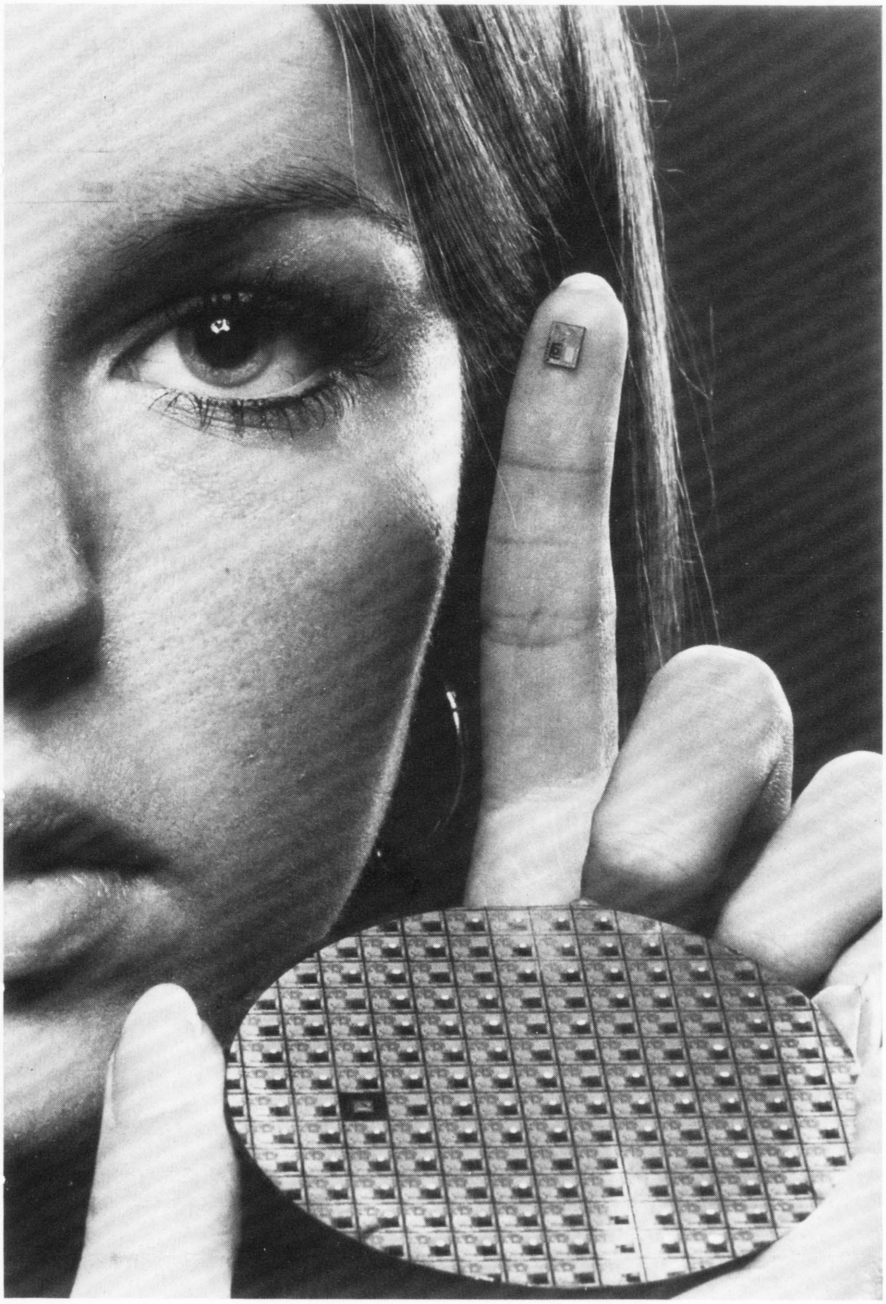
computers and people

formerly *Computers and Automation*

May, 1976
Vol. 25, No. 5



CONFETTI–SIZE COMPUTERS

MULTI-ACCESS FORUM

NATO ADVANCED STUDY INSTITUTE TO BE HELD IN GREECE, SEPTEMBER, 1976

From: Professor B. Shackel, Director
Department of Human Sciences
University of Technology
Loughborough, U.K.

A NATO Advanced Study Institute on Man-Computer Interaction (MCI) will be held at Mati near Athens, Greece from September 5 to September 18, 1976.

The Institute will review current knowledge and recent research on human aspects of man-computer interaction. Topics will include hardware and software design, programming, interaction with different classes of users, training and modelling. The emphasis throughout will be upon the ergonomics/ human factors problems and solutions. Papers on the main topics will be presented by invited lecturers, and these will be followed by seminars and discussions at which participants will be expected to contribute.

The Advanced Study Institute's program, sponsored by NATO, aims to further international collaboration between scientists through in-depth study of important areas of research.

Priority will be given to applicants who were accepted for the 1975 ASI on MCI which had to be postponed, but there will be a number of places for new applicants. Numbers are therefore restricted, so it is important to apply as early as possible. For an application, write the above address.

ADAPSO'S STUDY AND ACTION PROGRAM: THIRTEEN POINTS FOR A CHANGING INDUSTRY

From: J. L. Dreyer
Executive Vice President
ADAPSO
210 Summit Ave.
Montvale, NJ 07645

At the mid-year Management Conference of the Association of Data Processing Service Organizations, held in Atlanta, Georgia during April 1976, Mr. Leon Weisburgh, ADAPSO's president, presented the management of computer software, data center, facility management, and timesharing companies with an action program covering such topics as privacy and security, electronic funds transfer, communication regulations, and international operations.

The computer service industry program, as presented by Mr. Weisburgh, includes the following thirteen points.

1. Privacy and Security. ADAPSO will draft model privacy legislation for the private sector, calling for a preemptive statute that would eliminate any state laws and make the federal statute the law of the land.

2. Electronic Funds Transfer System. ADAPSO member companies already handle bank processing, sell software to banks, process retail stores, and process payrolls. With background in most areas involving potential EFTS applications, ADAPSO, at the suggestion of the EFTS Commission, is preparing standards for an acceptable interface to transfer systems.

3. Taxation. ADAPSO's Taxation Committee is presently studying what computer services are taxable: is an on-site programmer different from a temporary employee who is nontaxable; is an in-house programmer different from an on-site programmer; is customer programming different from package programming; are data processing services different from accounting or consultant services; and if you replace an in-house installation, are you different from any other subcontractor? As a result of legislation in several states, ADAPSO is drafting a legislation model for use in each state and is studying ways to assist member companies in their tax disputes.

4. Government Procurement. ADAPSO is studying ways to facilitate obtaining government contracts with a profit potential, convincing government agencies that they can buy outside services cheaper and more efficient than their own and restrict tax-free installations from competing with private business. Along these lines, ADAPSO will hold a two-day seminar on government procurement in August.

5. Annual Industry Study. ADAPSO, effective with its 1976 Annual Industry Study, will participate in a completely revised study to develop more meaningful trends.

6. Postal Regulations. What is the definition of a letter, with regard to data processing reports; how will word-processing equipment affect this definition in the future? Accordingly, ADAPSO is preparing a position paper on the statutory definition of a "letter."

7. International. An increasing number of computer service companies are involved in international marketing. ADAPSO will sponsor a two-day seminar in May that deals with data communications, tariffs, contractual obligations, and legal obligations.

8. Audit Guide. Commenting on the Audit Guide prepared by the American Institute of Certified

(please turn to page 7)

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 + ...

PURPOSES:

- to help you avoid pitfalls
- 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 and Deception
- Laxity
- Bias and Prejudice
- Ignorance

To Come

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

Topic:
SYSTEMATIC EXAMINATION OF GENERAL CONCEPTS

Already Published

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

To Come
- Strategy
- Teachable Moment
- Indeterminacy
- System
- Operational Definition

8 REASONS TO BE INTERESTED IN THE FIELD OF COMMON SENSE, WISDOM, AND GENERAL SCIENCE

COMPUTERS are important —
But the computer field is over 25 years old. Here is a new field where you can get in on the ground floor to make your mark.

MATHEMATICS is important —
But this field is more important than mathematics, because common sense, wisdom, and general science have more applications.

LOGIC is important —
But this field is more important than logic, because common sense plus wisdom plus science in general is much broader than logic.

WISDOM is important —
This field can be reasonably called "the engineering of wisdom".

COMMON SENSE is important —
This field includes the systematic study and development of common sense.

SCIENCE is important —
This field includes what is common to all the sciences, what is generally true and important in the sciences.

MISTAKES are costly and to be AVOIDED —
This field includes the systematic study of the prevention of mistakes.

