of the Border War
China, 25-16 B.C.	A Lull on the Northern Marches
China, 776-785	T'ang China versus Tibet
Byzantium, 776-785	The Caliphate versus the Byzantine Empire
Rome, 376-385	The Internal Invasion
France, 1676-1685	The Sun King Threatens

The authors study these periods with a careful description of a method to be used (the "cross-historical survey"), the variables selected, and the mode of assigning values to the variables. They then perform a good deal of complex statistical evaluation (including computerized searches and correlations) and arrive at scores. On the basis of the scores they arrive at "Findings", reported in Chapter 23.

In the summary of Main Findings (pp. 342 and 343) occur the statements:

— The chief object in our search in this study was for factors correlated with peace. We found none of any consequence.
— The main point of this pilot study is clear. If its findings can be trusted, they tell us that for Conspicuous States, at least, the search for peace and security through armed force is in vain. Those who live by the sword may indeed expect to perish by the sword.
— If this pilot study faithfully reflects the state of affairs in the world of power politics, and if that state of affairs continues unchanged, there is little hope for either peace or security in arms.

Of course, the first natural question is "How much belief should be placed in this study and its findings?"

The possibility of answering this question is greatly aided by the way in which this study is presented: publication of the input, the reasoning, the operations, and the output, in a truly scientific fashion. All the important evidence and methods used are laid wide open to examination by all kinds of judges, scholars, and interested persons.

Since I have not studied or used the method of the cross-historical survey, I cannot make more than a few reasonable comments. But the following comments, it seems to me, do certainly apply:

— It is pleasing that a branch of the U.S. Department of Defense has honestly supported a scientific study which comes out with an assessment totally contrary to one of the cardinal U.S. doctrines of defense: "Deter attack through military strength".
— This pioneering study suggests some interesting and important facts, which might substantially change the official views of this country and of many other countries about armaments and national defense.
— Here is an area of study where computer professionals who have training in statistics and the cross-historical method, could make a great contribution to society and peace.

Edmund C. Berkeley

Edmund C. Berkeley
Editor

MULTI-ACCESS FORUM

MINICOMPUTERS TO GROW 12 TIMES, MICROCOMPUTERS TO GROW 150 TIMES OVER THE NEXT DECADE – THE IMPACT ON HUMAN LIFE TO BE LIKE THE ELECTRIC MOTOR'S

Lucy Hendry
Frost and Sullivan, Inc.
Market Research Specialists
106 Fulton St.
New York, N.Y. 10038

Some 150,000 minicomputers and 100,000 microcomputers were installed toward the end of 1974. The numbers will soar to 2 million minicomputer and 15 million microcomputer installations over the next decade. Their cumulative value will exceed $30 billion for the ten year period. The market is so large as to appear unbelievable. The technology eventually will have an impact on our lives like the impact of the electric motor.

Growth is virtually assured since prices are destined to decrease to as little as $2,000 for a complete system by 1984. "A microprocessor, itself, will sell for $100 or less." The potential applications boggle the mind, and are reminiscent of the soaring markets that have occurred for calculators as their prices fell.

The market for mini-micro peripherals will parallel this growth, increasing from $525 million in 1974 to $690 million in 1975 to $2.8 billion by 1984. That comes to a cumulative market of $15 billion over the next decade.

Already, some 100 manufacturers produce miniperipherals, but the microperipheral market is just getting underway. The very first company in the field, for example, recently introduced a microcomputer-based tape reader, and plans to produce a full line of microperipherals.

Three major application areas — business data processing, industrial automation, and data communications — constitute 70% to 80% of the mini/micro computer market, and this concentration is expected to remain a feature of the market into the 1980's. The process industries, for example, will turn extensively to microcomputers for assembly line control, materials handling, and machine tool control.

Microprocessors used on automobiles and trucks to warn drivers of malfunctions are destined to become a reality in the late 1970's or early 80's. The current hang-up is the relatively high cost of the sensors in a microprocessor system.

And in accounting computers, we anticipate a revolution as the microcomputers and minicomputers reenter this lucrative market. Microcomputer systems, priced under $7,000, will displace both traditional accounting machines and service bureaus, especially for payroll and accounts receivables. Prices of microcomputer-based accounting systems will drop to $5,000 for a complete turnkey system by 1980.

Some 60 companies currently produce minicomputers and microcomputers. We foresee a blending of the two kinds of computers into a virtually indistinguishable product line, with price becoming the main distinction. For now, microcomputers tend to differ from minicomputers by having:

- Smaller word size (from 4 to 16 bits, with 8 bits on average).
- Slower memory cycle time (about one-fifth as much).
- More limited instruction sets.
- About 30% less cost.
- About 70% less power consumption.
- Custom-fitted controls for specific applications.

We forecast a 50-50 division of the market between mini and microcomputer systems. □

THE PRODUCTION OF SOMETHING FROM NOTHING: CREATIVITY

Richard P. Scivetti
Office of Data Services
Federal Energy Administration
Washington, D.C. 20461

Your recent editorial, "Can a Computer be Creative?" (Computers and People, January 1975) was responsible, interesting, and made several valid points. However, it is my opinion that your conclusion, "a computer can be creative", is erroneous.

Your example of Dr. A. L. Samuels' checkers program illustrated that programs or computers can learn through experience. I believe this to be true. I am sure the computer used with Dr. Samuels' program is a better checker-player now than Dr. Samuels.

However, this does not illustrate creation. It is an example of evolution. The computer started with something — a basic program from Dr. Samuels and a built-in methodology for adjusting it. Clever? Yes! Creative? No!

I believe creativity is the creation of something from nothing. For example, Galileo "created" something when he postulated, "suppose there was no air; a free-falling body would fall obeying a formula of $S = 1/2\ GT^2$." Remember, he had no clock; no one knew what air was, let alone a vacuum, and yet he devised a formula based on time and the concept of a vacuum. He truly created and he knew what he had done.

I cannot conceive of any computer with any program running for any length of time creating anything and recognizing it without having first been explicitly told some fundamentals.

Computers are not creative. □

POLITICAL ASSASSINATION ARTICLES IN "COMPUTERS AND PEOPLE" OR IN "PEOPLE AND THE PURSUIT OF TRUTH"?

1. From: Gregory Pierce
105 Piper Rd.
Wilmington, Del. 19803

I suppose that "Computers and People" will drop assassination and related articles and that they will be published in the new magazine, "People and the PURSUIT of Truth." Is that so?

2. From the Editor:

"Computers and People" will not drop an article or report on political assassinations if there is any mention of a computer or any use of a computer implied in the article. Also we will not drop an article or report on subjects of social importance, important avenues of progress, responsibilities of computer professionals, etc. But regularly a straight article or report on subjects related to political assassinations will be routed into "PURSUIT".

IMPROVEMENT OF OPERATIONS IN THE COUNCIL OF THE ASSOCIATION FOR COMPUTING MACHINERY, AND SOME OTHER TOPICS

Gerard Salton
Dept. of Computer Science
Cornell University
Ithaca, N.Y. 14853

(Based on a report as Regional Representative to ACM Members in the Northeast Region, Spring 1975)

Nonproductive Meetings

The ACM Council met for over eight hours on February 17 in Washington, D.C. It was a depressing meeting which even by our usual, modest standards must be judged to have been singularly nonproductive. My judgment may be colored of course.

One wonders what purpose is served by presenting to the Council time after time a crowded agenda filled with too many frivolities, trivia, and sundry propaganda items, thus guaranteeing that no time is ever available for deliberate reflection, and in-depth consideration of any issue. In such a situation, the officers and other Council members are all caught up in the same mad rush of activity, the aim of the former being to keep the members in line, while the latter present their more or less well informed viewpoints on all subjects. It goes without saying that coherent policies are hard to generate in such an atmosphere, and if a given issue is sometimes resolved satisfactorily, this is more a matter of luck than of sound consideration. Furthermore, fundamental matters of policy either do not come up at all, or else appear under the guise of a side-issue which is to be resolved without thinking too hard and without ever raising the main problem.

Publications Policies and Program

I might illustrate by citing the proposal from the Publications Board to charter a new publication entitled the "ACM Transactions on Computers and Data Bases", which incidentally was enthusiastically endorsed by a comfortable majority of the Council. Without for the moment going into the merits of this particular proposal, it may be worthwhile to recall where the ACM publications program comes from and where it is now. Ten years ago, this Association was alone responsible for the production and publication of the two most prestigious and respected journals in the computer field. Anyone with something important to say tried for either the Journal (JACM) or the Communications (CACM), and our journals set the standard for a whole field.

While our journals still exhibit great strength, there is no question about the fact that we have lost considerable influence in recent years. Indeed we are being outflanked right and left. For theoreticians, JACM is no longer a must; there now exist several well-managed alternatives, including the "Journal of Computer and System Sciences" published by Academic Press, and the "SIAM Journal on Computing". As to CACM, the IEEE Computer Society is attempting to move into the software field, and our own actions in creating the ACM Transactions on Mathematical Software last year, and now the Transactions on Data Bases inevitably lead to a change in the composition and structure of CACM.

In these circumstances, I would have thought that the Council would demand an in-depth examination of our publications program, before moving to approve yet another serial publication. But no! We were confronted in this new Transactions proposal by a full set of ready-made, self-appointed editors — they had originally negotiated with a commercial publisher before approaching the ACM — and the new venture was bound to be financially successful; so we jumped in without considering the effects on our program as a whole.

Submerged Misgivings

Of course, there are some submerged misgivings. The President in her written report to the Council states perceptively that

> "because it has not been possible to get a coherent long-range plan for the publications, we are drifting into strange situations, which may force actions which would not necessarily be taken in the framework of an overall sensible plan".

"Strange situation" indeed for the ACM to be finding itself in! After having been first, foremost, and alone in the field, we may (if all goes well) be left with our share of randomly chosen periodicals, and we will have become just another publisher of some financially successful journals. Of course, by "drifting into these situations" we will also have had to give up the control we formerly had over the quality and performance of our editors. Indeed, we are already accepting a full set of editors appointed by someone else.

Now I am quite ready to concede that all this may not be tragic. But would it not be reasonable for the Council to be aware of what was going on, and would it not be profitable if such matters were talked about during the Council meeting instead of being swept under the rug?

New Nontechnical Publications

I should incidentally point out that my misgivings about changing the character of CACM in no way imply that I disapprove of new, nontechnical publications for ACM members, assuming that that is what the members want. My own mail does not support the alleged trend in favor of nontechnical publications, but the few dozen letters one receives out of a Northeast membership exceeding 3,000 cannot be used as indicative of general thinking. I would merely say that I don't understand the rationale of abandoning

(please turn to page 34)

Selecting a Business Computer: Decision Criteria

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140 Sylvan Ave.
Englewood Cliffs, N.J. 07632

"A successful installation of a computer system can provide great benefits to a company; a poor installation can do great damage."

Opening the World of Computers to a New Segment of Business

The emerging technologies associated with minicomputers have made it possible for many small and medium sized companies to realistically consider using computers. Two major changes have occurred:

- The cost of computers has diminished greatly in the past five years. This has made an in-house computer justifiable in cost for many companies that could not justify it previously.
- Many computers have become "independent of professionals". This means, for long-term use, it is not necessary to hire and maintain a professional staff to run the system.

These two factors have opened the world of computers to a segment of the business world that is greater in number than all previous computer users.

The company executive is contacted on a regular basis by a wide variety of hardware manufacturers and turnkey vendors who offer business-oriented systems. In addition, he is bombarded with information from books, trade shows, and business contacts. It is difficult for the executive to make a realistic evaluation of the systems presented either from a cost or performance basis. This paper reviews the important steps required in selecting a business computer.

Developing a Specification

When a company feels it is ready to take a serious look at computers, it is desirable to develop a functional specification to provide a uniform, unbiased basis for soliciting bids for the system. Professional assistance from an unbiased and informed source may be needed in order to accomplish the functional specification.

The functional specification should cover the following topics:

Current Procedures

This section describes the procedures and traces the flow of paper that is needed to effectively run the organization. Volumes of all transaction types should be determined and personnel utilization by function should be estimated.

Management Perspective

This section covers management requirements from the computer system. Reports and information not presently available on a regular basis are defined and levels of importance are established.

System Concept

Based on the current procedures and future requirements, a system concept is developed. The concept describes such things as whether the system will be batch or on-line, methods of data entry, the types of storage media, etc.

Reports and Files

This section describes reports: their frequency, volume, size, and content. Files need only be defined in terms of their size and content. Growth percentages should be incorporated for long-range requirements.

Hardware Requirements

Based on the above it is possible to specify minimum hardware requirements both on an immediate and a long-range basis.

Implementation Plan

This section describes the recommended method of implementing the system on an orderly basis. Thought must be given to implementing only what can be absorbed effectively by the company.

With the functional specification in hand, the corporate executive is prepared to solicit and evaluate proposals for computer systems in an objective fashion.

Evaluating Bidders

The next step is soliciting proposals from system suppliers. The consultant can help assemble a list of viable companies. The request for proposal (RFP) should be as specific as possible to permit easy comparison of bids and bidders. The RFP should incorporate the specification as well as other pertinent data such as response dates, decision dates, etc.

There are three types of suppliers, and all three can be given consideration. They are: companies that supply hardware only; companies that will develop the software on any selected computer; and companies that supply both hardware and software in one package. The selection process should include consideration of the following aspect of each vendor's bid: hardware, system software, applications software, and maintenance.

Hardware Capacity: How Many Companies Are Using the Computer Model That Is Bid?

Many computer models that are offered by manufacturers are new. In addition, many new manufacturers are offering their first computer. Our experience has been that a computer system requires time to reach a level of stability. A sufficient number of the model being offered should be in the field to provide the manufacturer with a wide range of experiences and problems that will allow him to stabilize the computer. This number is generally in excess of 100 computers.

Does the Hardware Meet the Requirements of the Functional Specifications?

The specification gives transaction volumes, file sizes, and printing requirements. The computer system proposed must be able to process a day's work in a day; if it cannot, the system should not be considered. Printer speed must be such that all printing can be done in a reasonable amount of time. It is not unrealistic to have some reporting functions requiring overtime at month-end, but overtime should not be considered for printing requirements on a day-to-day basis. Print quality should also be checked, and the ability to handle special forms evaluated. The disc capacity must be sufficient to have those files on-line that are deemed necessary for immediate access. If data cannot be stored on-line in sufficient volumes, a change in the system concept may be required. Processing speeds are generally unimportant unless massive manipulation or sorting is needed on a daily basis. Processing speeds are rarely a problem in most business applications; however systems having on-line requirements using several data entry stations or inquiry stations must have enough processing speed to provide acceptable response time.

What Are the Capabilities and Costs of the Hardware in Terms of Expansion to Meet the Requirements Projected for the Next Several Years?

Some computer manufacturers have systems that have a limited capability to expand; although they can meet current demands, they may not be able to meet demands of the future. Promises of research or development or announcements of future equipment should not be considered. Only systems that exist today and are out in the field, and working, should be considered.

Some hardware manufacturers offer expansion capability in a different product line. The manufacturer may be selling a computer from one product line to meet today's needs and promising to switch to another product line to meet the needs of tomorrow. In these cases, it is necessary to consider the ease of converting programs from one system to the other. If the system requires a total rewriting of the existing software, those costs and time factors must be considered in the evaluation.