MONEY is important —
The systematic prevention of mistakes in your organization might save 10 to 20% of its expenses per year.

- - - - - - - - - - - - - - - (may be copied on any piece of paper) - - - - - - - - - - - - - - -

To: Berkeley Enterprises, Inc.
815 Washington St., Newtonville, MA 02160

( ) Yes, please enter my subscription to *The Notebook on Common Sense, Elementary and Advanced* at $12 a year (24 issues), plus extras. I understand that you always begin at the beginning and so I shall not miss any issues.

( ) Please send me as free premiums for subscribing:

1. Right Answers — A Short Guide to Obtaining Them
2. The Empty Column
3. The Golden Trumpets of Yap Yap
4. Strategy in Chess
5. The Barrels and the Elephant
6. The Argument of the Beard

( ) I enclose $_________ ( ) Please bill my organization

RETURNABLE IN 7 DAYS FOR FULL REFUND IF NOT SATISFACTORY
HOW CAN YOU LOSE?

Name ________________________ Title ____________

Organization ________________________________

Address (including zip) ____________________________

Signature ______________________ Purchase Order No. __________

Vol. 25, No. 5
May, 1976

computers and people formerly *Computers and Automation*

Editorial Offices Berkeley Enterprises, Inc
815 Washington St.
Newtonville, MA 02160
617-332-5453

Advertising Contact **The Publisher**
Berkeley Enterprises, Inc.
815 Washington St.
Newtonville, MA 02160
617-332-5453

"Computers and People", formerly "Computers and Automation", is published monthly, 12 issues per year, at 815 Washington St., Newtonville, MA 02160 by Berkeley Enterprises, Inc. Printed in U.S.A. Second Class Postage paid at Boston, MA, and additional mailing points.

Subscription rates: United States, $11.50 for one year, $22.00 for two years. Canada: add $1 a year; elsewhere, add $6 a year.

NOTE: The above rates do not include our publication "The Computer Directory and Buyers' Guide". If you elect to receive "The Computer Directory and Buyers' Guide", please add $12.00 per year to your subscription rate in U.S. and Canada, and $15.00 elsewhere.

NOTE: No organization in Switzerland or Morocco is authorized or permitted by us to solicit subscriptions for or receive payments for "Computers and People" or "The Computer Directory and Buyers' Guide". Such subscriptions and payments should be sent directly to us.

Please address mail to: Berkeley Enterprises, Inc., 815 Washington St., Newtonville, MA 02160

Postmaster: Please send all forms 3579 to Berkeley Enterprises, Inc., 815 Washington St., Newtonville, MA 02160

Change of address: If your address changes, please send us both your new address and your old address (as it appears on the magazine address imprint), and allow three weeks for the change to be made.

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

Front Cover Picture

This woman displays on her finger a microelectronic chip which contains 10,000 transistors interconnected as an electronic system. This device, called a large-scale integrated (LSI) circuit, is literally a "computer on a chip." It is used as the electronic system or subsystem for a variety of products, including calculators, cash registers, automotive controls, and telephone equipment. These chips are produced on wafers, like the one the woman is holding. The chips are now manufactured at a rate of 24 million a year, by Rockwell International of Pittsburgh, Pennsylvania.

Key

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

NOTICE

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

Can a Computer Apply Common Sense? – II

Can a computer apply common sense?

Of course, we mean by "computer" a "programmed computer"; and a first answer to the question is:

> If a programmer knows what common sense is in the situations where the program may be applied, then he should be able to include it in the program, and the computer should be able to apply common sense.

Do programmers know what common sense is?

Some perhaps do; many probably don't. Common sense is apparently not common nowadays, even if in "the good old days" it was common, which is doubtful. Certainly, there exists no textbook on common sense; I have been searching for such a book for more than a dozen years, and have never found one nor heard of one. Also, we have published a "Notebook on Common Sense" which has had more than a thousand subscribers, and not one of them has ever told us of such a textbook. (See the notice on page 3.)

Common sense in a computer program implies that the program will include sensible conditions and corresponding actions. In a payroll program, for example, it would be common sense to include a top limit on outgoing checks. The following condition would be implemented:

> If the amount to be paid to an employee exceeds ...., print out a notice to .... to obtain his specific authorization to issue the check.

But the crux of the issue is:

> What is common sense?

Only when we answer that are we in a position to apply it.

The definitions of common sense in the dictionaries are regularly filmy and insubstantial, for they define common sense in terms of synonyms, and those synonyms in turn are defined by other synonyms. What we require is observable (or "operational") features or elements or distinctions or characteristics that we can apply in situations.

This question was discussed recently in a course currently being given at Boston University on "Computers and Society." Society, that is, people, most certainly require of computers that the results they produce should be common sense results. This discussion resulted in recognizing six elements or aspects of common sense behavior, which are outlined in the table on page 7.

This brings us closer to a definition of common sense that can be used for computer programming. I would propose the following procedure for including common sense in computer programs:

— Provide sensible rules for as many as possible contingencies and conditions, as suggested or reported by experienced clerks, managers, and consultants. (I know of a valuation program in a large consulting actuary firm, which will provide up to 150 warnings for the actuaries using that program.)

— For situations not covered by these rules, provide an evaluating and deciding function in the way that a good game-playing program evaluates situations that may arise in the course of the game and makes decisions.

— Provide that the program can learn easily or be modified easily as a result of its own experience with persons using the program.

With enough interest, imagination, and thoroughness in programming, the degree of common sense in a computer program should be astonishing.

Edmund C. Berkeley

Edmund C. Berkeley
Editor

Note: An editorial with the title "Can a Computer Apply Common Sense?" was published on page 6 of the October 1971 issue of *Computers and Automation*, the predecessor of *Computers and People*.

Forum — *Continued from page 2*

Public Accountants, ADAPSO has found it too complex to practically understand, not consistent with regard to the varying ways files are maintained, and subject to possible misunderstandings. ADAPSO is meeting with the AICPA to rewrite the guide.

9. Communications Regulations. Key issues facing the remote processing companies include what part of data communications is subject to regulation (hybrid communications vs. hybrid data processing); how much do you keep common carriers from competing with private companies (such as Western Union's SICOM and AT&T's Dataspeed 40); standardization of hardware/software; and IBM's entry into communications. To meet these challenges, ADAPSO will continue its dialogue with the Federal Communications Commission and the Office of Telecommunications Policy Task Force, as well as sponsor seminars on new technologies.

10. Technological Advances. ADAPSO members, particularly data centers, are meeting in workshops to learn how to apply small business computers and remote processing terminals to data center operations.

11. Legal Aspects. ADAPSO will hold its first legal seminar this fall for both legal counsel and corporate management. The two-day seminar will be devoted to legal aspects affecting the use of computers, software protection, contracts and liability, among other factors.

12. Government vs. IBM. A special ADAPSO committee is monitoring the current trial and will be in a position to comment on any outcome of the trial as it affects the computer services industry.

13. Overtime Rates for Programmers. ADAPSO is addressing the issue of the exempt vs. nonexempt status of programmers in the industry by filing an amicus curiae in the case involving Automatic Data Processing and the United States Department of Labor in an effort to eliminate capricious and arbitrary interpretation of the Fair Labor Standards Act as it applies to computer programmers.

ORWELL WOULD HAVE OBJECTED

From: Neil Rowe
305 Memorial Drive
Cambridge, MA 02139

I think George Orwell would have vehemently objected to the conclusion of your February editorial:

"When one watches some tired hack on the platform mechanically repeating the familiar phrases — bestial atrocities, iron heel, blood-stained tyranny, free peoples of the world, stand shoulder to shoulder — one often has the curious feeling that one is not watching a live human but some kind of dummy. ... A speaker who uses that kind of phraseology has gone some distance towards turning himself into a machine." (from "Politics and the English Language," 1945)

This seems exactly the function of the synonym replacer you describe — to replace vital, living words and phrases with a mechanically selected synonym. Soon the synonym will come to lose almost all meaning, thrown heedlessly into disparate contexts. This seems precisely what Orwell was criticizing.