Expansion Costs

Expansion costs are not always on a one-to-one relationship. The cost of extending disc capacity, for example, may be more than just the cost of an additional disc. Computers have specific capacity in terms of the number of discs they can hold; and additional components perhaps must be added to increase disc space. This may also hold true for main storage and for the total number of peripheral devices allowed.

One way to gain insight into the viability of a particular product line is to review the new products (peripheral gear, system software, compilers, etc.) being developed. Some computer systems have reached a level of maturity and are being phased out by the manufacturer. Although these systems may meet your immediate requirements, one must consider the impact on maintenance and the availability of expansion components if production stops. A product line with a high activity of new announcements and significant advances in R & D is generally one that has not yet reached its peak and is a viable long-term product line.

Software Capability

The software provided with the system can be divided into two major categories:

- Application Programs, which are written by the software vendor specifically to handle functional requirements.
- System Software, which consists of the operating system, compilers, and utilities that are resources to be used by the programmers to make the system function effectively.

Of the two types of software, the system software probably is the most critical to the success of the system. If the operating system is not functioning correctly, the application software cannot work. In addition, systems software errors are much harder to find and correct.

Is the Operating System Stable?

The operating system that is provided with the hardware is the most volatile piece of software that the system uses. Operating systems reach stability after a number of releases correcting problems that have been discovered in installations using the operating system. An operating system often goes through a great many releases. An operating system cannot be fully debugged and work perfectly for the first installation — because all the possible combinations of uses cannot be tested in a small amount of time and therefore must be field tested. For this reason, great care should be taken in selecting any newly-released operating system. Like new hardware, the operating system should reach a level of stability through use over an extended period of time and in a number of installations.

What Programming Language Is to Be Used?

Another factor to consider is the programming languages that are offered with a particular computer. Some languages are very effective and efficient from a computing or processing standpoint. Others are not so efficient but can be easily learned by nontechnically oriented people. One language that is not very efficient but is easy to learn is BASIC. An individual can be taught to program in BASIC in a short period of time and will be capable of making minor modifications, additions, or deletions to programs that already exist. COBOL and RPG are somewhat more efficient business-oriented languages, but are more difficult to learn than BASIC. They should be considered only for computer professionals. FORTRAN is not as effective a business language as COBOL or BASIC; it should be considered only for computer professionals. Assembly language is the most efficient language from a computer standpoint but requires highly skilled professionals.

New Languages

Some turnkey vendors and many manufacturers have offered new languages that are combinations or derivatives of BASIC, FORTRAN, or COBOL. One should be very wary of these new languages. A compiler (the software that provides the use of a specific programming language) is very complex; it is generally developed and debugged over a long period of time. Newly-released compilers are less stable and more prone to error than compilers that have been in the marketplace for a long period of time. Therefore, a compiler that has only a few users should not be considered. What we should look for is a language that is proved over a long period of time and therefore is common. By common we mean that there are many people who know and understand the language well.

Application Programming

In terms of application programming, one should be sure that the software vendor can meet the requirements stated in the specification. The software vendor selected should have demonstrated ability in successfully completing software projects. A knowledge of your applications is helpful but often more reassuring than pertinent. A knowledge of business systems and a management orientation to the role that the computer should play in running a business is probably more important. More critical than the actual coding is the transformation of the functional specification into detail design specifications. Vendors should be asked to show detail designs of previous work. The design should be examined for completeness, for professional look and organization. It should contain an over-all system flowchart, application flowchart, narrative of processing routines, input layouts, report layouts, screen layouts, and test plan. A company that provides a good specification very seldom has difficulty in the programming aspects of the job.

Maintenance

Maintenance refers to the responsibility of the vendor to fix problems that may arise after a system is installed. Maintenance must be viewed in two parts: hardware maintenance and software maintenance. Hardware maintenance is generally supplied by the manufacturer. There are cases, however, where system suppliers have put together systems made up of various manufacturer's components. In these cases, either the system supplier or an independent maintenance organization will provide maintenance. Hardware maintenance terms should be checked carefully. With an inhouse computer system, computer downtime often severely impacts day-to-day business, and therefore, one must make sure that equipment failures can and will be corrected rapidly. Maintenance should be provided from a near-by facility. (Being geographically near-by reduces the mean-time-to-repair by the amount of time necessary to reach the facility from a distant location.) In addition, the maintenance facility should be sufficiently stocked with spare parts to alleviate the need to secure parts from a distant warehouse location. An adequate staff of maintenance people should be located at this facility so that response time on calls is kept to a minimum. The experience of other users should be checked in terms of responses to maintenance calls. Another safety factor one may want to consider is the availability of a back-up system to handle the processing in the event of extended outage.

Systems Software Maintenance

Systems software maintenance generally will be provided by the hardware manufacturer. The software vendor will provide applications program maintenance. Some turnkey vendors have modified the manufacturer's system software and therefore must provide system software maintenance themselves. One must carefully evaluate situations of this nature. Once the system software has been modified, it should be considered new systems software, and therefore, the installations using the manufacturer's software do not represent the actual number of implemented systems. Also, the number of people knowledgeable in the system software should be considered. It is risky if only one or two people understand the system software thoroughly.

In terms of applications program maintenance, one should make sure that the supplier has an adequate staff and adequate resources to provide responsive and continuing maintenance.

Risk Analysis

It is reasonable to assert that a number of hardware companies, turnkey vendors, and software companies could develop systems that meet your basic requirements. If you were to solicit proposals from all available sources and had the same system developed by these sources, you would probably find that 15% of the companies would do a superlative job, 60% of the companies would do an adequate job, and 25 % of the companies would fail miserably. With this in mind, an extra dimension must be added to the evaluation of potential bidders. That extra dimension is risk analysis. The analysis is made by hypothesizing situations that could develop in the course of your relationship with the supplier. One possibility to be remembered in these times is financial insolvency. A significant number of hardware manufacturers, turnkey vendors, and software companies have not been able to sustain themselves economically and have gone out of business. Other companies have withdrawn from the marketplace. The financial credentials of all potential suppliers should therefore be checked carefully.

In some cases, even though the company has stayed in business, the client has found it is not to his best interest to continue his relationship with the supplier. Therefore, the consequences of a supplier going out of business <u>or</u> being no longer wanted should be weighed carefully. One must be protected from total breakdown of the data processing facility if either of these events should take place.

Programs Risk

In this light, an important consideration is the language used to write the application software. It should be one that is known by a great number of people in the profession. Many people can program in COBOL, RPG, FORTRAN, and BASIC; significantly fewer can maintain a system in assembly language. Therefore, systems written in assembly language have a higher risk in case of supplier failure.

Similarly, system software must be maintained by an organization that has a large number of people who are familiar with the systems software and who can maintain it over a period of time. For this reason, we favor systems using the hardware manufacturer's standard operating systems and system software.

Equipment Risk

Equipment maintenance is another important consideration. When a configuration consists of various manufacturer's components, maintenance becomes a problem. If the supplier goes out of business, you will probably be able to find an organization that will contract to maintain your system, but the costs may be very high. In addition, very few people within that organization will be well trained in all aspects of the hardware to be maintained; long delays and poor service quality may be experienced.

The ability to upgrade the configuration to meet company growth should also be considered. If the product is no longer being manufactured, upgrades to larger configuration are obviously not possible.

Business References

There are some other points that should be considered in making a final selection. These considerations should be applied after the bids have been evaluated based on the criteria previously discussed.

It is important to check the references given by system suppliers. Most companies should be able to give references for projects similar in nature to yours. Questions that should be asked include: Did the vendor deliver what was promised? Was communication between the client and the vendor clear and concise, or were there misunderstandings during the course of the project? Was the documentation and the training supplied by the vendor adequate? Did costs change from the initial bid to delivery? If there was an increase, what was the cause of this escalation?

Some contractual matters also should be considered. The contract supplied by the vendor should be as specific as possible. It should define the hardware proposed and describe the software that will be produced. The development of the functional specification will have provided you with a good basis for a contract. The functional specification and proposal should become part of the contract and only slight deviations in hardware or software costs should be tolerated for the system required to meet the specification. It is not unreasonable for a vendor to require progress payments, but a sufficient amount of the total price (usually 20%) should be held back for payment on final system acceptance.

The contract should define acceptance very clearly. If the installation of the system is critical as to time and costs will be incurred as a result of late delivery, a penalty clause could be considered. The penalty clause should be accompanied, however, by an incentive clause for early delivery.

Price Reasonableness

Overall reasonableness in price should carry some weight. A bidder who is grossly higher than all other bidders or grossly lower than all other bidders should be viewed with suspicion. However, we feel that the very low bidder should be scrutinized more than the very high bidder. Most low bids result from a lack of understanding of the complexity of the problem or from a company trying to buy business. Either case portends problems for the buyer. Unreasonably short schedules should also be scrutinized. Systems should not be installed in a hurry. A longer schedule is often generated by concern on the part of the vendor for doing an adequate job during the design stage, allowing time for the interchange of ideas that is needed for the completeness of design, and for adequate time to train, test, and run parallel in the working environment.

Complex Undertaking

The installation of a computer system is a complex undertaking. A successful installation of a computer system can provide great benefits to a company; a poor installation can do severe damage. One must be ready to spend a considerable amount of management time and energy from conception through implementation to help ensure system success. If management is not willing to commit the company's resources to this complex undertaking, the chances of success are very small. □

Programming, Algorithms, and Programming Languages: A Simple Introduction

Lawrence M. Clark
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Framingham Centre, Mass. 01701

"Programming a computer is sometimes easy and often difficult, but the main concepts of programming are within the grasp of all people who can understand adding, subtracting, multiplying, and dividing with ordinary arithmetical numbers, and looking up information in tables or files and taking information out of those tables or files."

1. The Computer

One of the most spectacular developments of this century is the computer, a machine which performs long sequences of calculating and reasoning operations at great speed and with vast reliability. As a consequence, there is now at the service of man an inanimate power of over 200 billion calculating operations per second, supplementing the thinking and the memory of man.

One of the keys to success in handling this almost incredible development is the giving of specific instructions to computers, an art which is called "programming a computer". This art is currently practiced probably by more than 500,000 persons, who are quite often called computer programmers. Other names for them are systems analysts, computer professionals, information engineers, and so on. Some new developments reported on in this article imply that the number of computer programmers will diminish perhaps by half, because most of their functions will be taken over by new kinds of computer programs which will understand ordinary natural language or ordinary specifications and make computer programs, without requiring human beings to learn computer programming languages or produce programs, as is now the case.

2. Programming a Computer

Programming a computer is sometimes easy and often difficult, but the main concepts of programming are within the grasp of all people who can understand:

- adding, subtracting, multiplying, and dividing with ordinary arithmetical numbers; and
- looking up numbers or information in tables or files or directories, etc., and taking numbers or other information out of those sources.

3. What is a Program?

To make clear what is computer programming, it is useful to notice how programming of any kind (the "giving of specific instructions") is accomplished in general. Here are some examples of programming:

1. In frying an egg: Take a pan, some butter, and a raw egg. Put the pan on the stove, light the gas, put in some butter, melt the butter, crack the raw egg and pour it into the pan. Cook it for about four minutes. Then remove the egg, put it on a plate, and serve it.

2. In producing a melody, for example, the first two lines of the famous song "Drink to Me Only With Thine Eyes": Specify the musical notes in sequence, and how long each note is to be sung. (See Figure 1.)

3. In finding an average of five numbers: Take the numbers to be averaged, add them up, and divide by 5. For example, suppose the numbers are 100, 99, 104, 98, and 106. The sum is 505. The average is 505 divided by 5, which is 101.

A program is a sequence of specific instructions for doing any given operation or process. A program is a recipe in cooking; a score in playing music; a pattern with instructions for cutting out a dress and sewing it together; and so on. In calculating and reasoning, a program is a sequence of instructions for a person or a computer in order to calculate a figure or obtain a solution to a problem.

Programs can be classified: fast, or slow; cheap, or expensive; requiring skill and common sense, or not requiring skill and common sense; and so on. In the case of a computer, most of the time all the skill and all the common sense must be specified in fine detail. But some of the time a program may be constructed to learn from experience and to improve itself; then it is no longer true that all the skill and all the common sense must be specified in fine detail ahead of time.

4. What is an Algorithm?

A program by which some figure or solution is calculated, is called an "algorithm". The definition of algorithm is: an "effective calculating rule"; a sequence of instructions by means of which some number (or some name, symbol, or result) may be actually calculated; a sequence of calculating steps, a procedure, which gives a solution to a problem.

Lawrence M. Clark, by profession a mathematician, has been an informal student of languages and linguistics for more than 30 years. He says that one of his goals is "to make all the language of thought calculable like mathematics."

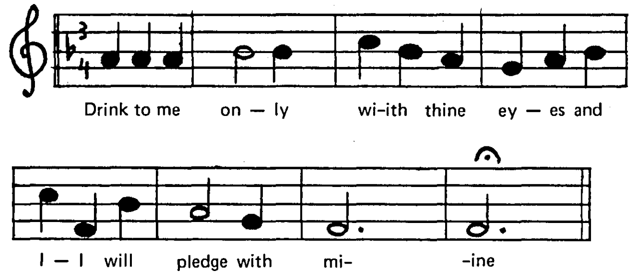

Figure 1 — A Program in Music

What is an example of an algorithm? Suppose we have the problem: What is the number of letters in the statement:

> There are probably more than thirty million computer programs in existence; and for most of them, exactly how they function is a mystery to the computer installations where they are used.

The first and obvious algorithm we might think of applying is:

> Count the letters one after another.

So we would begin at the beginning, saying out loud: T 1, H 2, E 3, R 4, and continue to count until finally, if we made no mistakes, we would wind up with D 154.

This is a good algorithm for a computer, which can be extremely exact. But a person cannot usually count reliably over one hundred. The human mind is remarkable for the number of its errors. Especially in rote operations like counting, there are likely to be mistakes from talking with other people, lapses in attention, and so on.

Another way is to use the following algorithm (see Figure 2):

1. Count the letters in each word in each line.
2. Write the letter count under the word, producing the word total.
3. Add the word totals in each line and produce a line total.

(1) Line	(2) Words of Statement / Underneath, No. of Letters in Word	(3) No. of Letters in Line
1	There are probably more than thirty 5 3 8 4 4 6	30
2	million computer programs in existence; 7 8 8 2 9	34
3	and for most of them, exactly how they 3 3 4 2 4 7 3 4	30
4	function is a mystery to the computer 8 2 1 7 2 3 8	31
5	installations where they are used. 13 5 4 3 4	29
		154

Figure 2

A Statement — Data for Application of an Algorithm

This is the fourth article in a series by Lawrence M. Clark. The three previous ones are:

1. "Languages Among Computers, Machines, Animals, and Men", January 1975, p 7 ...
2. "Computer Programs that Converse and Discuss", March 1975, p 24 ...
3. "Computer Programs that Understand Ordinary Natural Language", April 1975, p 14 ...

4. Add the line totals to obtain the statement total.

The first algorithm is good for a computer.

The second algorithm is much better for failure-prone human beings.

Let's consider another problem:

> A box in the shape of a cube is to hold exactly 300 cubic centimeters of powder. What length should the edge be?

Before the arrival of computers, the arithmetical process for finding cube root used to be taught in some elementary schools in the last year of teaching arithmetic. The process is complicated, and if you did not know algebra, very mystifying. But computers make multiplication so easy that another process (the incorporation of feedback into an arithmetical algorithm) becomes very easy:

1. Guess the length of the edge.
2. Try out the guess, seeing if it is too large or too small.
3. Improve the guess, making a new guess.
4. Recycle.