COMPUTER INDUSTRY ASSOCIATION PETITIONS FCC TO DENY AT&T TARIFF FILING ON DATASPEED 40

From: Becky Barna
Computer Industry Association
1911 Ft. Myer Drive
Rosslyn, VA 22209

The Computer Industry Association (CIA) has filed a petition with the Federal *(please turn to page 19)*

Table

Common Sense Behavior as Contrasted with Other Behavior

(1) Aspect	(2) Behavior that Shows or Uses Common Sense	(3) As Contrasted with Behavior Not Using or Showing Common Sense
1. Knowledge	Draws on ordinary common knowledge	Draws on scientific or technical knowledge
2. Initiative	Does not have already stated rules to work from	Works from rules as stated in a rule book
3. Approach to complex situations	Shows ability to deal with complex situations	Is baffled by complex situations
4. Problem solving	Is able to solve well many ordinary problems much of the time	Is not able to solve well many ordinary problems much of the time
5. Methods for solving problems	Is able to alter and improve modes for solving problems; makes experiments; looks for a way around obstacles	Has a tendency to stick to one mode for solving a problem, usually the first mode tried; does not make experiments; beats head against wall
6. Predictions	Is able to make good predictions in ordinary situations and choose accordingly	Is not able to make good predictions in ordinary situations and so chooses blindly

IBM and the Dwarfs: Peace in Our Time?

A. G. W. Biddle
Computer Industry Association
1911 N. Fort Myer Drive
Rosslyn, VA 22209

"However, knowing that someday justice will be done is kind of like knowing that someday we will die — if you just sit and wait for it to happen, you waste your life."

The largest and probably most complex antitrust case in history has finally come to trial. After a little more than a year, Judge Edelstein has heard the testimony of less than two dozen out of a possible three hundred witnesses for the Government and IBM. The case itself has been rather dull and boring — only the side shows and the diversionary tactics have attracted much attention. The true issues appear to have become lost in the adversary process. The lawyers argue about the computer industry that existed in the fifties and sixties while blithely ignoring the dynamic changes that are taking place in our industry every day. The marriage between computers and communications, the growing area of distributed processing, and the increasing power and capabilities of the minis and micros are but a few of the upheavals that make it clear to many of us that the trial taking place in Foley Square could turn out to have little connection with reality, and, perhaps, even less of a chance of restoring true competition to the computer and data processing industries.

The Court Room Is Only the Prelude

Each day it becomes more evident that our nation's antitrust laws are antiquated and unable to deal with a monopoly situation in a complex and fast-moving industry — that the corporate defendant has more power and resources than those assigned responsibility for antitrust enforcement. Those of us who are watching the case closely realize that much of what is taking place in the court room is only the prelude — that ultimately it will not be resolved on the basis of what the Chairman of the Board of General Electric or RCA perceive to be the use of monopoly power. Rather, the U.S. Government will use IBM's own internal documents to clearly demonstrate that the company has had monopoly power over this industry since the inception of general purpose computers as we know them. Their top management has known that they had this power, and that they have knowingly used it to suppress competition and to restrict the users' freedom of action.

However, knowing that someday justice will be done is kind of like knowing that someday we will die — if you just sit and wait for it to happen, you waste your life. If you get busy and go on about your business, at least the waiting time will have been well spent. I would like to talk about getting on with our business.

The U.S. vs. IBM case is now more than seven years old. Best guesses now indicate that the trial may well drag on for another two years — another year until a decision is made — and a year or more before the Supreme Court makes its decision. It's anybody's guess as to how long after that it will be before the Government's requested relief is decided and subsequently implemented — another five years wouldn't be too far off the mark. That brings us to 1985, at least.

No One's Interests Served

In the meantime, no one's interests are being served, unless perhaps the lawyers'. Dollars that should be going for research and development are being channeled to huge litigation efforts. Management talent, which is scarce enough in any industry, is focused on the management of litigation aimed at recovering some of the losses that have been inflicted on shareholders who invested in the mistaken belief that this was a wide open industry with lots of opportunities for growth and profit.

The experts, in forecasting growth in sales and earnings, are stymied by the many uncertainties that must now be considered in the equations — how much do you allow for treble damage suits? What would be the long run implications of a major restructuring of this industry? Will the EEC move against IBM because of its dominance in Europe? Will the now exciting micro, mini, and terminal companies grow and prosper, or are their days numbered as soon as IBM lawyers say it's safe to respond in full to these upstarts? These are all questions hanging over our heads. Needless to say, in this environment forward planning has become very difficult, not just for our member companies, but for IBM, and the remaining dwarfs as well.

This feeling of uncertainty has begun to permeate the user community also. IBM has been facing a growing credibility problem among users and as a consequence finds that it cannot manage the insertion of new technology as effectively as it has in the past. As shown in the Telex papers, IBM's move to the next generation was predicated on user acceptance of virtual operating systems as a prelude to the move to multiple processing and the growth of large communication-oriented networks drawing on extremely large data bases in a real-time environment. The only problem is that less than one-third of the expected number of users made the shift to virtual systems. As a result, IBM had to drop its future system program and go back to the beginning and start all over again. It would now appear that we will not see the next truly new generation out of IBM for another four or five years.

On the Threshold of a Giant Step Forward

Certainly this is not to the benefit of the user community, IBM's shareholders or, for that matter, the industry as a whole. You see, our industry is once again on the threshold of a giant step forward that could serve to maintain our position of world leadership in this vital industry. We are experiencing a revolution in the technologies available to us; extremely large scale integrated circuits are a production reality, rather than a laboratory curiosity; communications costs are dropping, while the availability of service is improving; data base management systems are becoming very useful and sophisticated languages in their own right; and the user of data processing equipment is becoming more sophisticated and results-oriented. Each of these factors by itself could lead to a continuation of the growth of our industry; taken together, they offer the opportunity for truly explosive growth — while at the same time offering the user rapidly declining costs per function.

But as an industry, we are at the moment unable to reach out and take this next giant step. Clearly IBM had anticipated the opportunities that I have described. Their planned FS and Q, their attempted move into satellite communications, their increased emphasis on systems network architecture, encryption, and remote processing all play a part in their overall strategy, and in the direction our industry is going.

One of the fundamentals of the data processing industry throughout the 1960s was the user's willingness to resystematize — to turn his company and his procedures completely upside down and inside out in order to move from the 1401 generation to the 360 generation with the increase in computing power that that represented — almost regardless of cost. The move from the 360s to the 370s wasn't that traumatic, for many of the basic functions continued much the same. Yet, many users have even refused this move. Today, however, if the user is unwilling to accept basic changes in the ways he uses the computer to run his business, it will be virtually impossible to move ahead with and capitalize upon the new technology that is available to our industry today — the giant step forward.

Gross Deterioration of IBM's Credibility

Our forward thrust, however, has been stalled. In IBM's case, the user has shown greater reluctance to buy merely on the basis of bigger and better or to accede to planned obsolescence geared to IBM revenue and profit plans.

And it has not been just the users who have been giving IBM management some sleepless nights. The ever growing antibigness sentiment in Washington has to give them cause for concern. Management time and attention is required by all of the on-going litigation. Various governmental agencies have focused greater attention on IBM and its future strategies, in part because there is so much antitrust smoke they feel there must indeed be a fire, and in part because IBM is beginning to move into markets and technologies where their presence has not before been felt.

The net effect of all of this is that there has been a gross deterioration in IBM's credibility over the past three or four years. Growing numbers of influential people are becoming alarmed by some of IBM's actions and are suspicious of their motives and moves. Even IBM's outside directors must consider the personal liability they face if some of the charges and allegations made against IBM management prove true. I believe that this has been recognized by IBM management and identified as one of their more crucial problems.

"True Competition on the Merits"

Therefore, it appears that it would be in the best interests of the user, the industry, and indeed IBM to see if there isn't a way that we might all come out from under the cloud of litigation and mistrust, and get on with the job of building an industry that is second to none worldwide.

From its inception, the Computer Industry Association has stood for one thing and one thing only — the restoration of free and open competition within the computer and data processing industry. We have always felt that the user and the industry would benefit from true competition on the merits. Most within our industry feel the same. The key, however, lies in the words "true competition on the merits." The government is seeking to bring this about by dividing IBM into pieces small enough to insure a dissipation of their enormous market power and control over the industry. We believe that the government's objective is laudable, and their intentions noble. We are not convinced, however, that litigation drawn out over three decades will accomplish it any more effectively than might be accomplished through a reasoned examination of the problems imposed upon this industry as a consequence of IBM's dominance and power. If, through a negotiated settlement, these problems could be resolved, I would have to support such a step — as would, I believe, the vast majority of our member companies. They too, like IBM, would like to stop contemplating death and get on about their business.

The immediate question then is how to address any kind of settlement, given the restrictions that it has to be acceptable to IBM management, acceptable to the user community, reasonable to the courts and the public, and acceptable to IBM's competitors as a meaningful step toward the establishment of a truly competitive environment.

Understanding Our Choices

Before proceeding, let's agree on our basic assumptions. First, IBM does in fact dominate the computer industry. The company has the requisite market power to control prices and prevent entry, factors which serve to channel or constrain growth. If the U.S. case and the private actions run their courses, it is a distinct possibility, if not a probability, that IBM will be split into a number of separate and distinct entities in order to dissipate this market power. In the unlikely event that IBM comes out of the various lawsuits relatively unscathed, it will only be a matter of time before IBM becomes subject to complete and total government regulation — a result that would have a chilling effect on our industry, the users of our products and services, and our nation.

From this understanding of the choices facing us, it becomes easier to formulate what must be done to develop a solution that is superior to these much less acceptable alternatives. Basically there are six areas in which I believe compromise might be reached.

1. Full Disclosure of Functional Interfaces and Protocols

Given that IBM has inordinate market power, it then follows that the company also possesses the power to set defacto standards relative to the architecture and use of computers and their subsystems. This has been shown to be the case throughout the computer's evolution, from the 80 column card through synchronous data link communications and virtual systems. This control over the architecture of the system, its media, and its interfaces may have been appropriate at the stage in development when "the system" consisted of four or five interconnected boxes in a glass enclosed, air-conditioned "IBM room." It is no longer acceptable when the user, faced with a tremendous investment in software, systems and procedures, and training, finds that the lack of functional interface specifications limits his choices among alternatives and may, in the future, force him to replace entire networks at the behest of the dominant supplier.

Just as Eastman Kodak recognized that its domination of the film market was threatened by the antitrust liability associated with its control over media (film) standards, IBM must realize that it is better to disclose any new rules of the game to its competitors, thus allowing them a chance to offer compatible products and services, than to lose the ability to control its own corporate destiny through a massive divestiture program aimed at the same objective.

I am not suggesting that IBM provide competitors with proprietary information as to the design of a device. Rather, they must provide all information necessary to allow others to develop and produce a device or product that will talk to, interconnect with, or otherwise be a functional part of the user's overall system. They should provide this overall functional interface information to the industry and to users at the same time that their systems architects provide it to the hardware and software implementation people within their own divisions and plants. Thus, if others have a better way of accomplishing the function, they are freed to do so, knowing that they can take their product to the marketplace and be judged on the merits ... not on the basis of compatibility with the new, but as yet undisclosed, IBM defacto standard.

Full disclosure of functional hardware and software interfaces, including protocols, would free our industry and bring about a tremendous resurgence of innovation — innovation that would benefit the user, the industry and even IBM.

2. Recycling the User's and Shareholder's Capital

As I am sure the financial world is aware, one of the major dilemmas facing IBM management over the past decade has been the utilization of their growing cash surplus. With a 65 percent to 70 percent share of the general purpose, data processing equipment market, it simply wasn't feasible to put more resources and emphasis on their traditional markets without accelerating their antitrust problems. The MC and MRC minutes reflect numerous attempts to identify growth and diversification opportunities that would achieve a return on investment comparable to that of the data processing business. They couldn't even pay the surplus out in dividends because of our nation's backward-looking tax laws and capital formation policies — so the monopoly profits just keep accumulating. They are now in excess of $4.5 billion, and we find that IBM is in the cash management business about as fully as it is in the computer business.

Given that to be the case, why not recycle that money back into the computer business? In a sense, it represents the users' money, since it may be viewed as the difference between the prices that IBM has historically been able to charge and those which would have prevailed in a more competitive marketplace.

Computer Industry Acceptance Corporation

We are suggesting that one condition of settlement of the current litigation might be the establishment of a Computer Industry Acceptance Corporation, not unlike GMAC or similar industry finance companies. This would provide a financing alternative, a discount window if you will, which would accept standard contracts executed between IBM and its customers, and between the non IBM portion of the industry and their customers. If IBM were to assign $2 billion of its present surplus to the Acceptance Corp., the company would be able to finance up to $8 billion in user lease contracts using normal leverage. As I see it, the proposed lease finance company would accept only standard "no risk" contracts yielding a market rate of interest. IBM could avail itself of the window if it wished on the same terms and conditions as its competitors, but only up to a maximum of 25 percent of the portfolio. IBM shareholders shouldn't object, since they bought into the computer business in the first place — not the banking business, the CD business, or the reinsurance business.

Since the contracts themselves would be based solely on the user's credit worthiness, the only risk to the Acceptance Corp. would be the long term viability of the manufacturer or provider of services. This would largely be assured by the proposals I am now setting forth. Obviously, restrictions would also have to be levied to prevent the use of the Acceptance Corp. scheme as a tool for unfair competitive practices such as discrimination against consumers who buy other manufacturer's equipment, tie selling, and economic coercion. I personally believe that these problems are solvable.

3. Total Unbundling of All Products and Services

As an element of any realistic settlement, IBM must agree to completely unbundle all product and service offerings, i.e., to price and offer each hardware, firmware, software, and service function separately. Provisions must also be made to insure that cross-subsidization of products and services does not take place. One of the major retardants to the healthy growth of our industry stems from IBM vertical integration — from overall system architecture through components, assembly, and manufacturing of almost every conceivable data processing device, and including marketing, maintenance, software services, and soon, perhaps, communications.

We believe that vertical markets can be created within IBM short of a massive breakup of the corporation and its integrated activities. To achieve this, IBM would have to offer its components and standard subassemblies to all comers at prices that realistically reflect costs and volumes. They would have to separately price all functional components of the system, including, but not limited to, a separation of maintenance from lease prices, operating systems, system software, diagnostics, application programs, customer engineering and services, user education and training, as well as the prices charged for the various functional devices that make up the system itself.

Disclosure of interfaces, as noted in my first suggested settlement criteria, coupled with true unbundling would give the user of the future complete freedom to assemble a data processing system that is both unique and optimized to his specific needs. For those who truly believe that IBM does indeed have the best of everything for all people, he would be free to continue as an all IBM shop. For the more sophisticated user that sees the computer as a management tool, not as an end in itself, new opportunities would unfold that would increase performance and lower costs without jeopardizing the integrity of the data processing function within the user organization. I think that this is a worthy end in itself.

4. Elimination of Questionable Business Practices

There is presently much confusion both within our industry and without as to what constitutes legal vérsus illegal practices for the dominant firm in an industry and how these relate to IBM policy. Without clarification of the rules, and a codification of what is permissible and what is not, it is likely that our industry will be engulfed in litigation for many decades to come. This would indeed be counterproductive and unfortunate. The adoption of a workable and enforceable code of ethical conduct by IBM and the rest of the industry would be a sound step in the right direction. The announcement of nonexistent products should be prohibited and punishable by a substantial fine, as should coercion, reciprocity, refusal to deal, threatened withdrawal of services or support without valid cause, and false and misleading representations as to the viability of competitors or the integrity of competitive products. Although these are clearly contrary to IBM corporate policy today, perhaps steps must be taken to insure that the salesman in the field is not motivated to violate these mandates by certain knowlege that the loss of an established IBM account will cost him his job.

5. Barred from Participation in the Data Services Business for an Additional Ten Years

In order to allow the development of meaningful alternatives for the user of data processing products, IBM should agree not to re-enter the data services business, including the offering of batch processing services, time-sharing services and/or network operation services for an additional ten years from the date of any settlement. As has been shown in the past, the data services business provides too many opportunities and too great an incentive for abuse by an integrated supplier as large as IBM. The terms of the CDC settlement foreclosed that market to IBM, but that stipulation is scheduled to expire in two years. The intended result of that settlement, which has been partially achieved, was to open up the data services market to vigorous competition by many suppliers. Today, competition in data services has proved to be a great benefit to the computer user, both in terms of the wide range of service offerings available and of reduced costs. Until competition is restored to the rest of the industry, I propose that this one submarket which has progressed toward a competitive stance be foreclosed to IBM or any of its subdivisions as originally provided by the terms of the CDC settlement.

6. Barred from Participation in the Communications Business

Due to the growing interdependence of computers and communications, any company which is allowed to function as both a common carrier (which is subject to government regulation) and an EDP manufacturer (which is not subject to regulation) poses special dangers to competition. Thus far the FCC has required that in such instances, corporations set up and maintain separate entities as a practical step to reduce potential conflict of interest and to prevent abusive marketing practices. IBM has recently attempted entry into the domsat industry. However, because of the company's sheer size and resources, many observers still see such entry by IBM as being fraught with anticompetitive dangers for the data processing industry, as well as the domestic satellite communications industry.

The potential for abuse lies in the fact that any parent corporation, and especially one as large as IBM, will doubtless sense the reality of being able to "control" its separate corporate entities. An unfortunate result is that the data processing industry must bear the risk of a possible integration of data processing and communications services which might take the form of bundled pricing, cross-subsidization, and technical dominance of the domsat market. IBM would actually have the ability to offer end-to-end data processing and communications services to the detriment of the independent carriers and suppliers in both industries.