How this process might work using a computer is shown in Figure 3.

(1) Cycle	(2) Guess	(3) Trial	(4) Decision	(5) Improved Guess
1	6	6 x 6 x 6 = 256	too small	1
2	7	7 x 7 x 7 = 343	too large	-.2
3	6.8	314.432	still too large	-.1
4	6.7	300.763	very close; accept and stop	....

Figure 3

Finding the Edge of a Cubic Box of Volume 300 by a Succession of Guesses, the Method of Successive Approximation

This algorithm in mathematics is called the Method of Successive Approximation because it makes use of each guess or approximation in succession in order to make a better guess. It is a very general, powerful, and valuable method, and one particularly well suited to computers. But it is not well suited to human beings doing arithmetic on paper, because the quantity of arithmatical work is considerably increased.

These two examples show some interesting and important properties of algorithms:

1. Efficiency. They can be efficient or inefficient.

2. Devices for Calculating. The usefulness of an algorithm often depends on what devices are being used for calculating.

3. Time. The execution of any algorithm takes time.

4. Synonyms. Exactly the same algorithm can often be expressed in many different ways. For a human being, the statement of an algorithm may draw on his knowledge or common sense. For a computer, the algorithm regularly must be completely and precisely stated.

In the past 20 years as computers have developed more and more, algorithms have received a great deal of attention. The speed of a computer is regularly over 100,000 calculating operations per second, or about 10 billion calculating operations per day of 24 hours. But even so there are algorithms which are far too slow for any computer. To find out the best move in a position in playing chess (when there are 32 pieces on the board) by computing all possible future moves and future positions and comparing them, cannot be done by any computer.

However, the speed of computers has changed greatly the distinctions between good algorithms and poor ones. Many algorithms which used to be poor have become good, especially many which used to be barred because of the large quantity of arithmetical operitions. Often an important and fascinating problem is to improve an algorithm so that it changes from barely useful when used on a computer to practically useful and really efficient.

5. Instructing a Computer to Do Something

We now know what a program is and what an algorithm is. But how do we instruct a computer to execute an algorithm?

Computers are extraordinarily simple machines conceptually. A common kind of general purpose digital computer can be thought of as a very like a railroad system with four stations, a control tower, tracks, switches, telegraph lines, and freight cars. The freight cars are loaded with information (in electrical and magnetic patterns) and they travel through the system almost at the speed of light. Whenever a shipment of information is to be made, the switches have to be set beforehand, for the platform from which the information leaves and the platform to which the information goes. (See Figure 4.)

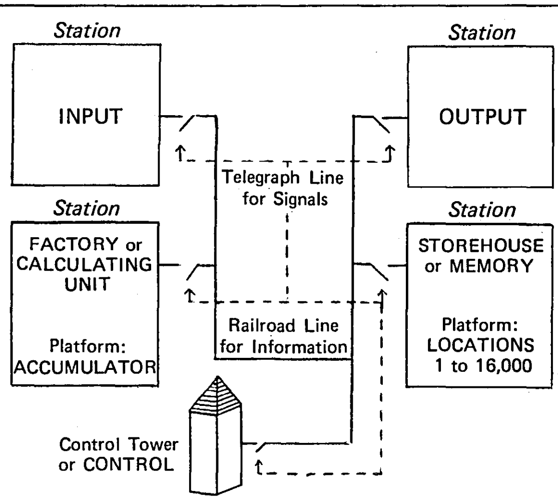

Figure 4

The Extraordinary Conceptual Simplicity of a Computer

Some of the important platforms for information are:

INPUT, where information comes in;

OUTPUT, where information goes out;

THE ACCUMULATOR, a location in the arithmetic unit which is a kind of grand central for arithmetical or logical operations (such as addition or comparison — in some computers there may be many accumulators);

LOCATIONS 0 to 16.000 (say) in the storehouse, where loads of information (or "bytes") can be stored until erased.

For example, suppose we wish to add 12 and 31, and obtain the total 43. How would we set up a computer to perform this operation? The instructions which would have to be carried out are shown in Figure 5 (for a particular computer).

(1) Step	(2) Description	(3) Machine Language
1.	Put 12 in some location, say, 354.	354/ 000012
2.	Put 31 in some other location, say, 355.	355/ 000031
3.	Make sure that location 356, where we plan to put the answer, now contains 0.	356/ 000000
4.	Put the following instruction in some location, say, 344: Load the accumulator with the contents of 354.	344/ 200354
5.	Put the following instruction in the next location, 345: Add the contents of 355 into the accumulator.	345/ 300355
6.	Put the following instruction in the next location, 346: Deposit the contents of the accumulator in location 356.	346/ 040356
7.	Put the following instruction in the next location, 347: Stop (i.e., halt) (because we are finished)	347/ 740040
8.	Run the program starting at location 344.	(use switches)
9.	Look in register 356 (the answer register) to see if the expected answer is now there (and sure enough the answer is there).	356/ 000043

Note: The "machine language" is the actual machine language of an actual computer. It is in the scale of 8, or octal, and the computer is a PDP-9 made by Digital Equipment Corp.

Figure 5

Persuading a Computer to Add 12 and 31 and Give the Answer 43

Notice how exasperatingly detailed are the instructions, and how much easier it would be just to add the two numbers without using a computer and having the trouble of programming it. But once a program has been worked out slowly and exasperatingly, it can be executed for many other given numbers, and the execution at almost a million operations per second is far faster than a human being.

6. Systems for Instructing a Computer: Programming Languages

The foregoing is an example of the standard way of instructing a computer about 25 years ago. It was based on human translating of each of the detailed necessary instructions in an algorithm into more or less the bottom level of computer commands understandable to a computer.

But since that time, there has been great progress in developing languages for instructing computers. Perhaps the first important improvement was the development of helpful memory-aiding aymbols for commands. For example, "load the accumulator with the contents of ..." became LAC. Then instead of writing 200354, the programmer could write LAC 354, and a supervising computer program would translate that into the basic machine language 200354.

Languages for programming are now classified into two kinds: special purpose languages — that apply in special fields such as graphic design, or architecture, or the manipulation of symbolic expressions — and general purpose languages that apply in a great many fields such as business or science or industry or engineering in general.

7. The Three Commonest Programming Languages

The general purpose language which is most in use is COBOL (acronym put together from the words Common Business-Oriented Language, dating from about 1962). Probably 80 to 85 percent of all programs used in businesses and in business-like operations in all organizations are written in COBOL. These programs almost without change can be used on any computer. The Federal government, before it accepts any bids to sell a computer to the government, requires that a COBOL "compiler" as it is called exist for that computer. A compiler takes in a program written in a programming language and converts that program into the machine language of the particular computer.

Still important but less widely used is the programming language FORTRAN (the acronym is derived from "formula translation"), derived about 1955 or 1956 at IBM. Its main purpose is translating formulas and expressing procedures in mathematics, science, and engineering. A third important programming language is BASIC, which was worked out at Dartmouth College, Hanover, N.H., about 1966 by John Kemeny and Thomas E. Kurtz, then of the mathematics department. Its purpose was to make computing not only accessible to but also inviting to all the students and faculty at Dartmouth in a time-shared interactive computer system.

BASIC is in use at many other colleges and schools, and has spread widely in business and elsewhere. Both BASIC and FORTRAN have been very successful in the sense that some 10 or 12 percent of all computer programs in use have been written in these languages. Many manufacturers of computers have made compilers for BASIC, FORTRAN, and COBOL so that programs written in any of these languages will run on computers of their manufacture.

8. How Does One Know that a Program is Right?

When a program has been written, the first thing to be done is to test it, to see if it is correct. Does it operate on at least one sample problem and for that problem give the right answer?

Regularly, the first draft of the program fails. Then the process of "debugging" is invoked, removing "bugs" (errors) from the program. There are two kinds of bugs: the common bugs and the rare bugs. It is often rather easy to find the common bugs: what produces a frequent wrong answer is usually rather easy to track down.

But the rare bugs produce a real headache. The lore of programming contains some wonderful tales. My favorite story is of a New York City payroll program which for three weeks flatly refused to produce a payroll check for a certain city employee. According to the story, the employee started suing the city for his pay. Finally, the bug was found and removed; it was associated with the employee's name "B. J. Void": the programmer, thinking nobody would ever have the last name "Void", had used that word as a signal or marker in the program.

After a program has been checked on a suitable number of representative samples, and has given the right answers for all of them, it is regularly assumed to be correct. The assumption is not safe, but may be further confirmed by many months of running. Ordinarily small bugs are found from time to time and removed.

On one occasion, reported by Robert W. Bemer, a program which had been three years in use in a military installation was being tried on a new computer, and some errors showed up. Somebody at the installation was directed to investigate, and the response, after a little while, was "Sorry, general, three years of wrong answers!"

9. Documentation

In theory, a program is verified by its "documentation". This is a set of descriptions in ordinary natural language which say what each modular part of the program is doing, and what the whole program does.

Because the program is written in a specified exact programming language using special meanings of words and symbols, it is difficult when reading the program to be certain about just what it is doing. It is also difficult to make sure that the program is doing just what it ought to do, and not something else. So programmers are regularly charged with producing "documentation", descriptions that specify what the program is doing.

COBOL is to some extent self-documenting, since it is a verbose language using a great many English words, though often with unusual or even strange meanings. But dozens of English words are reserved for special uses. So documentation is still needed. For other programming languages, documentation of a program may be a much bigger task. For programs in other languages documentation is regularly more difficult.

Now it seems to be generally true that if a programmer has a flair for making computer programs, then he has no flair for writing clear English; nor does he like to do it; and when he does write English, what he writes is not clear. Also, over and over again he does not write down what is "obvious". It may be obvious to him but it is not obvious to the next reader. And so documentation most of the time is in sad disorder. The computer installation manager pounds on the table and demands from a programmer good documentation for a just-finished program. But the programmer calmly says, "Which do you want, Joe, that new program that we urgently needed two weeks ago? or documentation of the program that I have just finished and which is running and doing a good job?" And Joe, out-maneuvered, surrenders, and asks for the new program.

In fact, it is sometimes said that to get 99% of a program right takes half the time, and to get the remaining 1% right takes the other half of the time.

10. Artificial Programming Languages: Advantages and Disadvantages

The artificial programming languages that now exist number over 400. Many of them are most skillfully designed, and aid markedly in thinking about algorithms and designing them. This is particularly true for a programming language called ALGOL, designed by a committee in Europe about 1960. The advantages of artificial programming languages include:

- <u>Ease of Use</u>. They are much easier to use than the programming languages that were restricted to one computer.
- <u>Generality</u>. As computers change, programs (or software) written in these languages to solve classes of problems remain unchanged.
- <u>Treasurehouse of Algorithms</u>. The programs written in these languages constitute a treasurehouse of algorithms, expressed in a form that a computer can understand.
- <u>Treasurehouse of Skill</u>. The programs written in these languages constitute a treasurehouse of know-how and skill — so that much knowledge of procedures will never again be lost.

But they also have many serious disadvantages:

- <u>Costly Learning</u>. The programming language has to be learned by a human being.
- <u>Costly Translation</u>. The algorithm has to be translated by a human being, from the form in which it is originally thought of and expressed, into the form required by the programming language.
- <u>Costly Completion</u>. Although nearly all of the program can usually be written rather quickly, the completion of the program and the removal of mistakes takes a large amount of time, effort, and resourcefulness.
- <u>Sensitive to Errors.</u> When a human being (with training and common sense) is given an incomplete algorithm, he can usually deduce what needs to be done in cases not covered by the algorithm. But a computer will regularly make errors, since it has only the common sense which may be programmed into it (some computer programs include processes of learning from errors).
- <u>Costly Understanding</u>. The understanding of a program, finding out what it does and does not do, is difficult. This understanding regularly depends on the documentation; and often the documentation is poor. Perhaps as much as a quarter of the time it is so hard to understand what a program is doing and not doing, that modifying the program for new requirements is impractical. And it takes less time to start over and write the modified program afresh from start to finish.

11. Drucker's Comments on Human Programming

Peter F. Drucker, management consultant, educator, and writer, in an article in 1966 predicted:

> We will become less and less dependent on the programmer. We will be more and more able to put information into the computer directly in something akin to ordinary language, and to get out of the computer something akin to ordinary language. Today the programmer has to translate from ordinary language into the computer code. This is the greatest limitation of the present system. It cuts the computer's speed down to the speed of a human being — and this, in handling logic, means it cuts it down to a very slow speed. It also creates the need for employment of many essentially unskilled people. Yet on their skill and understanding the ability of the computer to perform depends altogether. /1/

12. Computerized Production of Programming and Documentation

Clearly, it would be a very great help to transfer to the computer two jobs:

- making computer programs out of ordinary natural language (programming);
- converting computer programs into ordinary natural language (documentation).

The computer specializes in being accurate; a human being finds it extremely hard to be accurate. The computer specializes in speed, almost a million operations of calculating and reasoning per second; a human being, less than 5 per second. The computer specializes in reliability — better than one mistake in more than 100 million operations. The human being suffers from a usual error rate of worse than one error per thousand operations.

The objective of programming a computer using ordinary natural language has become closer and closer to attainment.

13. Time-Shared Interactive Programming

One of the approaches to a very natural and easy use of the computer is interaction of a human being with a time-shared computer using a computer terminal. Because of time sharing and the difference in speeds between the human being and the computer, about 30 people can have apparently simultaneous access to the computer. Each computer terminal stores, in temporary storage called a "buffer", what the person wants to do as he types it in. The computer checks, perhaps 30 times a second, to see if any buffer needs attention. If it does, the computer immediately gives it attention. The human being at the terminal may have 20 to 50 brief commands that he can use with an interactive computer program. He may even have the command "HELP", which will call out of the computer instructions on how to use his computer terminal.

The computer terminal may consist of a keyboard, on which the person can type, and a roll of paper on which his typed characters will appear (as in a teletype). But the computer also can control the keys, so as to type out on the roll of paper the answer to each problem posed. For example, there are inter-

(please turn to page 31)

THE INDIVIDUAL:

His Privacy, Self Image, and Obsolescence

Paul Armer
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"I have immodestly dubbed the 'Paul Principle': 'Individuals often become over time uneducated and therefore incompetent at a level at which they once performed quite adequately.' "

Computer and Communications Technology

We are engaged in this conference in the process of technological assessment. Consequently, I should first like to talk about the technology of computers and communications. I'm more comfortable talking about that since I am a computer technologist and not a lawyer, nor a political scientist nor a psychiatrist nor a psychologist nor a sociologist nor an economist, nor an educator. Of course, the list of things I'm not is endless, but the disciplines I have just enumerated will all be impinged upon in what I have to say today.

The first observation that I want to make is that the distinction between computers and communications is becoming very fuzzy. Professor Anthony G. Oettinger of Harvard has proposed that we recognize this by combining the two words into "compunications". I have trouble pronouncing it but I agree entirely with the idea. It used to be the case that all computers were physically confined to one room and serviced one user at a time. Today a computer system may have several hundred or even several thousand terminals, spread over thousands of miles, connected to it over communication lines. The various users may wish to send messages to one another via the computer system — in fact, the major purpose may be the interchange of messages. An airline reservation system is an example of this. Approaching this fuzzy distinction between computers and communications from the communications side, we observe that modern sophisticated communication systems are, in reality, computers.