Any assurances that the separate entities would be prohibited from promoting or selling each other's services ring hollow. Users would not be blinded to the fact that though there are separate entities, IBM does indeed offer both data processing and communications services and, hence, users would be inclined to negotiate the combined services accordingly.

This proposal for settlement is therefore conditioned on the requirement that IBM be precluded from entering the communications field as a common carrier. This should in no way restrict IBM's involvement in the manufacture and servicing of communications equipment on a competitive basis in the data processing market.

Although I have not broached the subject of enforcement or the monitoring of compliance with respect to a settlement, it is obvious from our experience with the 1956 Consent Decree that an alternative and more effective supervisory body must be provided. The body must be one that can readily adapt itself to even the most subtle changes in technology and marketing practices.

Conclusion

The proposal expressed here is but a departure point, but after weighing the alternatives I think it can be agreed that it's a meritorious starting point. The Government's proposal, for example, is based primarily on the premise that a fragmentation of capital would be a sufficient means of restoring competition. A major shortcoming of that proposal over the one I have outlined is that relief could be as much as five or ten years away, and the market

(please turn to page 23)

Toward a Model of Brain Function

National Science Foundation
Washington, DC 20550

" 'Computer simulation of the ways in which patterns change during transmission from one neural layer to the next promises to be a powerful tool for prescreening and refining concepts of neural network and circuit functioning for use in biological experimentation.' "

In 1955, a highly respected scientist predicted that a computer would become world chess champion in ten years. The prediction is a measure of the exuberance even among some members of the scientific and engineering communities, following the appearance of the first electronic computer in the late 1940s.

In the ensuing years, though their work was far from representative of the mainstream of either the computer or the neurophysiological sciences, there were researchers who confidently wrote programs intended to turn computers into thinking machines. And "thinking machines" and "electronic brains" became common euphemisms for computers. In the absence of a better biological model, it was often proposed in those days that the human brain worked like a complex switching system, one that could be duplicated by a large computer; the mysteries of human intellect would be solved, it was suggested, once a computer was programmed to perform intelligent acts, and the circuits and switches that made it work could be traced.

"If I were doing what a computer does," went an often-quoted saw of that time, "I would think I was thinking."

Nevertheless, 20 years later, though both the computer and brain sciences have made impressive strides, chess crowns still fit human heads; robots that combine human eye-hand coordination and human judgment have proven predictably elusive. And those researchers who once thought more powerful computers and more sophisticated programs alone might offer solutions to the simulation of intelligence now realize that if understanding, no less simulation, of brain function is ever to become reality, there are many fundamental theoretical questions in the computer, mathematical, psychological, and neurophysiological sciences that still must be resolved.

Predictions vs. Performance

That realization achieved a focus in the early 1970s when, in response to a large number of applications for support in the field of artificial intelligence, Britain's Science Research Council asked a mathematician, Sir James Lighthill, a Fellow of the Royal Society, to prepare an independent nonspecialist's report on the subject. The council wanted an overview by someone outside the field who possessed substantial experience in multidisciplinary research involving aspects of mathematics, engineering and biology.

Though Lighthill did not address himself, of course, to the main lines of research in either computer or brain sciences, his "personal view" of 25 years' work with artificial intelligence, including computer simulation of brain function, led him to the conclusion that the initial exuberance might have been naive.

"When able and respected scientists write . . . that possibilities in the 1980s include an all-purpose intelligence on a human-scale knowledge base; that awe-inspiring possibilities suggest themselves based on machine intelligence exceeding human intelligence by the year 2000 . . .," the British scientist noted in his 1972 report to the SRC, "Artificial Intelligence: A General Survey," "one may wish to compare the predictions of the past against performance. . . ." The performance, he asserted, has been characterized by "lamentable failure" of "inflated predictions." In work on the central nervous system encompassing modeling and simulation of the brain, he observed, "workers who entered the field around ten years ago confess that they felt a degree of 'naive' optimism which they now recognize as having been misplaced."

"The Brain Just Doesn't Work Like a Computer"

The record has not all been negative. Computer-driven assemblages of equipment have been devised to pick up, recognize, and assemble the pieces of a water pump, improve their own checker-playing ability, and announce: "Good morning. I am a computer. I can read stories and speak them aloud. . . ." These are not toys. Nor is the understanding their development represents trivial. Advanced automation systems, the computer sciences broadly, and brain research itself have all been advanced by these efforts. So has understanding of the limitations of the approach.

"The brain just doesn't work like a computer," states Hirsch Cohen, chairman of IBM's Research Review Board and, like Lighthill, an applied mathematician. "The more sophisticated we became, the more we realized how difficult the problem is."

Reprinted from *Mosaic*, vol. 7, no. 2 (March-April 1976).

Sir John Eccles, whose study of electrochemical transmissions in the brain won him a Nobel Prize in 1963, agrees. ". . . no insight into the mode of working of the nervous system can be gained if one starts from the premise that it works like a metal computer," he has declared. "This analogy with the computer rests on a superficial similarity with the process of input and output and may be dangerously misleading."

The Combinatorial Explosion

Though computer systems are now capable of handling several operations simultaneously, for example, they are still far more limited than the brain in this regard; attempts to simulate the working of a human brain run into what is called the "combinatorial explosion." One impulse traveling to the end of a neuron triggers signals in, say, ten connecting cells. Each of these triggers ten more interactions, and the combinations increase from 100 to 1,000 to 10,000. "The brain contains some ten billion nerve cells each with as many as 10,000 connections to other neurons," says John Holland, professor of computer and communication sciences at the University of Michigan. "Even if we could understand what the cells are doing, we don't have computers to handle that kind of input." Lighthill says that a "general cause for the disappointments that have been experienced is failure to recognize the implications of the combinatorial explosion."

Modeling a Model

Robot modeling, rather than robot building, is one way to approach the barriers to progress. Terry Winograd, assistant professor of computer sciences and linguistics at Stanford University, in one of the more successful efforts to date, has programmed into a computer's "imagination" a table covered with blocks of various shapes and colors, and an imaginary artificial arm to move them around. The program accepts and carries out commands in natural English to perform well-defined, simulated, block-stacking operations. It also queries impossible and ambiguous commands. In constructing the program, two high-level programming languages were used: one to program events in the abstract tabletop world and one to perform language analysis. While the computer can easily store as many words as are included in the average adult's vocabulary, so far it has only been "taught" to handle simple sentences. It can understand a sentence like "remove the red block," and it can alter a schematic television screen picture of several blocks on a table by removing the red block.

Winograd explains, however, that the significance of developing such a program is not the imitation of human performance but rather the understanding that the exercise provides of how the brain works. The program to create understanding in the computer of the command "remove the red block," for instance, involves multiprocessing — different simultaneous operations for grouping together certain phrases for analysis (i.e., "the red block"), establishing the meaning of "remove," and so on. But it is where the computer stumbles that reveals more precisely where differences between machine and human capabilities lie. Told, for example, that "Tommy had just been given a new set of blocks," and that "He was opening the box when he saw Jimmy coming in," the computer has great difficulty in answering the simple question: "What was in the box."

Coping with Ambiguities

To Winograd this illustrates the role that context or knowledge of the world around us plays in understanding even just simple sentence combinations. So far the computer cannot cope with the ambiguities that make up so much of our daily speech, gaps the brain bridges from its store of common experience.

"There is a certain amount of criticism of AI [Artificial Intelligence] work on the basis that it doesn't do what a person really does," Winograd explains. This misses the point, he feels, because teaching language to a computer must be done in pieces, and the assemblage of pieces does not behave as if it were the whole system.

"Still, people who design computer systems are guided a lot by their intuitions about human intelligence, whether they admit it or not," he adds. "What we hope is that a lot of the underlying structure is the same, and as we build more and more of the complete system then it will be able to behave more and more like people. At that point we will be able to make very sharp comparisons."

Lighthill cautions against overvaluing the goal of creating machines that do intelligent things. These capabilities, he points out, are only a small part of the cerebral processes that make humans unique. "It is a truism," he writes, "that human beings who are very strong intellectually but weak in emotional drives and emotional relationships are singularly ineffective in the world at large. Valuable results flow from the integration of intellectual ability with the capacity to feel and relate to other people; until this integration happens, problem-solving is no good because there is no way of seeing which are the right problems."

Closing the Gaps

Nevertheless, there is sufficient reason to be optimistic about continued improvement in the ability of computers to perform intelligent operations — if not to replicate human intelligence. Progress in the computer, mathematical, and neurophysiological sciences are all involved. "Around 1955," Holland observes, "a favorite statement was that it would take a computer as big as the Empire State Building to simulate the human brain, and Niagara Falls would be needed to cool it. Today, this probably can be reduced by a factor of 100. A pocket calculator can now do operations that five years ago required a $500 machine the size of a small suitcase. It's impossible to guess how far technology will advance by the end of the century."

"It is true that too many people claimed much more than they produced, and it is appropriate to fault them," adds Walter R. Reitman, professor of psychology and computer science at the University of Michigan. "Still a great deal has been accomplished." As an example, Reitman mentions a program for playing checkers designed by Arthur Samuel at Stanford University. It was probably the first one capable of learning by experience. With it, a computer beat both Samuel himself and the checker champion of Connecticut. It plays at tournament level. Reitman is completing a program which he expects to play proficiently the Oriental chess-level game of Go.

"We made quite remarkable progress in the past 25 years," notes Jack D. Cowan, professor of biophysics and theoretical biology at the University of Chicago. "Physics has taken 300 years to get where we are today. The brain is more complex, but we have many more scientists working on it than we did in physics. In five or six generations we might reach the sophistication of present-day theoretical physics, if technology keeps developing at the same pace."

A Wealth of Data Now Available

One foundation for optimism is the extent to which it is now being realized that success in understanding the brain by modeling is related to how closely the work is tied to the fundamental disciplines of psychology and neurobiology. This was not always the case.

Most brain researchers agree that in the 1950s a tremendous distance existed between data and models. Sometimes there was no relation at all. A person in the field would write a computer program directly from a notion of how a process such as learning or memory might operate. Today, a wealth of data is available from experiments in neuroanatomy, physiology, and psychology, and models and modelers are more closely linked with it.

"Conversely," as Lighthill notes, "psychology and neurobiology will benefit to an extent closely related to how far computer-based researchers behave as if they felt integrated within one or more of these fields. Psychologists and neurobiologists especially gain increased appreciation of the value of computers for theorizing about complex systems and for making sense of complex masses of data. . . . Some of the best work is by experimental psychologists with a good knowledge of a complex mass of data, who have acquired the skills needed to build computer models for interpreting it. . . ."

Modelers, many of whom work with National Science Foundation support, fall into groups, from those who work with general concepts such as learning and intelligence to those who try to simulate the working of a single neuron.

Such is the nature of current neurobiological research, however, that the more ambitious the modeler — the more general a brain model he attempts — the smaller the volume of actual, reliable data is available on which he can build.

Down to Basics

On the most abstract level are members of the artificial intelligence school who attempt to get machines to do intelligent things without using direct psychological or neurobiological data. They attempt to represent intelligence or problem-solving ability as a step-by-step procedure that can be programmed into a computer, with the expectation that this approach will lead to new insights and strategies that can be used by the experimentalists who work with actual data.

On levels intermediate between modeling of behavior and of the action of a single neuron, however, a large number of researchers are trying to tie together elements of brain structure and function. Cowan, for example, worked on methods of building reliable computers with unreliable components, and applying the equations of statistical mechanics to neural networks, before coming to the University of Chicago in 1967. He puts this combined approach to work in the determination of a one-to-one correspondence between perception and changes in the patterns of nerve-cell firing. To this end he and his colleague, H. R. Wilson, test human perception with series of striped patterns that gradually appear out of a uniform background. A subject adjusts the contrast until a pattern disappears, appears clear, or is matched with another pattern. This behavior is then compared with anatomical data from the visual cortex of cats and monkeys.

The result is the formulation of mathematical equations that, Cowan believes, describe what goes on in a specific area of the brain. "They describe changes in the overall pattern of activity of large networks of nerve cells," he says, "and make predictions about behavior that can be tested experimentally." This could not be accomplished without a close link to biological research.

Mathematical modeling of the type Cowan does differs from computer modeling in its approaches. "It allows you to take data on a limited number of cells," says Cowan, "and make inferences about the activity of large-scale neural networks. It allows you to deal with the unobservable." John Holland, a communications scientist by training, agrees: "You can find out how dozens or even a hundred neurons interact, but it's a long jump from there to ten thousand, ten million, or ten billion. The only way I know to make that jump is through mathematics." Nonlinearities can be exploited, with the aid of mathematics, Holland says, to dampen the effects of the combinatorial explosion. Heuristics sometimes achieve the same end.

Programming Hunches

According to Lighthill, heuristics means "the program stores and utilizes a large amount of knowledge derived from human experience in solving the type problem concerned." John McCarthy, director of the Artificial Intelligence Laboratory at Stanford University, defines it simply as "shortcuts for avoiding having to search through all the possibilities." Humans use heuristics when they have a hunch,or when experience allows them to disregard a large number of possibilities without testing each one. Both humans and machines use heuristics, when they play chess, for example. "Picture all the possible moves in a chess game as levels of branches on a tree," McCarthy explains. "As each player moves to a new position, he reaches another level of possibilities, or branches, for the next move. This continues through levels or branches until the final move of the game. A programmer can avoid dealing with these endless branches of possibilities by making the program look at only a small part of the move tree . . . Instead of looking all the way to the end of the game, it might only look three or four moves ahead. For example, to protect a king or queen, the computer will evaluate the limited possibilities for a move that will accomplish this goal and allow for future moves."

A human player can look farther ahead because he does not try to deal with all possible moves. From analogy or experience, the human, without methodical, step-by-step analysis, eliminates moves that will not accomplish a goal. Also, human players have hunches about winning strategies, and do not deal with all the possible moves outside a strategy he or she has adopted.

The effort to build "hunches" into computer programs, that is, shortcuts which reduce complex problems to more manageable ones by eliminating entire sets of possibilities, faces a major stumbling block, however: Neuroscientists do not know yet how the brain accomplishes it. Nor is it known whether such heuristics, or intuition, can be reduced to a rigorous step-by-step procedure. To find out, researchers such as Edward Feigenbaum at Stanford work with people who are experts at tasks they are trying to get a computer to do. Scientists such as Nobelist Joshua Lederberg have talked through what they do while performing a specific task. From this Feigenbaum attempts to determine what the shortcuts are and how the scientist figures them out. This strategy has resulted in a program that is fairly successful in working out the molecular structures of chemicals. The program "manifests many aspects of human problem-solving techniques," says Feigenbaum. "It works faster than human intelligence in solving problems from an appropriately limited domain."

The Layered Brain

Heuristics also becomes important when neuroscientists try to go from the results of what happens at a single neuron to two- and three-dimensional patterns of neural activity. Researchers now look at the brain as a series of sheets of neurons multiply connected to each other. "One of the most crucial features of neural organization," says the October 1974 Neurosciences Research Program Bulletin, "is an apparently hierarchical superposition of layers in both the structural and functional areas. The hierarchical organization of neural centers is so obvious that it is almost trivial: the spinal cord, lower brainstem, upper brainstem, and cortex. Similarly, in the sensory pathways, there are the receptor level, several levels for local feature analysis, subcortical nuclear level, and several cortical layers."

A rather strict topic or place relationship exists between any point in one level and a particular point in the next level, both in an upward or downward direction. In other words, a map or positional code passes from layer to layer. There is a one-to-one relationship, for example, between points on the body's sensory surfaces and points on the somatic sensory cortex. "If you shine a pattern of light on the retina," Cowan explains, "an equivalent pattern reaches the visual cortex. It is stretched and distorted in some ways but it is not scrambled — it is an ordered representation."

Knowledge that such positional maps exist is programmed into a computer; it enables the computer to expand its interpretation of localized events. It supplies a hunch or shortcut that saves the computer from having to explore all the possibilities that could result from that event. Just as a human may know the approximate solution to a problem by analogy or experience, so the computer program incorporates the fact that the local interaction represents a pattern of large-scale activity that is present in certain brain layers, and that particular neurons in that pattern have a fixed relationship to other neurons. Layer by layer processing of the maps or nerve-firing patterns can be analyzed by computer simulation.

Multiple Representation

"Computer simulation of the ways in which patterns change during transmission from one neural layer to the next," says the NRP Bulletin, "promises to be a powerful tool for prescreening and refining concepts of neural network and circuit functioning for use in biological experimentation."

But the straightforward representation of the body periphery in the brain's sensory and motor centers occurs on a gross scale. Examining finer details, researchers find that the same spot of the periphery is represented centrally in many different ways and in different contexts, often over different routes and relay mechanisms within the same gross map. As an example, a cat's fore and hind limbs are represented in its anterior lobe and twice in the posterior areas of its cerebellum. Scientists are working on computer simulation of various cerebellum models that take into consideration this multiple representation. These attempt to explain how information is received from and sent to the limbs via spinal nerves and the various parts of the cerebellum, and how command and control functions are transmitted between the cerebral cortex and cerebellum.