"Factor of Ten" Change

To make my next point, I'd like to use an analogy originally put forward by Richard Hamming of Bell Labs. /1/ When things are changing rapidly, we find that the concept of "an order of magnitude" or a "factor of ten" is a convenient measure of that change. For example, we can travel by foot at about four miles per hour, by auto at 40 miles per hour, and by jet aircraft at something more than 400 miles per hour. Each mode differs from its predecessor by an order of magnitude — a factor of ten. The capability of getting around at 40 miles per hour has profoundly affected our way of life, and jet travel has shrunk our world immeasurably.

Contrast the pace of these changes with what has been occurring in the computer field. The last order of magnitude change in transportation speed for the jet set took about 50 years for us to achieve, and while another factor of ten may be but 10-15 years in the making, another order of magnitude beyond that, at least for earthbound travel, is probably infeasible. On its trip to and from the moon, Apollo 11 averaged less than 4000 miles per hour. But the speed of the electronic portions of computers (not the mechanical portions) has been increasing by an order of magnitude about every four years, and it looks like that pace will continue at nearly that rate of change for awhile, despite the limitations of the speed of light. The speeds of the mechanical computers of the 1940's were measured in seconds whereas the internal speeds of today's computers are measured in nanoseconds, where a nanosecond is one-billionth of a second. One differs from the other by nine orders of magnitude. Light travels 186,000 miles per second but only about one foot per nanosecond. A nanosecond is to one second as a second is to thirty years.

Size

Size (again I'm talking about the electronic portion of the computer) decreased by an order of magnitude in the last ten years, and will probably decline by three orders of magnitude during the next decade. The details of today's computers are not visible to the naked eye — the details of the computer of the future will not be visible in an optical microscope, since electron microscope techniques will have been used in their fabrication.

Cost

Most important, the cost of raw computing power has declined by an order of magnitude every four years, and this trend looks like it will hold for awhile. The amount of computing power in the U.S. has been expanding by an order of magnitude in something less than four years.

Time Sharing

And there is another most important trend taking place in the computer field; namely, the introduction of time sharing where many small remote terminals,

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in the form of a typewriter or teletypewriter, are connected to a single large computer over communication lines. Because of the high ratio of computer speed to terminal speed, it appears to the user at the terminal that he has the complete attention of the computer. Thus computing power is being distributed in much the same way as electrical power and telephone service.

A moment ago I talked about the way the cost of raw computing power was declining. Many other costs are associated with using a computer — the costs of the mechanical devices for getting information in and out of the computer for one thing. Taking a larger view of what's happening to costs, an SRI report /2/ prepared for the FCC recently predicted the cost of doing a fixed computer task would decline at about 25% per year for the next decade.

It's a common occurrence in the computer field for newly announced products to be at least twice as cost effective as their predecessors. For example, a recent CalComp ad stated "Our disk drives work twice as fast. For about half as much." /3/ Suppose that the cost of automobiles or housing dropped by half this year? There would obviously be a considerable impact on society as a result. But this sort of change in economics is taking place in the computer field. It would be very surprising if such rapid changes were not profoundly affecting society.

Blurred Distinctions Between Computing and Communicating

Let me now turn from computers to communications technology. I stated earlier that the distinction between computers and communications is becoming blurred so one might suspect that similar changes were taking place in communications as have taken place in computers. Not so. The previously cited SRI report projects only a 2% per year decrease in cost for communications in the next decade while saying that the costs have been relatively constant in the past. I would conjecture that the reason for this discrepancy is that the forces of the marketplace just don't apply to the field of communications. The computers of the 1950's were built of vacuum tubes. If I were to say that none of those tube machines are in use today, someone might find one or two or half a dozen still working and prove me wrong — but the number is very small. In fact, the field is now entering the third generation based on transistor technology. (Counting the tube generation, this makes it the fourth generation in 20 years.) Yet the telephone industry in some localities still uses equipment installed in the 1920's and doesn't plan on completing the changeover to electronic switching systems until nearly the turn of the century.

There are some encouraging signs, especially the recent rulings of the FCC which tend to introduce a little competition into the communications marketplace. From my somewhat biased point of view, these rulings come very late and don't go nearly far enough. But I applaud the direction of movement and hope that future appointments to the FCC don't reverse it.

On the technological front, communications satellites hold great promise for cost reductions. And cable TV is apt to have a profound impact on communications, in the broadest meaning of that word, with a concomitant impact on society. The television aspects are trivial compared to the communications aspects.

Privacy

Let me now turn from the technology to the assessment. I could spend all my allotted time talking to you about the positive things that can be said about the impact of computers on society; how they have contributed to a rising standard of living, enabled us to get to the moon, helped to cope with the problem of increasing complexity in our social organizations, contributed to better health and education, etc. But those areas do not represent problems for which some actions need to be taken. So I'll be talking about the negative aspects of the impact of computers on society. But please don't forget all the important positive affects.

My focus will be on the individual, his privacy, obsolescence and self-image. I will not address the issue of the impact of computers and automation on employment in the usual way that topic is thought of, since it has been covered by previous speakers. My discussion of obsolescence is, however, a variation on that theme.

I'd like to first take up the privacy question — I'll be discussing it in the context of the computer and not with respect to wire-tapping, psychological testing, private investigators, etc.

Stream of Information About Ourselves

As we go through life we generate a fantastic stream of information about ourselves and our activities. Most of that information is never recorded; e.g., most of our cash financial transactions, what we ate for dinner last night or what time we went to bed. If you get an electrocardiogram even once a year, the sampling rate is like four out of a million. What information that is recorded and collected is widely dispersed and somewhat difficult and expensive to assemble. Information exists in small, widely dispersed puddles. But the advent of computer utilities and rapid changes in related technology are making it feasible to draw these puddles together into large pools of information. To put it another way, present systems give the individual a measure of privacy that he may lose in the computer utility area. Further, the rapidly changing economics are making it economically feasible to record in machine readable form much more information about our actions.

These pools of information are springing up all around us. The biggest one of all, the National Data Bank, is still in the discussion stage, thanks to concern about its impact on privacy. But many other pools are already in existence or, close at hand, on the Federal level, and also at State and local government levels. In the private sector, the trend towards computerization and centralization of credit bureaus is viewed by many as a greater threat to privacy than the National Data Bank.

Most of the people who discuss privacy talk about it as though it were inviolable. Unfortunately, it isn't. Like motherhood, there are some problems associated with it. The trouble arises out of conflicts between the individual's right to privacy and society's right of discovery. By the latter I mean the belief that society has the right to know anything that may be known or discovered about any part of the universe — and man is a part of the universe. Society aspires to know the universe.

Aspirations of Society

Society has raised its level of aspirations in many ways — we look for improved efficiency in government, better law enforcement, and more rational programs in general. To do this, government needs more and better information about what is going on — information about people and organizations. Government also feels that it must have information to protect society from disorder and subversion. Thus, today, we read of proposals to consolidate government files and to establish national data banks of various types.

The common good cannot be realized in a society consisting only of private entities — it requires some renunciations of the rights of personal and corporate privacy.

There is also a conflict between the individual's right to privacy and his pocketbook. Some of the proposals being made with respect to the regulation of credit bureaus may double or triple the costs of such operations. The proposers of such regulations often seem to assume that the added costs will be borne by the credit bureaus, presumably out of their profits. That is nonsense. If the credit bureaus are to stay in business, the added costs must be passed along to the consumer — credit will become more expensive. I'm not saying that I'm against such regulations or that I worship efficiency. Rather, I want to make the point that privacy will cost money and a choice will have to be made between these two conflicting goals.

Pollution Costs

You may also have gotten the impression, from my comments about the telephone system, that I also worship the forces of the marketplace. I don't. At least not blindly, for they just don't work in many areas. Pollution is a prime example of a problem which arises because the costs to society of pollution do not enter into the market mechanism. Pollution is an example of so-called "externalities" or "third-party" effects; an individual cannot exercise a choice in the marketplace as to the cleanliness of his air or water. Only government regulation, or the fear of it, can impose some measure of control on the problem.

Privacy Costs

This holds true for privacy as well. In credit bureaus, for example, the individual is a third party not involved in the market aspects at all. The seller of the information is the credit bureau; the buyer is the grantor of the credit.

I want to point out that the problem of privacy has been with us for a long time and has not been brought about by the computer. But the computer, by introducing orders of magnitude change into the economics of the situation, is bringing about significant qualitative changes. We might consider one aspect of this change as positive: the computer is focusing light on a situation of long standing, where reality is undoubtedly much worse than most people realize. As a result of the examination going on, some aspects of the problem may be improved.

What can be done about assuring individuals and organizations an appropriate level of privacy in the era of computer utilities? One of the problems with doing something about privacy is that it lacks, as do pollution and other social problems, an organized constituency. Things happen in this political world of ours because of pressures. But these pressures or forces must be focused to be effective. For this reason, there exist all kinds of trade associations, labor unions, etc. The force most difficult to focus, even though large, is that of the man on the street. Look at the difficulties associated with passage of laws related to consumer protection, automobile safety, meat inspection, truth in lending and gun control. The power of the populace, compared to that of the groups lobbying against such laws, has not been very great in the past.

Cashless, Checkless Society

All the forces of the marketplace are pushing us towards the cashless and checkless society — towards the computerization and centralization of data banks. In the cashless and checkless society, much of the information about our actions which goes unrecorded today, will be captured by the system and remain available in the system. Orders of magnitude changes in the economics of recording, collecting and processing of information about individuals are taking place. Counterbalancing political and social pressures are not effectively focused.

In general, we find only a few congressmen and senators, plus a few isolated scholars and writers, and the ACLU pleading the cause of privacy. Most of their presentations tend to be philosophical in nature, as this one is, rather than in-depth studies. One reason is that scholars and organizations interested in the problem are limited in the places to which they can look for financial support. If one is interested in doing research on the problems of health or education in our country, he can look to the Department of Health, Education and Welfare; but if he is interested in privacy, he can look only to private foundations. The most respected study on privacy which resulted in Alan F. Westin's book entitled "Privacy and Freedom" /4/, was supported by a grant from the Carnegie Foundation.

The work that was done at the Rand Corporation (my former employer) resulted either from related work on military security or was supported by Rand Corporation funds, which can generically be thought of as similar in nature to foundation support. Very few studies of the problems of privacy have been explicitly supported by the executive branch of U.S. government.

The Costs of Good Privacy Arrangements

In accepting the invitation to give this speech, I agreed with the staff of the committee that I would discuss what I felt to be appropriate legislation with respect to privacy. In an attempt to do so I reviewed my own thoughts, a large number of papers and all the proposed legislation I could get my hands on, not only U.S. originated but from the United Kingdom, Canada and several states. I began to list general provisions (e.g., requiring that all data banks be registered or that the individual have access to his own files and be told anytime the information is revealed to another party, etc.) Then I asked myself "which of these are good?" In general, they are all good. But the problem is that each has a cost associated with it. And I don't know those costs, so how can I make a judgment as to what is worth what it costs and what is not? I further believe that some of those costs are not really known by anyone since some of those costs will be obtained only by experimentation.

Consequently, I abandoned the idea of trying to give you my recommendations as to what regulations should be written into legislation.

If what I say is true, then the immediate problem is how to organize ourselves in order to determine what regulations should be adopted. I believe I know at least the form of the answer as to how to organize ourselves. This answer has also been proposed by others. (For example, A. R. Miller.) /5/

It is my belief that some organization in the executive branch of the government should be charged with concern for the problem of privacy, just as the Department of Defense is charged with providing for the common defense and as HEW is charged with the problems of health and education. Don't misunderstand, I'm not proposing a cabinet-level organization. Locating such an organization within an existing agency which is a major collector and user of data on people or corporations is "like asking the goat to guard the cabbage patch". For this reason, Miller suggests either the FCC or a new independent agency.

Congressional Committee on Privacy

Another notion seems pertinent. Just as there are committees in the Congress concerned with defense, health and education, there should be a committee or subcommittee whose purview is privacy.

What might such a "privacy bureau" do? At a minimum, it might turn out an annual report on the state of privacy in the country, which would provide some illumination. But, more important, it should have staff to study the problem, to estimate costs and benefits and to draft legislation, just as HEW may draft legislation in the health area. And like the Public Health Service, it should have money for research grants and contracts and money for experimentation. Industry (e.g., the credit bureaus) might bear some of the experimentation costs. The privacy bureau should be charged with developing a register of data banks, both private and public. And possibly after some future date, no data banks should be permitted to exist without the privacy bureau's approval of their operations. It should attempt to assess the value of public data banks, including the National Data Bank and modifications thereof, while developing methods, procedures and technology to safeguard the information stored in such banks. The only way we can go about defining a balance between the individual's right to privacy and the common good is through the political process. It is important to realize that there is no right or proper or correct balance. The privacy bureau is needed to do the staff work for the political process.

Before going on to another topic, I want to be sure that I don't leave you with the impression that I feel that no regulations should be passed while the problem is studied further. For example, the Associated Credit Bureaus, Inc., has endorsed Senator Proxmire's Fair Credit Reporting Act. Presumably they have evaluated the costs associated with implementing its regulations and feel that they are not excessive. I believe that piece of legislation should be passed. The only danger I see in its passage would be complacency that the problem had been taken care of. The bill doesn't go far enough in providing protection, but on the other hand, the costs of extending it need to be studied.

Neither do I wish to give you the impression that little research has been done so far. Two years ago my research assistant at Rand turned out an annotated bibliography containing some 320 entries. /6/ Much has been done since, both in this country and abroad, especially in Canada. But the many excellent ideas advanced need to be evaluated in greater depth than they have been so far.

I haven't paraded before you a number of horror stories citing invasions of privacy. I believe we've all heard enough of them and are convinced that there does exist a substantial threat to privacy resulting from the unprecedented changes taking place in computer and communications technology — which I have paraded before you.

I would like to end the privacy portion of my talk with a quotation from the previously cited article by Miller:

> Perhaps the most imperative need at this point in time is a substantial input of human resources to help solve the many privacy problems posed by the new technologies.

Technological Obsolescence

When we think of the impact of computers on employment, we usually think of the situation where the introduction of a computer or some technological change results in the fact that a given job no longer exists. This impact of technological change on employment is quite visible. But there is another form of impact, more subtle and much less visible. And one which, I believe, has some very serious implications for individuals, organizations, and society.

A recent magazine article /7/ cited a number of unpleasant incidents in which middle managers in mid- or late-career suddenly found themselves fired or demoted. The article concluded that a middle-management union was the obvious answer to providing protection against the economic disaster for the individual inherent in such incidents.

What is the Disease?

To me, the union approach focuses on the symptoms rather than on the disease itself. What then is the disease? I would argue that there are three possible explanations for such incidents. The first is that the position disappears due to a merger or reorganization and is not related to the competence of the individual. The second possible explanation is the "Peter Principle" /8/ which states that individuals will rise in an organization until they reach their level of incompetence. The third explanation is one which I have immodestly dubbed the "Paul Principle", since it goes hand in hand with the "Peter Principle". The Paul Principle states that "individuals often become, over time, uneducated and therefore incompetent at a level at which they once performed quite adequately."