One Neuron at a Time

Still further down the scale, at the level of a single neuron, British researchers Alan L. Hodgkin and Andrew F. Huxley in 1952 developed equations for describing how impulses propagate along a nerve cell axon. Hodgkin and Huxley used axons of giant squid and shared a Nobel Prize for their work in 1963. Their complex equations have since been simplified and a number of workers, often doing research in tandem with biologists, are developing models of signal transmission along nerves and across the synapses that both separate and link connecting nerves.

IBM's Cohen, who has been at work since 1962 as a "personal scientific venture" on simulation of a single nerve cell, points out that nerve signal propagation is similar to transmission of an electric impulse along a cable. The modelers' equations predict characteristics of the signal such as its wave form, speed of travel, attenuation, etc., but they do not give any indication of what information it carries or how. The synapses may hold a key, but details of what occurs at the synapse remain a mystery to the mathematicians. Does the synapse act as a filter? Does it block or pass certain kinds of signals? Does it serve as a feedback device, amplifying small changes in the signal, preventing noise or controlling buildup of a signal? Cohen notes that a lot of good work has been done in the chemistry and statistics of synapse action. "This is ripe to be put into equations for modeling," he says, "but no one has done this successfully."

Simpler Systems

Modelers still struggle with much simpler problems, such as what happens when a single nerve fiber bifurcates into a small and large branch. From a single cell, small circuits form the next step upward. At this level neuroscientists work on problems such as trying to understand how certain moths develop the ability to detect the sonic echolocation signals that bats use to home in on them, a system that seems to involve only two neurons. Evidently in the course of evolution and natural selection the circuit became modified in such a way that it triggered evasive action by the moth. Researchers are trying to understand what these changes are and what kind of information is sent to the moth's motor system.

Others study what goes on in an intact insect brain. Once it is determined that a fly or ant is behaving naturally, Holland explains, "then microelectrodes measure the pattern of neural activity during this behavior. This type of research provides clues to handling larger neural organizations."

(please turn to page 23)

Publishing and Technological Developments: An Interim Report – Part 2

Andrew H. Neilly, Jr.
John Wiley and Sons
605 Third Ave.
New York, NY 10016

"Technical publishers believe, after twenty years of nervousness, that they and their books have learned to coexist with the computer."

The Rise of English as the International Language

The impact of Russia bursting upon the world as a major technological power in the almost forgotten Sputnik era threatened our monopoly as the most scientifically sophisticated nation, and gave education and scientific training a new sense of urgency.

But to me, the chief development in the 1950s and 1960s was the ascendancy of English as the dominant language of international trade, science, and communication. Anywhere in the world today English is either a second language or the language of the professional, almost without regard to discipline. Neither Russian nor Chinese seems to threaten it. In India, where street battles are fought over one or another of the eighteen official dialects, no person can seriously consider himself educated without a command of English; in Japan, one finds only a limited need for translation from the English at the college level. It's interesting that the largest German publishing house, Julius Springer, is issuing more and more of its original titles in English.

The Computer

Technical publishers believe, after twenty years of nervousness, that they and their books have learned to coexist with the computer. In this hope it is possible that we emulate the lady who defended the King James version of the Bible: "If it was good enough for the Apostles, it's good enough for me." McLuhan was no help to our self-image, and one recalls George S. Kaufman's remark, "Forgotten — but not gone."

Wiley was one of the first to publish in the computer sciences. With M.I.T. Press we published Norbert Wiener's Cybernetics; Berkeley's Giant Brains was seminal (as publishers like to put it). We produced a series from General Electric on transistors, the device that replaced the vacuum tube and set the course for miniaturization, printed circuits, and other devices essential to the incredible advance in computer technology.

But, we wondered, have we watered the seeds of our own destruction? I think not. We are persuaded that a publisher, through his editors, acts as mediator between an infinite amount of knowledge and the limited need of the reader. He reduces uncritical quantities of information into selective and evaluated quality. Like a good lens system he acts to filter, condense, and focus without distortion.

Elegance of Presentation

There are some books that could well have been better produced and distributed by a computer. It can play the role of author, printer, and distributor in some cases, and do it better than the publisher's traditional methods, but a computer is an author only in the most limited sense. It can only spill out what has been put into it.

One of the chief characteristics of a lasting book is its elegance of presentation, a quality not confined to the display of higher reasoning in advanced mathematical treatises. It is true of such varied and specialized titles as Kenneth Andrews's The Planning of Corporate Strategy; Samuelson's Economics (an all-time best seller); Cotton and Wilkinson's Advanced Inorganic Chemistry; or Jesse Shera on Librarianship.

Meanwhile, we take on the coloration of the times. Our shipping, billing and other activities are computer-based. In our office we use a time-shared computer to calculate the required return on investment on every book. It tells us alternatives we can deal with in author's royalties, printing quantities, and prices under varying conditions of size and cost. (Unfortunately, it cannot give us the vital ingredient — how many copies will it sell?)

The New Technologies

The "information industry," as it is broadly and variously known, has become a permanent part of the lexicon, involving creators and disseminators in all media — electronic, film, hard copy, microform, computer-based, and satellite-transmitted. It includes government, nonprofit, private-for-profit companies and consortia — all seeking ways to collect and store data without which, presumably, our technological society cannot exist, and which grows exponentially. Its advocates are fond of stating, "Information growth in the next 25 years will exceed that of all information generated in the last 2000." The National Science Foundation estimates the growth of scientific information at 8 to 10 percent a year;

Based on an address given to the Friends of the Emory University Library, in Atlanta, Georgia on November 13, 1974, and published by John Wiley & Sons, Inc., Copyright © 1975. Part 1 of this article was published in *Computers and People*, April 1976.

the Organization for Economic Cooperation and Development expects the literature to grow at 4 to 7 times this present rate, exceeding the ability of indexing and abstracting services to catalog it.

Data bases abound, detailing everything from the total input of NASA from its inception to the last moon shot; project ERIC is a catalog of educational research projects. The National Technical Information Service stores government technical reports. The complete genealogy of the members of the Church of Jesus Christ of Latter Day Saints is stored in a mountainside, poised to provide, on demand, documentation for the "vicarious salvation of the dead."

Iran, which can well afford it, in common with other developing nations that cannot, is intent on building a National Information System designed to accelerate its technological progress. UNESCO projects an international information network connecting most of its member nations with technical data.

Xerography

Book publishers were determined not to be left behind in the new technology. We early began to issue slides and film strips with our books. Language publishers issued records and tapes, later whole language laboratories. Many of us became movie producers of sorts; we talked of and published multimedia educational packages. We embraced the teaching machine and, taking B. F. Skinner at his word, reinforced our belief that the machine, along with programmed instruction, would become standard in every classroom, possibly displacing the teacher and becoming in every home the ideal medium of instruction.

Among the new technologies, and bound to affect publishers and libraries perhaps most of all, is Xerography or photocopying — the ability to reproduce anything in print quickly and cheaply — from a one-page extract to an entire book, printed and bound on demand. No modern library is without its coin machine, which allows the "user" to copy anything of value to his research or term paper. Every school system has a battery of machines copying tests, exercises, articles, and whole chapters of books for tomorrow's classroom. Student-operated enterprises on many college campuses offer the professor quickly produced, though shabby and illegal, texts combining chapters of various books, selected for his individual class, and produced without regard to author, publisher, or copyright.

Copyright

Insofar as authors write books in the hope of both recognition and compensation, and publishers prosper in direct ratio to the number of units sold, it follows that uncontrolled copying threatens the publishing process.

Photocopying also has brought publishers and librarians, normally the closest of allies, into adversary positions, converging, at the moment, on new copyright legislation before Congress. (It has been before Congress for eight years, but there now seems some reason to hope for passage.)

Article 1, Section 8, of our Constitution, reads:

"The Congress shall have power to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings."

Unlike patents, copyright protects on the method of expression, not the basic thought. It is the narrowest kind of monopoly, protecting only the choice of words, not ideas. In effect, it gives the author his right to publish and permits publishers to engage in publishing.

Specialized Journals

The publishers' function is to bring to the public the works of an author. If we cannot do so on an economic basis we will redirect our efforts to other activity. In our company, the most immediate threat is to our professional journals. We publish 22 highly specialized journals. They are restricted in their readership to a small body of scientists and educators. Subscriptions range from 750 to 3000. They are difficult to launch (usually three to five years to break even) and expensive to produce. Seven of the 22 are marginal or worse. Our renewal rate in the United States is level or dropping, not because of obsolescence, but because the number of multiple subscriptions is down and the frequency of copying is increasing, particularly among libraries.