The Amputation of Cancerous Legs

Perhaps an example will help explain what I have in mind. Let me take it from the computer field, since its technology is changing very rapidly. Suppose an individual has risen in a company to where he is responsible for all computer and data processing activities in the company. The demands of his management duties leave little time for actually working with the technology of computers and data processing. Over time, his proficiency in the technology becomes less and less current — he becomes technologically obsolete and less and less able to perform his job. Eventually, he may be demoted, pressured to resign or even fired. He becomes one of the horror stories of the previously cited magazine article. To have a middle management union force a company to keep him in that position is similar to legislating against the amputation of cancerous legs. It is a disservice to the health of the organization and also to the individual who can not help but feel less and less adequate to the demands of his job as time goes on.

The occasion of this individual's problem wasn't a discrete event like the installation of a computer, automation equipment, or the introduction of a new technology. Rather, the problem developed slowly over time as the technology changed while the individual failed to keep his knowledge current. I've seen many examples of this, not only in the computer field but in all areas of human endeavor which involve significant amounts of science and technology. And I include the businessman, because there is a large component of science in management these days. And the problem isn't confined to middle-management — it's just as prevalent at the top and at the lower echelons.

I've seen a number of executives who were psychologically in a bad way because they were aware that they were technologically obsolete and were no longer in control of the organizations they managed. These individuals had climbed to responsible positions in large companies; they didn't lack native ability. Rather, they had become "uneducated" for the job they held.

The Intellectual Capital Coined in School

Let me put this another way. It used to be that an individual could go to school, take a job, learn through experience and do well until retirement — drawing in his later years, so to speak, on the intellectual capital he coined in school and on the job. This is now very difficult in many positions. Now the pace of things is such that significant changes take place in a period of time which is short compared to the life span of man. Today we find companies terminating men of a given specialty, while hiring young men fresh out of school in that same specialty. We find companies restricting the percentage of older men among new hires; we find companies in trouble because their managers are obsolete. And as I mentioned a minute ago, we find individuals psychologically disturbed because they feel that they are obsolete.

H. Bentley Glass, President of the American Association for the Advancement of Science, recently said, "A scientist must constantly renew, extend and reorganize his knowledge, or in approximately eight years he will be beyond hope as teacher or practitioner." /9/

Continuing Education

We might think of two levels of continuing education. The lower level consists of evening classes, reading, or attending short intensive courses while continuing to hold a job. At the higher level, one would not attempt to hold down a job but would devote full time to education for a significant period of time (say six months to two years).

It seems to me that for many positions, the part-time level is becoming less and less adequate — the individual uses up his intellectual capital faster than he can replenish it. If we were to suggest to a man in mid-career that he should consider taking (say) a year off to attend school full time, he would probably reply that he couldn't afford that — he'd have a serious capital problem — one measured in dollars.

If part-time continuing education is going to be inadequate for many positions (and I believe it will), then society has a problem. How is full-time continuing education to be financed? The tuition costs are a small part of the total — the major problem is that individuals will have to forgo income while they are not working.

Last year the Prime Minister of Sweden, Olaf Palme, described a related idea of continuing education which he calls "recurrent education":

> I think the best way for me to illustrate the question at issue is to assume . . . that all post secondary education is organised on a recurring basis, that all people, after completing upper secondary education, go out into a job, that after some time at work they take another period of education, then return to a job again, then return to a job again, pass through another period of education and so on . . . For the individual, recurrent education ought to have several advantages. We all have a need for variety, whatever our occupation is. The student with educational neurosis and the person in working life with symptoms of stress would both perhaps get to grips with their problems if they were given the opportunity of a change of problems for a time. Leisure time would be used by many in a more valuable way than now and the individual would have a better opportunity to get to know his aptitudes. Absolute individual failures would be less common, as everybody would have a repeated second chance. /10/

Sabbatical Leaves

The academic world has had a sabbatical leave system for a long time — it's part of the academic culture and employers accept the expense as part of the cost of doing business. The academic world also has its equivalent of the middle management union called tenure, but that's another topic. Can we transfer the sabbatical mechanisms to other industries? I suspect not, though a few large firms do support some activity along these lines. But it's infinitesimal compared to the need I foresee. The private sector is very competitive compared to the academic world and I just don't see industry incorporating sabbatics into their culture — it would just be too easy for some firms to avoid the costs of sabbatics and hire, at a small premium, the newly refurbished employees of their competitors. Thus, I see the need for a broadly based mechanism, somewhat in the nature of the social security system. There are problems other than financing such a system — the mechanics aren't at all obvious to me and motivation will be a major problem.

What might be the costs of such a continuing education program? Since I haven't and can't describe it precisely, a precise cost is impossible. But we can, I think, come up with an approximate cost. Let us assume that 5% of the labor force is involved in continuing education at any one time and therefore not working. Let us further assume that the cost per person in terms of both the forgone income and the cost of providing the education, is $8,000 per person involved per year. Assuming a labor force of seventy million, we get an annual cost of about thirty billion. That looks expensive. Can we afford it? We can if we want to. That's about 3% of our Gross National Product. It's less than half our defense budget. And it's about the same as the annual increase in productivity. Further, in time it would undoubtedly cause productivity to increase more rapidly. And, ironically, it would also increase the pace of change — the very thing which makes such a program necessary in the first place. In that sense, such a program is somewhat self-defeating — we'll have to run even faster just to stay even.

Pace of Change

An assumption in what I've been saying is that the pace of change is actually accelerating. Is that really true? Actually, not everyone agrees that it is. In particular, economists look at such metrics as the growth of productivity and conclude that it isn't speeding up at all. Sociologists tend to disagree with them violently — I'm with the sociologists. Considering the steadily increasing effort going into research and development, one would expect the pace to be increasing. Not too long ago, most of mankind was desperately engaged in producing enough food to keep alive — even today, in the underdeveloped countries of the world, most of the labor force is engaged in food production. In a highly organized industrial country like the U.S., a few percent of the labor force produces more food than our country can consume. This, plus our high level of per capita income, permits us to devote a significant portion of our large Gross National Product to research and development — thus generating more change. It has been pointed out that something like 90% of the scientists and engineers who ever lived are alive today. Considering all these factors, it would be surprising if the pace of change were not accelerating.

The Computer is a Major Agent of Change

The computer is a major agent of such change. There is hardly an area of science, technology or human intellectual endeavor where the computer doesn't have a large impact on the pace of research and development.

Thus I believe that the most significant social implication of the computer is its role as an agent of change and the consequent fact that significant changes now take place in a period of time which is short compared to the life span of man. I've already told you of the problems I see flowing from this as they relate to individuals and a need for continuing education. To put my point another way, man must learn to adapt in a rapidly changing world. And society must provide mechanisms which help him to adapt.

Institutional Adaptation

Individual adaptation isn't the only problem since institutional adaptation is very much geared to the life span of man — the old guard frequently stays on until retirement — especially in our public institutions. There are other hindrances to institutional adaptation in that they often have a great deal of built-in inertia. Large organizations cannot be moved rapidly. Our forefathers deliberately built a lot of inertia into our systems of government.

Society can afford to lose, through lack of adaptation, a few institutions in the private sector where there are many similar organizations. But in the public sector we have little redundancy; each country has but a single national government.

John W. Gardner in "How 20th Century Man Let His Institutions Go to Pieces" /11/ stated, "The true task . . . was to design a society (and institutions) capable of continuous change, continuous renewal, continuous responsiveness." At times I can be rather pessimistic about the possibility of that happening. Individuals don't adapt very well and institutional adaptation (at least today) is tied to individual adaptation. To put the problem in the form of a pessimistic analogy — not only is the patient (society) ill but so is the doctor and the doctor's education and experience are not appropriate to the illness at hand.

Let me bring the matter a bit closer to home. The computer industry now claims to be the third largest industry in our economy, starting from a dead start less than 30 years ago. Some industry prophets predict that it will pass the automotive industry and become "#1" as early as 1980; others aren't as optimistic as to when but are just as positive that it will become "#1". I have argued that computers and communications are having and will have a fantastic impact on our society. If this is indeed the case, then one would hope that one would find expertise in computer and information science well represented in the "establishment". Yet as I scan the distinguished roster of the Panel on Science and Technology, I do not find a single person representative of the computer and information sciences. And I would be most pleasantly surprised if any members of the Committee on Science and Astronautics had more than a passing acquaintance with computers and information science. Some of the panelists may have considerable experience using computers in their own disciplines, but from my point of view, that's like the difference between being a pilot and an aeronautical engineer. The National Academy of Science does have a computer scientist, Professor Anthony Oettinger of Harvard, as Chairman of its Computer Science and Engineering Board, but he isn't a member of the Academy. I presume the reason he isn't is that he's too young.

I hope I'm not being too parochial, and I certainly don't mean to condemn you for not being computer scientists. Rather, I'm trying to make the point that institutional adaptation is geared to the life span of man. And since so much change now takes place in a period of time which is short compared to that life span, institutions are having trouble adapting. Unless you've been to school in the last ten or twenty years, you're unlikely to have any formal education in computer science. But that means you're probably young, which means that it is unlikely that you are a member of the establishment.

I would like to point out that my own formal education was in Meteorology, not Computer Science.

Man's Self-Image

Computers, communications, and rapid technological change in general are all striking serious blows at individual psyches. Certainly the individuals who epitomize either the Peter Principle or the Paul Principle feel most insecure and lack a feeling of accomplishment and worthiness. The computer might be thought of as just one more step which began with Copernicus telling us that we are not the center of the universe, Darwin raising doubts about divine creation and Freud saying that we are not completely rational. The concept of an all-powerful, infinitely fast computer is a real threat to man's self-image. It appears to him as something which competes in an area of human endeavor (intelligence) which he associates most closely with his own humanity.

I believe that most men do not have too much trouble in making the intellectual leap from the Fourth of July rocket to Apollo 11's trip to the moon. They are fantastically impressed, but they have a feeling that they understand the process. But the leap from the adding machine or desk calculator to the computer which can carry on a conversation with the user is one which is totally beyond most men's comprehension. □

ALL IN GOOD TIME: "TDMA"

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"High capacity time-division multiple-access (TDMA) communications networks are highly resistant to jamming ... and are cryptographically secure ...."

Part 1

The small-town telephone system of not-so-long ago was a real charmer. Everyone who had a phone could simply pick up the receiver and put a call through — if the circuit was open — or listen to whatever was being said on the line. Great for getting information around, but poor for privacy and access priority. An urgent call to the doctor's office might have to wait until Mrs. Busybody finished spreading the latest gossip over the line.

The New Party Line

But today there's a new development that's adding a new dimension of privacy and access priority to the old "all for one and one for all" mode. As before, anyone who picks up the receiver has an open line, and everyone he or she wants to talk to — one person or everyone in town — is instantly alerted to pick up the receiver and listen. However, the transmitted words are automatically put on the circuit in a code that's understandable only to the people the sender wants to reach, just in case there's a Mrs. Busybody type that tries to sneak a listen on someone else's call. And this coded information is transmitted in about the time it takes to snap your fingers.

This means that where a gabby caller might have tied up the line for an hour, the same information can now be transmitted in a fraction of a second. So — in the same hour, the open circuit can now permit everyone to transmit and receive information.

Time-Division Multiple-Access (TDMA)

Highly advanced information-distribution systems are being developed along the lines of this type of approach to communications technology. These high-capacity time-division multiple-access (TDMA) communications networks are highly resistant to the electronic countermeasures capable of jamming today's systems, and are cryptographically secure against eavesdropping or exploitation. This new concept also increases system communication reliability, decreases vulnerability to snooping and atmospherics, and conserves the overcrowded frequency spectrum.

Combining the capabilities of the digital computer — particularly its precision control of functions in a time-ordered sequence — with the unique use of the time spectrum, the new systems employ advances which were not available just a short time ago.

Digital Transmission of Voice

One of the key attributes of these advanced systems is that they transmit data in digital form instead of by voice. This "digitalized" data can be directly transmitted between such interfacing electronic systems as a surface station and an aircraft. This makes it possible to free the pilot from the rote chores asoociates with routine communication functions — although the system permits voice transmission, when necessary, via a vocoder which converts voice signals to digital form. Not only does this feature heighten system reliability by reducing human error potential, it also wrings every millisecond of advantage from the whiz-kid speed of digital data systems.

Ten Seconds to 1/1000 of a Second

For example, data that might require up to 10 seconds to communicate by voice transmission takes as little as a thousandth of a second, digitally. This kind of speed makes a molehill out of the growing mountain of vital military information that is staggering present communication systems — and does so while conserving the frequency spectrum to a spectacular degree.

Frequency Spectrum to Time Spectrum

Previous attempts to meet the demands for increased communications have usually centered around using more and more of the frequency spectrum — to the point where over-crowding of the spectrum has now become a major part of the problem. Present systems require each branch of the military service, as well as commercial aviation, to have its own assigned band, or frequency, for transmitting communications, navigation, and identification data.

Because the new system utilizes the time spectrum instead of the frequency spectrum, it permits military data, along with that of commercial aviation, to be transmitted on a single band of frequencies. That's a little like being able to assign about four families to the same phone number — a four-party line, if you can imagine it — while providing each family with greater privacy and security than they had with separate numbers.

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In present system technology, data is transmitted over a narrow portion of the frequency band — a segment of the spectrum that contemporary electronic countermeasure techniques could readily locate and effectively jam. The new systems, however, permit random distribution of data in small bits over a wide bandwidth area — continually hopping from one frequency to another. People who are supposed to receive the information know, by prearrangement, the frequency on which the data will be transmitted. The system's inherent anti-jam capabilities can deter even sophisticated jamming techniques.

128 Time Slots per Second

To operate in the spectrum of time and capitalize to the fullest extent on the speed of computerized digital data, the new systems transmit bursts of information in synchronized, sequenced units of time — 128 time slots per second. So much data can be transmitted in so little time that there is ample capacity left over for such housekeeping chores as having the system check itself for integrity of performance.

Since a digital computer performs millions of operations per second, the precise control and management of time is an inherent part of its operation. This capability, routine for computers, performs remarkable feats of system coordination when applied to communications technology.

Access in Five Milliseconds

For example, the number of participants in a single network of one of the advanced digital communication systems can range from two to nearly 100,000. Access to the system for each transmitting subscriber can be as often as each five to eight milliseconds or as infrequently as once every 10 to 12 minutes, depending on individual requirements. (Listening in on the hookup, of course — like the old telephone party line — is full time.) Yet, every time a burst of data arrives at a given time slot, only the individuals for whom the data is intended can unscramble and hence understand it.

Synchronization

The synchronization of both surface-based and airborne computers participating in a digital system network takes into account the transit time required for each burst of information and allows for a time interval between messages. Thus, the computers in a system network "know" their positions relative to one another. This capability is being utilized in special systems that will enable operational commands to pinpoint the location of each member of a military unit — and give each member of the unit an accurate reading on his own location.

Thus, in terms of military applications, the new digital systems will enable all current, or real-time, information needed for decision making to reach the proper levels, all along the line, in time for adequate response, whether on a multi-national interoperational mode or on a more limited scale.

Perhaps the best way to suggest some of the impact of the new equipment is to point out that the reading time for this article is approximately eight minutes — but that in digital form, if you happened to have a computer handy, the message could be transmitted in about 80 milliseconds. That's a savings of over seven minutes and 59 seconds.

In addition, there would be ample time to take in a digitalized version of the motion picture, "Gone with the Wind", still leaving over seven minutes and 57 seconds. Enough time to call to Mrs. Busybody and get the latest word — on everything.

Part 2

The Time Spectrum: A New Communications Dimension

The Time-Division Multiple-Access System, much like its telephone "party line" predecessor, is deceptively simple: it permits its users to exchange real-time information over a single communications channel on a time-ordered basis that is determined by the urgency of the user's need. This results in an information pool that is constantly updated via the contributions of the participants.

Figure 1 depicts mode of access to a much simplified TDMA system of only six subscribers, or users.

Previously, each multiple user required his own segment of the frequency spectrum for communications (A). TDMA systems stack the users sequentially in time (B), each sharing the same segment of the frequency spectrum. This frees large portions of the spectrum for other individual users, or other TDMA uses (C).

Master computers insert each time-sharing user into a transmit cycle (D) that allocates him the number of time slots necessary to meet his individual requirements. (Note the red-colored user has twice as many time slots as other users, presumably because his need to contriubte to the information pool is twice as great as other users.)

Users transmit sequentially in time (E), and they are free to receive any or all transmissions, once again based upon their need-to-know.

Figure 2 represents a typical Time-Division Multiple-Access system (F), and a breakdown of its components.

The gross time segment, 12.8 minutes, is first divided into 64 individual 12-second time frames (G). In turn, each of the frames is divided into time "slots" (H), with each slot representing an opportunity for message exchange. Each frame is divided into 1536 time slots.

Each time slot, 7.8 milliseconds long (I), is further divided into three components: a synchronization burst, a section containing the transmitted information, and a guard period at the close.

When these time slots are reinserted into the gross 12.8-minute cycle, users are provided with 98,304 opportunities to exchange information. At Hughes this new computerized approach is being investigated for use in communication, navigation and identification systems; position locating and reporting systems; and in drone control.

See the diagrams on the next page. Since in this reprinting four colors are not available, the colors have been designated by corresponding names instead of by printing in the corresponding color.

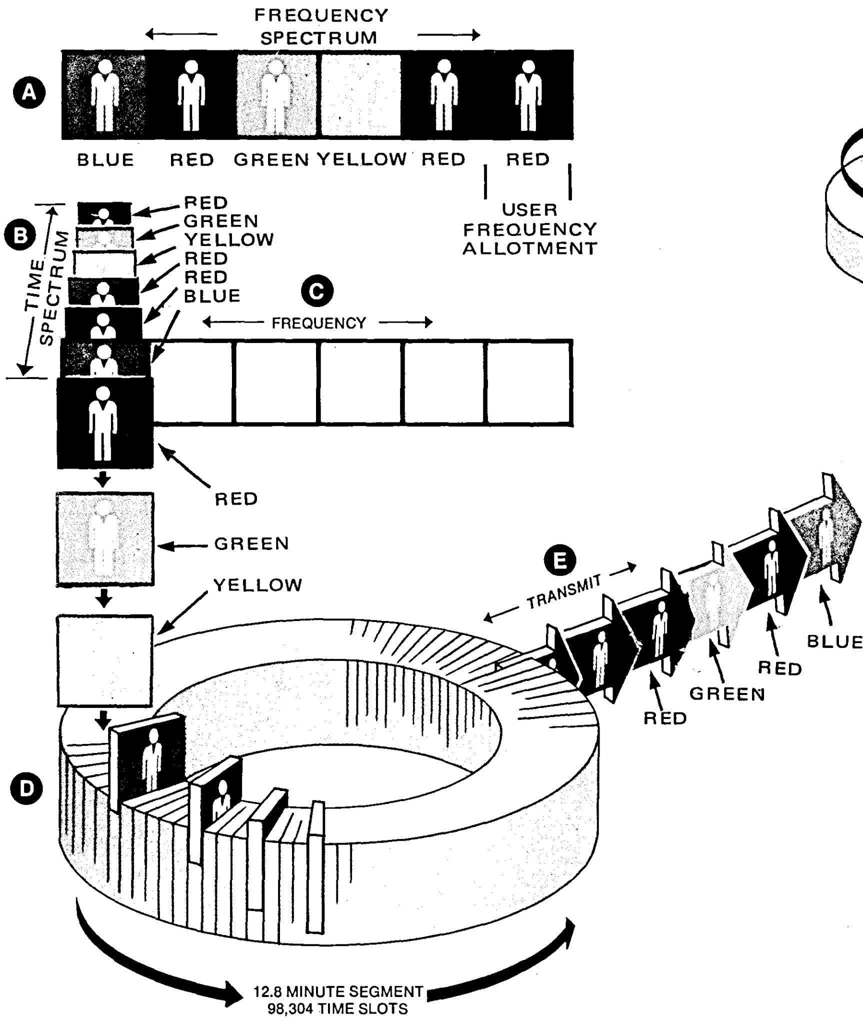

FIGURE 1

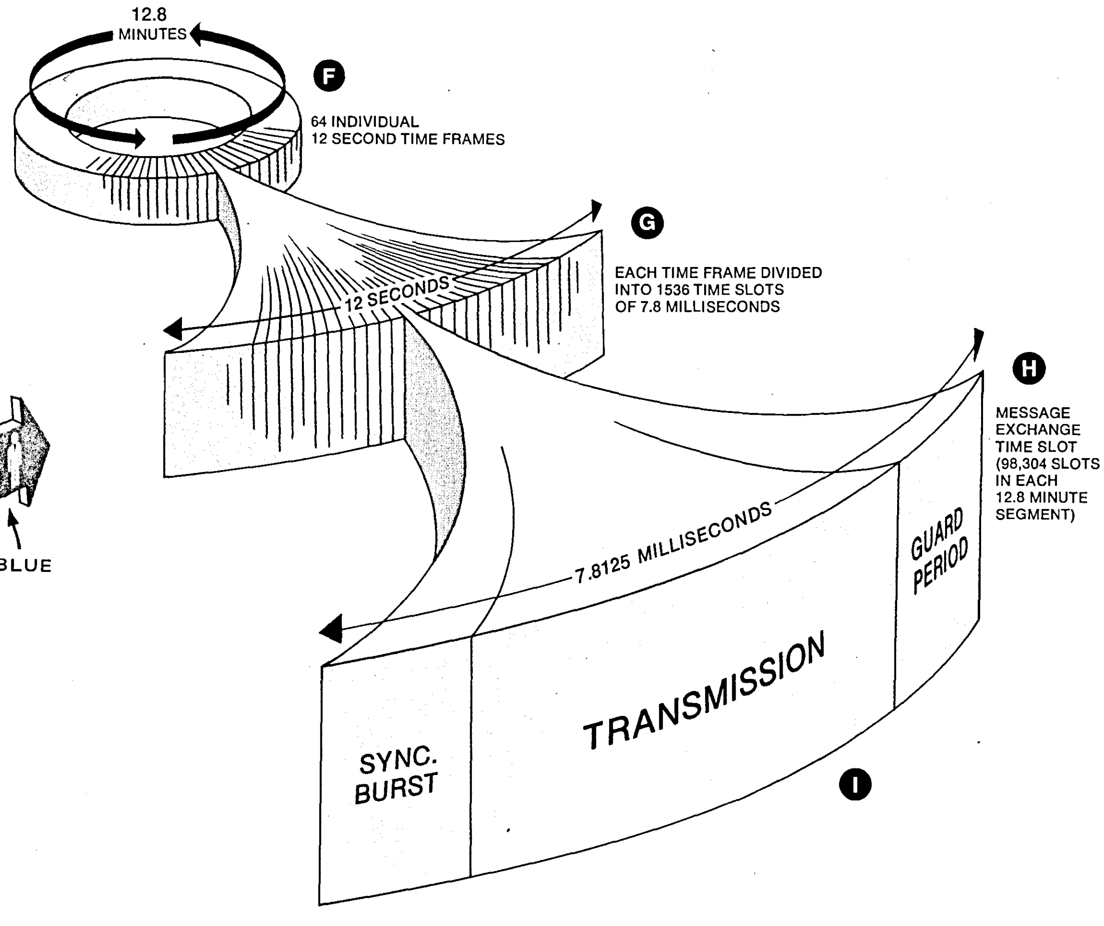

FIGURE 2

The words BLUE, GREEN, YELLOW, RED designate different users. The squares containing figures of persons designate slots assigned to users.

Computers in Use: Analyzed by Standard Industrial Classification: 1974 Compared with 1968 – Part 2

Ed Burnett
Ed Burnett Consultant, Inc.
176 Madison Ave.
New York, N.Y. 10016

Transportation, Communication, and Utilities

While the SIC system treats these three components as one, it is usually best to review them separately -- giving the following penetration ratios.

Classification	Computer Installations 1974	Computer Installations 1968	Universe	Penetration Ratios 1974	Penetration Ratios 1968
Total	1538	1172	90,000	1/60	1/80
Transportation	927	583	75,000	1/80	1/100
Communication	325	294	9,000	1/30	1/30
Utilities	386	295	6,000	1/15	1/20

The major entity here, Transportation, is, of course, a conglomerate of classifications itself -- and it includes "Local Truck Transportation" (40% of the transportation universe) where the penetration ratio in 1968 was something like 1 in 1,500 and even in 1974 is only 1 in 900. Other forms of transportation are much higher. Each segment it will be noted shows increased penetration in 1974 -- and the ranking by penetration ratio is exactly the same over the six year span.

TRANSPORTATION
Number of Computers & Penetration
1974 Compared with 1968
by Types of Transportation

SIC	Classification	Number of Computers 1974	Number of Computers 1969	Universe	Penetration Ratios 1974	Penetration Ratios 1969
40	Railroads	195	128	1000	1/5	1/8
45	Air Transportation	118	114	1200	1/10	1/10
46	Pipelines	15	10	180	1/12	1/20
47	Miscellaneous	53	42	1300	1/25	1/30
44	Water Transportation	47	37	2200	1/50	1/60
4214-31	Storage	94	49	6000	1/65	1/120
4213	Over the Road Trucking	216	148	15000	1/70	1/100
41	Bus Trans.	54	36	10000	1/200	1/300
4212	Local Trucking	33	20	30000	1/900	1/1500

Contracting

In 1968 only one classification of Contractors (Heavy Duty Construction -- SIC 1621) showed a penetration as high as 1 in 200. By 1974 both 1611 (Highway & Street Contractors) and 1621 were at the 1 in 150 level -- and contractors as a whole showed a greater advance in penetration than any other major class of business -- namely from 1/2500 to 1/1000. But at the 1/1000 level, Contracting was and is at the very bottom of the heap in penetration -- along with retailing. General Contractors, where some penetration might be expected (except the average company is quite small) shows less than one computer per 1000 companies in both 1968 and in 1974. From the percentage of computer in use (Table I) it will be noted that Computers in Contracting now represent 1% of all installations, whereas in 1968 the proportion was 1/2 of 1%.

Extractive Industries

Penetrations of Extractive Industries (Mining, including production of petroleum and gas from the ground) moved from 1/100 in 1968 to 1/80 in 1974. Over half of all computers in use in this field are in crude petroleum -- where by 1974 the penetration was same/in 15 (as opposed to 1/40 in 1968).

Agriculture, Forestry & Fisheries

The ninth and last major classification is "Agriculture, Forestry and Fisheries." (SIC codes 01 through 09). This classification both in 1968 and 1974 represented about 1/4 of 1% of computer locations -- with the penetration increasing modestly in the intervening period from 1/400 to 1/300.

Special Notes on Manufacturing by Two Digit SIC Classifications

When computers in use are examined by two, three, and four digit groupings (Table VIII) the number of listings with penetration ratios of 1 in 10 or better increases from 52 in 1969 to 79 in 1974.

As in 1968 the list of top penetrations is principally in Manufacturing. In 1968 only 4 of the 52 were outside Manufacturing. In 1974 this had increased to 9 of 79.

Food manufacture (SIC 2000) splits rather neatly into eight distinct three digit groupings. When these are arrayed by penetration (1974) they spread as follows:

SIC	Classification	No. of Computer 1974	No. of Computer 1968	Universe	Penetration 1974	Penetration 1968
206	Sugars	31	13	150	1/5	1/10
209	Miscellaneous Foods	145	106	1,700	1/12	1/20
207	Confectionery	76	47	1,300	1/20	1/20
203	Prepared Food Products	121	80	2,700	1/25	1/30
201	Meat Products	126	88	3,200	1/25	1/40
208	Beverage Industries	152	104	4,000	1/25	1/40
202	Dairy Products	125	96	4,000	1/30	1/40
204	Grain Mill Products	77	63	3,400	1/40	1/60
205	Bakery Products	79	32	3,300	1/40	1/100

In Apparel (SIC 2300) the basic figures are:

Classification	Computer Installations 1974	1969	Penetration 1974	1968
Men's & Boys Wear	113	89	1/25	1/35
Women's Wear	119	91	1/60	1/80
Misc Apparel	22	NA	1/100	NA
Misc Fabricated Textile Prods	43	NA	1/100	NA
Total Misc.	65	65	1/100	1/100
Total	297	249	1/50	1/70

It is interesting to note that while the actual number of computers found for Men's and Boys', and for Women's is equal; the penetration in Men's wear is considerably higher.

In Paper and Allied products (SIC 2600) over half of the computer installations in both 1968 and in 1974 are in Paper Mills. Mill operators are eight times as likely to install a computer as a convertor of paper. Mills show a penetration of about 1/5 while the rest of paper products average out at 1/35.

In like manner, in Printing and Publishing (SIC 2700) a magazine publisher or a book publisher or a producer of business forms is ten times as likely to install a computer as a conventional printer. (In 1968, however, this ratio was twenty times rather than ten times -- so printers are beginning to be penetrated. As in 1968, it is likely that Daily Newspapers more closely approximate specialty publishing than printers in general, on a penetration basis. But the SIC system utilizes code 2711 for all newspaper producers, 1700 daily and 8000 weekly alike ... with the liklihood of computers for country weeklies, as yet, being pretty close to nil.

The entire field of Chemicals and Allied Products (SIC 2800) shows a remarkable similarity in penetration.

Classification	Penetration Ratio 1974	1968
Industrial Chemicals	1/10	1/10
Pharmaceuticals	1/12	1/15
Perfumes & Cosmetics	1/15	1/20
Miscellaneous Chemicals	1/15	NA
Paints	1/30	NA
Soaps & Detergents	1/40	NA
Agricultural Chemicals	1/40	1/60

In 1968 Rubber and Plastics (SIC 3000) averaged out to one computer per 30 plants. (In 1974 this had improved to 1/15). These averages, however, are a bit like the one-to-one relationship in an animal stew made of one cow and one rabbit. For part of rubber and rubberized products are obviously among the most computerized segments of manufacturing (average ratio now 1 in 2 or 3) while production of articles from plastic materials indicates a ratio of 1 in 200 in 1968 and 1 in 60 in 1974. (Production of plastic materials is found primarily in SICs 2821 through 2824 where the average computer penetration was roughly 1 in 35 in 1968 and 1 in 15 in 1974).

In the major metalworking classifications the penetration ratios found in the two studies are as follows (Note: there are minor segments of Metalworking found in classification 2700 (Electrotyping), 2500 (Metal Furniture) and 3900 (Silver, Jewelry, Caskets, Musical Instruments, Pens). However, the great bulk of all firms classified as Metalworking are in codes 3300 through 3800.):

SIC	Classification	No. of Computers 1974	1968	Penetration 1974	1968
3300	Primary Metal	493	354	1/15	1/20
3400	Fabricated Metal	651	301	1/40	1/80
3500	Machinery, except Electrical	1290	977	1/25	1/30
3600	Machinery, Electrical	1284	948	1/7	1/10
3700	Transportation Equipment	641	432	1/10	1/15
3800	Professional, Scientific & Control Instruments	324	244	1/15	1/20

In the Primary Metal Industry (SIC 3300), actual primary production of steel and of aluminum show penetration ratios ten to twenty times that shown for such secondary production operations as Casting and Forging. Primary production of lead and zinc show a computer penetration well behind that of the two basic production metals of our economy. Copper is midway between the two groups -- with Secondary Rolling, Drawing, and Extruding of Copper showing more computer penetration in 1974 than for Aluminum.

In 1968 the only classification in Fabricated Metal with a penetration of 1/10 was Metal Cans. In 1974 Metal Cans were at 1/8 and Bolts, Nuts, Screws, Rivets and Washers show 1/10.

Machinery, except Electrical (SIC 3500) is a peculiar form of metal stew. One exceptionally large classification (3591 - Machine Shops) -- over one third of all plants in this classification -- shows up in 1968 with one computer and in 1974 with four ... while production of all forms of office machines even as early as 1968 shows an average of at least one computer per plant. Engines and Ball Bearings as might be expected, also show a high penetration.

Machinery, Electrical (SIC 3600) moved from 1/10 in 1936 to 1/7 in 1974. Transportation Equipment (SIC 3700) moved likewise from 1/15 to 1/10. But SIC 3600 shows a much more even spread of computers. In 1968 of 33 four digit classes in SIC 3600, ten showed penetration ratios of 1 in 6 to 1 in 10. By 1974 there were 20 such classifications with ranges of 1 in 2 to 1 in 10 (and several more near 1 in 10).

Transportation Equipment (SIC 3700) includes two of the four digit classifications with highest penetration ratios -- Motor Vehicles (1/2) and Aircraft (1/1). But, as would be expected, penetration for parts for Motor Vehicles falls off (in 1968 to 1/20 and to 1/12 in 1974). Aircraft parts likewise fall off (to 1/15 in 1968 and to 1/10 in 1974).

Miscellaneous Manufacturers (SIC 3900) show a substantial penetration increase from 1/100 in 1968 to 1/30 in 1974. This increase is the largest (in ratio) in all 21 two digit manufacturing classes.

In 1968 there were two widest exceptions to the average penetration ratio of 1/100. These were Pens and Pencils (1/20 in 1968, near 1/15 in 1974) and Carbon Paper and Inked Ribbons (1/10 in 1968, 1/8 in 1974). In 1968 computers were found in 17 of the 27 four digit classifications in SIC 3900 -- with none being found in Jewelers Findings, Lapidary Work, Diamond Polishing, Feathers and Plumes, Buttons, Candles, Lampshades, Morticians Goods, Umbrellas, and Miscellany. By 1974 only two of these classes show no computers on this list.

THE RELATIONSHIP BETWEEN NET WORTH RATING AND COMPUTER INSTALLATIONS

Establishments			Computers	
All Establishments	3,600,000		19,357	
Less non-rated Services	430,000		4,206	
	3,170,000	100%	15,151	100%
Establishments rated $20,000 net worth and over	855,000	27%		
Establishments rated under $20,000 net worth including Listed but not Rated	3,315,000	73%		

Evaluation of This Analysis

These data were derived from an analysis of the files (1968 and 1974) of "Companies and Institutions with Computers" compiled for and with the help of "Computers and Automation." In compiling this mailing list, every effort has been made to keep only one record per address. Thus, these data understate the NUMBER of computers accounted for.

Bias

For two classifications Federal Government (SIC's 9100 and 9155) and Colleges (SIC 8220 within 8200-8299) ... data was obtained covering almost every installation.

To the best of our knowledge, no other bias is involved in the collection, compiling, analysis, coding, converting, and machine handling of this file. However, it is reasonable to expect that Data Processing Services, with an outlet for publicity through the magazines have been much more likely than any other classification to send in data about their new computer installations. This classification has been removed from both sets of data.

These data are indicative, however, at best. The entire SIC coding structure commercially available has an error factor estimated by major users in the 10% to 15% range. All codes for rated business come from some 2,000 enumerators working for the primary credit reporting service in the United States. Codes for the last few years have been established by a central coding office ... which provides a measure of control. However, most codes in this service still reflect field created codes. About 30,000 entities, primarily plants in manufacturing, report multiple SIC's. For reasons of simplicity and cost, only the primary reported SIC has been utilized in this analysis. A third avenue for error has been on the conventional "read-post-tag" operation of coding what is essentially a mailing list. This has been done by experts in both list compilation and in list conversion, and unique identification numbers used for every record touched -- but a small number of human errors naturally have intruded. And some problems exist with the change in SIC coding from 1967 codes to 1972 codes.

In this light, data between one major class and another are reasonably significant. The breakdowns of penetration within 2-digit manufacturing are obviously meaningful. But differences, unless considerable, between 4-digit groupings must be considered highly tentative.

The data, by size (net worth), are valid only as gross indicators. They understate, by a considerable proportion, the correlation of penetration of computers to company size (as measured by net worth rating assessed by the credit reporting company). This is so for a number of technical reasons. In the first place, the ratings are estimates -- and based, primarily, except at the upper 1% of the range, on data provided to the credit service by each reporting company. Secondly, branch operations which should bear the same rating as the home office are, for all practical purposes, reported as "listed but not rated." Thirdly, many companies refuse to volunteer any data. Fourthly, the credit service while listing all manufacturers and most wholesalers, covers only the top portion of such classes as retail and services.

Universes

The concept of "Penetration of a given Universe" is not utilized conventionally in management science ... primarily because so little is known (usually) about the actual parameters of the universes under study.

In the business world three companies now publish a considerable volume of data on companies (and institutions) which function as employers. These three are Dun and Bradstreet, National Business Lists, and Computer List Marketing, a subsidiary of Ed Burnett. The data here on the employing universe as a whole come from all three -- with some subjective decisions by the author. (For example, Dun and Bradstreet rated and/or lists about 1,400,000 retailers, the figure selected here. By merging this list with classified listings, a number approaching 2,400,000 is probable, and the U.S. Census of Business shows even more. The penetration in retail using the more modest 1,400,000 is less than 1 computer per 2,000 stores. Little would be gained by including every unrated "mom and pop" store.)

For comparability between 1968 and 1974 data, 1968 universes have been used throughout. The figures for business companies rated $20,000 net worth and over come from a 1968 analysis of names (without addresses) published by net worth rating by Dun and Bradstreet. At the time this analysis was made Dun and Bradstreet itself could not furnish such data. At the time this was produced, this was considered the best approximation, based on statistical counts, then available. The data is reasonably adequate for the rough penetration proportions published here.

As noted in the text, there are a number of "universes" to consider.

From a size point of view they range as follows:

a.	Companies (Home offices only) rated $1,000,000 and over in 1968	36,000
b.	Companies (Home offices primarily) rated $20,000 and over in 1968	855,000
c.	Establishments (employers) rated and non-rated considered as potential business and institutional market for computers in 1968	3,500,000
d.	Census reported employers (non-farm) ... including professionals and one-man businesses	6,600,000

The penetration data presented here -- one computer for so many establishments -- basically is applied to "c" and "b" above.

In credit reporting, non-buying branches (as branch units of a chain) are omitted. Branch plants in manufacturing are virtually all included as each plant is a buying entity. Overall, branch plants represent about 10% of all plants reported. But this proportion can be very misleading insofar as concentration of production is concerned. For example, about half of all such branch and subsidiary operations (some 14,000) are controlled by the 1,000 largest manufacturers -- the so-termed "Fortune 1,000." These 1,000 companies (with their branches and subsidiaries) account for over 70% of all employment in manufacturing and over 75% of all value added to manufacture.

SIC

For those who wish complete information on this valuable classification system, the purchase of the "Standard Industrial Classification Manual" published by the United States Department of Commerce ($2.50) is strongly recommended.

For a brief review of the way SIC works and some of the pitfalls involved, see the article "OF SIC" by Ed Burnett, published in the March 1968 issue of "Reporter of Direct Mail"(now "Direct Marketing") Garden City, New York. □

TABLE I
PERCENTAGE OF COMPUTER INSTALLATIONS BY MAJOR SIC CLASSIFICATION
1974 Compared with 1968
(omitting Computer Services & Service Bureaus)

SIC	Computer Count		% of U.S. Total		Classification
	1974	1968	1974	1968	
All	24,540	17,589	(100.00)	(100.00)	U.S. Total
01-09	74	56	.30	.31	Agriculture, Forestry & Fisheries
10-14	237	170	.96	.96	Mining Industries
15-17	246	98	1.00	.55	Contracting
19-39=	9,376	6,498	38.20	36.94	Manufacturing Industries
19	48	32	.19	.18	Ordnance
20	922	639	3.75	3.63	Food
21	26	35	.10	.19	Tobacco
22	302	201	1.23	1.14	Textile Mill Products
23	297	249	1.21	1.41	Apparel
24	105	64	.42	.36	Lumber & Wood Products
25	149	68	.60	.38	Furniture & Fixtures
26	319	187	1.29	1.06	Paper & Allied
27	622	521	2.53	2.96	Printing & Publishing
28	733	524	2.98	2.97	Chemical & Allied
29	200	227	.81	1.29	Petroleum Refining & Allied
30	256	141	1.04	.80	Rubber & Plastics
31	90	72	.36	.40	Leather & Leather Prods
32	225	144	.91	.81	Stone, Clay & Glass
33	493	354	2.00	2.01	Primary Metal Industries
34	651	301	2.65	1.71	Fabricated Metal Industry
35	1,290	977	5.25	5.55	Machinery Except Electrical
36	1,284	948	5.23	5.38	Machinery, Electrical
37	641	432	2.61	2.45	Transportation Equipment
38	324	244	1.32	1.38	Prof & Scien & Control Instr
39	399	138	1.62	.78	Misc Mfg Industries
40-49	1,538	1,172	6.26	6.66	Transport, Comm & Utilities
50-51	2,301	1,232	9.37	7.00	Wholesale Trade
52-54	1,118	792	4.55	4.50	Retailing
60-67	3,192	2,967	13.00	16.86	Finances
70-74	898	398	4.67=	2.26	Services, Bus & Prof
7399/7387	omit	omit	omit	omit	
Other	1,133	398	4.67	2.26	
80-99	5,324	4,206	21.69	23.91	Services, Social
82	1,966	1,830	8.01	10.40	Service, Educational
91-94	2,283	1,910	9.30	10.85	Service, Governmental
Other	1,175	466	4.78	2.64	Service, Other

Note: The remainder of this article consists of tables: Table II, Computer Penetration Ratios of Business Universes by SIC Classification; Table III, Distribution of Computers by Major SIC Classifications; Table IV, Penetration Ratios for Computers in Use by Major SIC Classification; Table V, Percentage of Computers by Major SIC Classifications; and three more similar tables. These will be published in later issues of "Computers and People" as suitable space may become available. If any reader wants them soon, please write to the editor; the timetable for publishing will be hastened if there is sufficient interest.

active editing programs which provide through rather simple commands very powerful editing of text.

Even if the human being could use ordinary natural language in talking to the computer, he rapidly changes to single or double character commands since they are faster to type. Furthermore, the interaction is a very good learning situation. It is controlled by the learner, who is interacting with an extremely patient and sometimes very friendly computer program (if it is well designed). In this case, part of the programming is inside the computer and the rest of the programming is inside the mind of the human being sitting at the computer terminal. It is hard to see how any amount of ordinary natural language could improve the interaction between the computer and human being. The happy relation is only really disturbed if too many persons are trying to use the time-shared computer at once. Then the system becomes sluggish, then really slow and very exasperating — but this is due not to a programming fault, but insufficient equipment.

14. Artificial Intelligence and Communication with Robots

In addition to the widespread development of interactive "intelligent" programs in the area of what is called "artificial intelligence", many investigators are pursuing the goal of having a computer program understand ordinary natural language, respond in ordinary natural language, and display other kinds of intelligent behavior. These investigators include groups at Mass. Institute of Technology, IBM Corporation, Stanford University, Bolt, Beranek, and Newman, Xerox Corporation, and other locations. The Artificial Intelligence Laboratory at M.I.T. began in 1958. Most of these groups, however, have major concerns with problems quite different from programming a computer using ordinary natural language.

For example, at the AI Lab of M.I.T. one of the investigations deals with telling a computer program in ordinary language certain information about the location, shape, and color of certain blocks. These blocks might be a red cube, a green pyramid, a blue cylinder, etc. Then the program is commanded to make certain rearrangements of the blocks, such as placing the green pyramid on top of the blue cylinder. The program has to deduce how to perform these rearrangements, and how to answer in natural language questions expressed in natural language about the rearrangements.

So far there has been a degree of success in persuading computer programs to deal correctly with ordinary natural language in limited contexts, such as the giving of instructions or the posing of questions to a robot (the computer program controlling the robot). But of course a much higher degree of success is needed before:

- — computer programs can be made from the start using ordinary natural language; and
- — computer programs can be modified easily using ordinary natural languages.

But it is reasonable to expect that these two developments will be attained before long.

References

1. "What the Computers will be Telling You" by Peter F. Drucker, in the "Nation's Business", Vol. 54, No. 8, August 1966. □

Armer — *Continued from page 23*

Learning What a Computer is All About

There are many computer specialists who believe that it takes at least a week of intensive instruction to teach "computer concepts" to executives — men who are way above average in intelligence and education. No wonder many lesser individuals feel that it is impossible to learn what computers are all about. And if he doesn't believe he can do it, he cannot.

Several years back, an IBM psychologist did an interesting study which showed that a significant percentage of the population tended to think of computers as "the fearsome thinking machine" /12/. As might be expected, this view was held less by the well-educated (24% of those with a college degree did hold this view) than by the less educated (44% of those who had not completed high school). This view was highly correlated with feelings of alienation, suspicion, bitterness and with intolerance of uncertainties and ambiguities. In fact, once it is known where a person stands in terms of alienation and intolerance of uncertainties, variations in education make no significant difference at all in predicting whether or not an individual will hold the "fearsome thinking machine" attitude toward computers. Alienation is certainly on the increase in today's urban society, so we shouldn't be too surprised if the percentage of the population who fear computers is also increasing.

Coping with Rapid Change

Men feel that they just can't cope with the rapidly changing environment in which they live. Or they may just decide not to try to cope, as some of the younger generation are doing when they head for the rural areas to form their communes. This fear of a world that is changing so rapidly that one is unable to function well in his job, or in his role as a citizen of the world, is not confined just to the less educated. I believe the Paul Principle is operant at the highest levels of industry, science and government. I wish I were able to take a secret poll of the individuals in this room as to whether or not they felt they were an example to some extent of the Paul Principle. I'd bet that at least a third — possibly a half — of you would secretly admit to it. I know I would.

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(Continued in next issue)

Computing and Data Processing Newsletter

COMPUTER STUDY OF POLE VAULT SHOWS PRE-BENT POLE COULD BOOST RECORD

News Bureau
Univ. of Southern California
Los Angeles, Calif. 90007

The world record for the pole vault probably could be raised by at least one foot above the current mark of 18 feet, 5-3/4 inches by using a pole with a built-in curve, according to a computer analysis by a University of Southern California engineer.

The study also projected that a hypothetical "super-athlete" who embodied the strength and height of a Wilt Chamberlain, the speed of an Ivory Crockett, and the balance and agility of an Olga Korbut theoretically could clear the crossbar at 28-1/2 feet by executing a technically flawless vault.

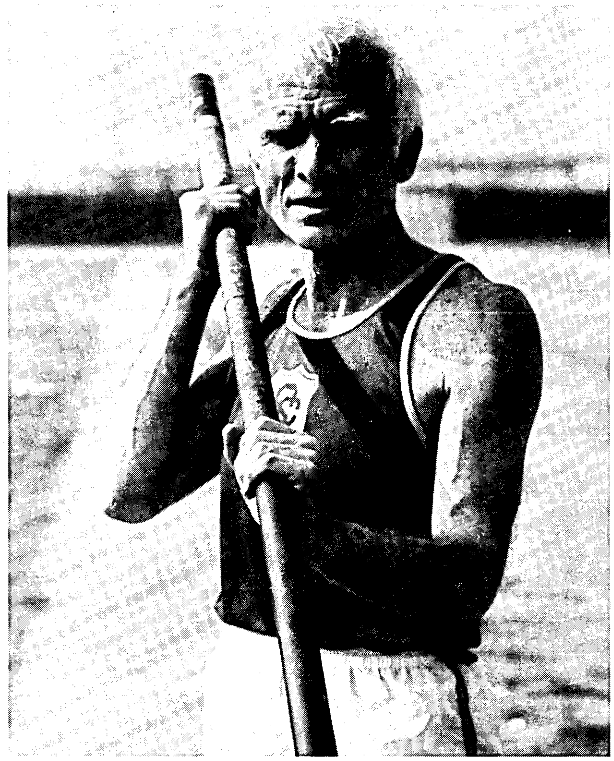
The research was carried out by James B. Vernon, associate professor of mechanical engineering at USC. He also is an amateur vaulter who, at age 58, is the holder of national AAU and Senior Olympic titles for his age group.

Prof. Vernon programmed the university's computer with a series of equations that represented in mathematical terms the physical factors involved in the vault. By adjusting variables such as approach speed and pole flexibility in his computer "model", he hoped to discover what physical attributes and vaulting techniques were important for success in the event.

The most striking conclusion was that a pole with a pronounced curve could significantly increase the height of a vault, although the athlete does not get something for nothing.

"The pre-curved pole must be stiffer than a conventional one," Prof. Vernon said, "and the athlete must be strong enough to harness the increased load imparted as the pole springs back during the 'pull-up' phase. All things considered, the world record probably could be raised by at least a foot with a properly curved pole."

Poles with a slight degree of curvature are in limited competitive use this season, but Prof. Vernon's calculations show that the greater the bend, the greater the height. As a practical matter, however, he believes a curve of about one foot out of line at the midpoint would yield the optimum height advantage without making the pole too unwieldy. An analysis of the computer showed that a pole curved 1.3 feet should theoretically result in a vault that was 1.8 feet higher than could be achieved with a standard pole.



Pole-vaulting professor, 58-year-old James B. Vernon of USC, analyzes vaulting techniques on an IBM computer and then tests his findings on the track. One arresting theory: A pole with the proper built-in curve could probably boost the world record by at least one foot.

The curved pole is a logical next development for the flexible, but straight, fiber glass pole that superseded the earlier rigid ones made of bamboo or metal.

"When the vaulter sprinted down the runway and planted the end of one of those old rigid poles in the box, his arm had to 'give' like a shock absorber under the sudden load," Prof. Vernon explained. "Much of the energy that should have gone into the vault was dissipated.

"With the advent of the fiber glass pole in the early 1960s, there was a spectacular increase in world record performances although the pole itself had no energy. Why?

"Because the flexible pole bends during the take-off, storing energy like the wound-up mainspring of a wristwatch. This potential energy, which was lost by the rigid poles, is transferred back to the vaulter as the pole straightens."

A pre-curved pole would be stiffer than a conventional one, yet it would feel "softer" at takeoff because the initial load buildup would be more gradual and even less of the vaulter's energy would be dissipated. Prof. Vernon believes that the effect, which was not included in the computer model, comes into play even with the slightly curved poles in use today.

As for the ultimate 28-1/2 foot height, ten feet higher than the current record held by USC alumnus Bob Seagren, the professor said the mark should not be viewed as an upper limit, although he doubts it will be attained in this century.

"It's an indication that world records in this event will continue to be set for many years to come," he said. "And a 20-foot height is certainly within the range of the present generation of vaulters."

The computer used in the studies was an IBM System 370, Model 158.

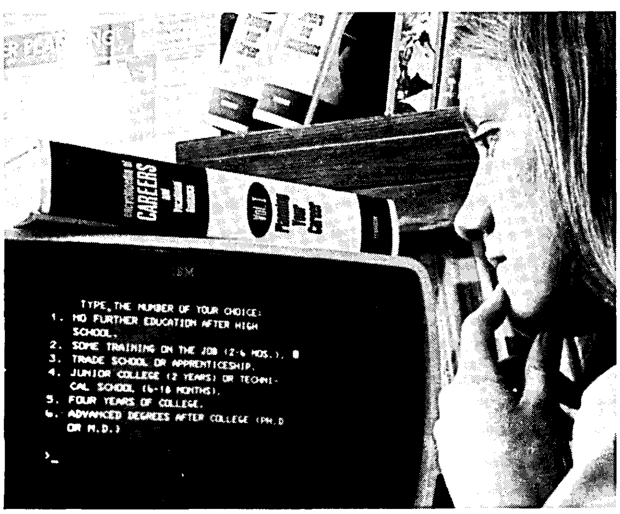
COMPUTERIZED VOCATIONAL INFORMATION SYSTEM FOR HIGH SCHOOL STUDENTS

JoAnn Harris
Willowbrook High School
Villa Park, Ill. 60181

In 1966 this high school set out to simplify and improve its vocational counseling for its students. The solution was the Computerized Vocational Information System, which has proved so successful that it has been adopted by over 100 other educational institutions, in the United States and foreign countries.

In this way, thousands of high school students have discovered that a computer can be a very helpful career guidance counselor.

The computer does this by comparing the student's personality traits, ability, grades, and interests with whatever career is selected. Students "talk" with the computer through terminals. Conversations are flashed on the screen.



The computer helps students explore 450 occupations, get information on 1,500 colleges, investigate specialized and technical schools or apprenticeship information, check local jobs available or get military facts. It also provides information on scholarships, loans, and grants.

As the student — junior high, senior high, or community college — explores the various career opportunities, the computer continually checks to see if he or she is on the right track. If an appropriate career is selected, the computer might respond:

"The plan you have chosen seems fine. This plan seems to fit your ability as measured by tests. At this time your grades are not as high as your ability predicts they could be."

However, if the student is way off base, the computer might say:

"Your choice puzzles me somewhat. I've compared it with your record, and the two don't seem to match. The best way to clear up this problem would be to see a counselor."

The computer can store vast amounts of data, retrieve them instantaneously, interrelate them, and sort through them by different characteristics. This enables the CVIS to function well.

The computer can quickly match student information with information about a job, course, or school. This enables the student to bridge the gap between self-information and career information and make the connection personally meaningful.

The system is not designed to replace counselors. The program assists both students and counselors in the information-collecting and sorting stage which usually precedes deciding about careers.

In addition to assisting students, CVIS has relieved counselors of many clerical duties.

Some comments by students include: "It's cool; it's exciting; it knows a lot; it knows my capabilities; it's too smart; and I found what I can do when I get out of high school."

One girl said, "I wanted to find out about being a nun. The computer didn't care, but my counselor would have laughed at me."

NEARLY $1 MILLION MORE PRODUCT WITH THE SAME AMOUNT OF RAW MATERIAL VIA A REPROGRAMMED COMPUTER

Alan Hirsch
Gross and Associates
630 Fifth Ave.
New York, N.Y. 10020

Reprogramming a process control computer at a plastics production plant in Pasadena, Texas, has saved $891,500 during the first year of operation.

The plastics plant was the Adams Terminal of Phillips Petroleum Company. The computer reprogramming was supplied by Applied Automation of Bartlesville, Oklahoma.

Howard R. Burman, manager of the Adams Terminal said "During the year ending Nov. 30, 1974, the digital computer system controlling production rates of particle form reactors increased production, valued at $876,000 per year; reduced off-specification product, valued at $11,000; and reduced reactor maintenance and shut downs, valued at $4,500."

The computer controls the concentration of ethylene and the recycle flow rate of isobutane to the reactor. It also calculates the solids in the reactor and controls the comonomer addition rate for hexene or butene.

The digital computer system applies to reactor control and includes chromatographs downstream and upstream.

A similar system installed in 1975 is calculated to cost some $200,000, which means payout is achieved in three months.

"About half of the plastics producers are under computer control," Burman said. "We believe the Japanese were the first to put a particle form reactor on computer control."

He said inefficiencies were shown immediately. "The reactors had their highest production in the first month they were on production rate control and a more uniform product within established specifications has resulted."

The basic computer has a magnetic core memory of 16,384 words, which contains the instructions and data for the operation. The input system takes 26 analog signals from each reactor and calculates heat and material balance. A new set of data is calculated every six seconds.

The operator sets production rate and ethylene concentration, and adds catalyst to obtain the production rate. By observing the computed solids, ethylene concentration and production rate, the reactor operator knows when to increase or decrease the catalyst feed rate. □

Forum — *Continued from page 8*

one of our greatest assets (CACM) in order to create new nontechnical publications. One of my colleagues on the Council has framed a law stating "thou shalt not tamper with CACM". I am sorry to say that that position represents a minority on the current Council.

Sensitive Issues

The main problem at Council sessions has to do with the rushed atmosphere and the avoidance of nearly all fundamental issues. But in addition there is another trend in the making dealing with socially or politically sensitive issues. During the meeting last November, the Council expressed its misgivings about the lack of safeguards relating to the use of universal identifiers, such as the social security number. This particular Council action was indeed the only one picked up by the outside press.

This time around, Aaron Finerman presented some preliminary resolutions concerning conditions to be fulfilled at ACM-sponsored international conferences — basically that such conferences should be freely accessible to all scientists, and that acceptance or rejection of papers submitted to such conferences should be based on technical excellence rather than political considerations.

This issue arises from the common, but nonetheless outrageous, habit of many nations in blackballing nationals of those countries of which they disapprove. Thus Cuban scientists have been refused entry visas into the United States for many years, and nationals of South Africa, Israel, Taiwan, etc. find difficulties in presenting papers and attending conferences in many countries of the world.

Now obviously Aaron's resolution is unexceptionable on moral, professional, and scientific grounds. Only let's not assume — even if we manage to attract the attention of the public press — that we have indeed accomplished something effective by passing resolutions of this type. The problem is of course that no government (including our own) is likely to change what are considered to be internal policy matters simply because the ACM sets up rules to that effect. One wonders when whether this type of activity really makes sense.

Resolutions Adopted

In taking up so much space with overall policy matters, I have reduced my opportunity for discussing in detail the various "sense of Council" resolutions that actually were adopted, and the multiplicity of "straw votes". But I shall mention the most important items.

The Council reaffirmed (but did not discuss) its earlier mail ballot votes concerning the Long Range Planning Committee (LRPC) report. The understanding was that proposals adopted by a majority of two-thirds of Council members voting — at least 13 votes out of 19 votes — would in fact be implemented. The following recommendations, among many others, received two-thirds of the votes cast:

a) production of a common periodical less technical in outlook than CACM;
b) "unbundling" of the publications;
c) more active support of standards developments;
d) addition of a conference coordinator at headquarters;
e) increase in the amount of published business-oriented materials;
f) enhancement of our image as the primary publisher of scholarly material in computing;
g) reaffirmation of most of our current policies with respect to chapter support, educational activities, student and overseas memberships, and financial management ("the attainment and maintenance of financial stability is of primary concern").

Joint Membership with the British Computer Society

The Council also finally adopted the joint membership agreement with the British Computer Society. There was considerable unhappiness on the part of the people representing the ACM in these negotiations over a variety of road blocks conveniently introduced by the British at various times. I would like to take the time to describe these for you in detail so that you might appreciate how tortuous the interactions between professional societies can sometimes be, but I won't.

Professional Development

Recommendations were presented to the Council from the Professional Development Committee regarding the carrying out of professional development activities. There seemed to be a feeling among Council members that seminar speakers should, like other ACM volunteers, receive no honorarium for their activities.

Financial Progress

After all this, let me end on a cheerful note: the financial position of the ACM continues to improve: at the end of December 1974 we were almost $150,000 ahead of budget, compared with about $50,000 ahead of budget in September and October 1974. □

GAMES AND PUZZLES for Nimble Minds – and Computers

Neil Macdonald
Assistant Editor

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

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

NAYMANDIJ

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

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

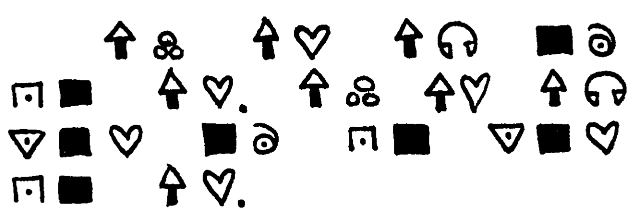
NAYMANDIJ 756

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

MAXIMDIJ

In this kind of puzzle, a maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the 10 decimal digits or equivalent signs for them. To compress any extra letters into the 10 digits, the encipherer may use puns, minor misspellings, equivalents like CS or KS for X or vice versa, etc. But the spaces between words are kept.

MAXIMDIJ 756



NUMBLES

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

NUMBLE 756

```
                 The      T H R E A D
                   X      B R E A K S
                   -------------------
                          R I A T W E S
      BD = KW           I R I I K W S
                      E A K R I S H
                    K W I T S I E
                  W K A I N T I
                I R I I K W S
                ---------------------
              = K B T S R W R A A K I S

               6047  4292  8902  11489
```

We invite our readers to send us solutions. Usually the (or "a") solution is published in the next issue.

SOLUTIONS

NAYMANDIJ 755: Reverse sequence column 14.

MAXIMDIJ 755: The present for the present, the future for the future.

NUMBLE 755: The wood has eyes, the wall has ears.

Announcing the publication of a new monthly magazine, first issue May 1975

"People and the Pursuit of Truth"

- The Watergate crimes and punishments have changed the atmosphere in the United States.
- Congressman Henry B. Gonzalez of Texas on February 19 introduced H. Res. 204 in the U.S. House of Representatives, calling for an investigation of political assassinations in the United States.
- More than 1500 persons attended a conference on "The Politics of Conspiracy", Jan. 31-Feb. 2, in Boston, called by the Assassination Information Bureau.
- Rusty Rhodes of "The Committee to Investigate Political Assassinations", Los Angeles, Calif., has collected more than 250,000 signatures calling for a new congressional investigation.

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- solutions to great problems that are functioning well in other countries, yet are almost never talked about in the usual American press.

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2) The relation of the Central Intelligence Agency to the killing of President Allende of Chile
3) Concealed activities of the CIA, FBI, Pentagon, and other entities that are disruptive of the domestic affairs and rights of other countries and of the people of the United States

FIRST ISSUE: May 1975, eight pages, full size, photooffset, two pictures of the "Oswald Window"

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