As subscriptions drop, prices go up. As prices increase, fewer libraries can or will subscribe. And the ultimate result will inexorably follow. We simply will stop publishing journals that drop below break-even point or that cannot be made viable. It's hard to see who will benefit from such a dismal course of events. Nor is it persuasive to argue that it would not be such a bad thing to remove the profit-making publisher from the journals scene, since the most affected publishers are the nonprofit societies — the American Chemical Society, the American Institute of Physics, and the like. They are in exactly the same position; the same patterns hold. We have worked with these societies in efforts to bring the Russians into an international copyright convention and to prevent unauthorized distribution through the socialist countries. The Russians last year joined the Universal Copyright Convention, and we finally can report progress in arranging translation and distribution rights in both directions. It is ironic, then, to find ourselves making new common cause against the libraries, our best customers and allies in the United States.

Computer-Based Interlibrary Loan System

In the current controversy over photocopying (Section 108 of the Senate Bill), most areas of disagreement have been eliminated. Specifically, the publishers have agreed to the librarians' concept of "fair use," that is, a copy of a small portion of a book is fair use; a copy of a whole journal article is fair use. Publishers agree that librarians should not be liable for the misuse of photocopying machines on their premises; the only inhibition is that of systematically making copies for library systems and networks, and it is the publishers' position that for this there will have to be payment.

Reasonable agreement on this essential point should not be difficult. The technology is there, the mechanics of computer-based interlibrary loan systems, already on the drawing board, can easily encompass a licensing system. It would operate automatically with minimum cost, based upon reasonable fees. The argument that librarians or "users" would go broke attempting to pay fees is hardly sustainable; we have not reached the stage of discussing fees. Indeed, we have repeatedly brought representatives of the library community to the bargaining table. Twice they have backed away from agreement, but a third effort is now under way in Washington.

The First Amendment

A major concern of the book world over the years involves freedom to read. The 1970s have seen a battering of First Amendment rights in the government's effort to restrain publication by the New York Times and the Washington Post of the Pentagon Papers, and its prior restraint of the Marchetti manuscript, The CIA and the Cult of Intelligence. We have witnessed an FBI search and examination of the bank records of the Universalist Unitarian Church as a result of publication by Beacon Press of the Pentagon Papers.

This episode goes beyond the area of free speech and includes freedom of association and assembly. Any precedent that the government is free to investigate, without notice, the background and political affiliations of an individual or group suggests problems for all educational institutions.

The Freedom to Read Committee of the Association of American Publishers works in this and in the area of censorship. In 1970 the President's Commission on Obscenity and Pornography issued its report finding that exposure to obscenity does not lead to criminal or antisocial behavior and recommending that consenting adults be allowed access to any reading or visual materials they choose. Our AAP Board in 1973 endorsed the report and urged that restrictions on consenting adults be repealed; that only carefully drawn legislation protecting minors and unwilling adults be enacted.

A Major Step Backward

Both Supreme Court decisions in that year constituted a major step bacward. In Miller V. California it found that material no longer had to be "utterly without redeeming social value" to be found obscene but, instead, could be so found if it lacked "serious literary, artistic, political or scientific value." The definition of value excluded, among others, was educational value. Finally, the Court held that material was no longer to be judged by a national standard as previously, but by local standards.

The invitation to local censorship was heard and quickly accepted. School and library censorship has increased dramatically and is likely to continue. As a result we have seen the unhappy situation in which a bookseller could be hustled off to jail without civil examination by a complaining parent on the grounds that the bookseller is responsible for knowing the possibly obscene content of every book on his shelves. One need not project this very far to see its effect upon libraries.

Our objective in Freedom to Read (and in a media coalition that we have initiated) is to push for restoration of state or, preferably, national standards; to monitor state and federal legislation, and to defend where possible the victims of this absurd situation. In this, happily, we have the cooperation and support of the American Library Association and Special Libraries.

The Colleges

It is difficult for us at Wiley to look upon the college market with anything like amused detachment, since about half of our business comes from it. Nevertheless, it is fascinating to note some of its behavioral chacteristics. It is cyclical, fragmented, suffers from a volatility of student and faculty attitudes, and has some tough problems in its immediate future.

Fifteen years ago we were major publishers in the various fields of agriculture; about ten years ago enrollments shrank markedly. Books were often replaced by feed manufacturers' handouts and similar literature. In the past three years, however, this pattern has changed and enrollment in agriculture and forestry is on the rise.

Freshman English, Western Civilization, or whatever the standard introductory course most popular on campus, was threatened by competition from courses in ecology and the environment, designed to save the earth by impressing upon the entering students the risks of pollution and depletion. But in a short time it became obvious that the environment was unlikely to be improved simply by awareness or sensitivity; that certain scientific, mechanical, or engineering techniques were required to even begin to deal with the enormity of the problems. These courses are already disappearing from the curriculum.

Engineering is even harder to chart. Standard courses in electrical, civil, mechanical, and chemical engineering flourished in the post World War II period. Sputnik and the sophisticated military technology of the Cold War period led to a heavy reliance on mathematics, physics, and basic science as the primary educational tools for engineers. Employers, however, found it disconcerting in that they were forced to retrain the engineer in the specifics of his job after he appeared carrying his Master's or Ph.D. Five years ago, enrollments in engineering dropped sharply, reflecting the decline in aerospace industries, and the unemployed fifty-year-old engineer. One could shoot a cannon through the engineering labs on any campus without danger to human life. Now, however, the professional societies have announced a new impending shortage, enrollments are increasing, and the engineer is restored to respectability on the campus. One wonders how long this will continue.

It appears that where two or three are gathered together, there will be a seminar. The specialization and fragmentation of course offerings is difficult to follow. An acquaintance of mine reported that, while waiting for an appointment in a sociology department in one of our major Eastern universities, he studied the various course listings. He was astonished to find a semester course listed as Death, 201. As he contemplated the import of this twelve-week exercise, he turned the page to find its successor, Advanced Death, 202.

Reports on student attitudes have been widely circulated; we have seen a succession of campus moods, ranging from normality, if there be such, through protest, violence, apathy, and now, apparently, to dedication and excessive task orientation. Two-thirds of the freshman class at Dickinson College, for example, have announced their major to be pre-med or pre-law. This year the University of Rochester Medical School had 4700 applications for an entering class of 97, and the vocational and technical schools report heavy application to occupational training courses. At the very least this suggests there is a great need for more enlightened counseling on both the high school and university levels.

How Will Private Colleges Survive?

Projections of college enrollments and college expenses are worrying administrators, faculties, and publishers alike. At present there are approximately 9.8 million students enrolled at colleges and universities in the United States, with about 3.7 million part-timers. The population of four-year colleges has been essentially stable for several years, with increases in two-year junior and community colleges only. Garland Parker, Provost of the University of Cincinnati, whose record on enrollment futures has been consistently better than the Office of Education, predicts a small overall increase up to 1980, with a rather precipitous enrollment drop thereafter, based on simple demographics. The New York State Board of Regents is pondering a probable 23 percent dropoff beginning in 1980, at a time when they are still constructing new dormitories and classrooms for the multicampus state university.

The most serious question raised here is what will happen to the private college's ability to attract students and funding; how will it survive? My own guess is that we will see a wider move to state funding on a per capita student basis, equalizing the cost of education between the private and state-owned universities, similar to legislation passed last year in New York. In the course of this legislation, incidentally, it was discovered that the all-in student cost per year in the private universities was approximately $1700 less than that of the state system. Also, we will see federal direct-to-student support, which must be backed by institutional aid if private colleges are to be helped.

I anticipate that the percentage of high school students going on to college, contrary to recent experience, will increase; that more adults will find themselves on the campus full time, or involved in campus-based programs in continuing education. Private universities will have to enlist more corporate support, a good investment for all concerned, and the number of annuity plans, guaranteeing lifetime income to alumni in return for a bequest, will assume increasing importance. In this context, Robert Sproull, president of the University of Rochester, is reported to have coined the phrase, "Where there's death there's hope."

In any event, supporters of the private college will have to marshall their forces in the years immediately ahead. Economics aside, it is always politically difficult for government to stop something that has been legislated; the pressures to continue public campuses will be intense regardless of need.

Reading Books

I see no evidence that viewing, whether television or computer console, is likely to replace reading in the near future, but it is, clearly, doing nothing to improve it. We are concerned with the decreasing ability of entering college freshmen to read. This ultimately affects the quality of authorship and editing in the future. The college phenomenon is partly explained by open admission policies, particularly in two-year colleges, but SAT scores are dropping in the verbal category all over the country for reasons apparently not yet clear.

Are these the effect of new media, a cultural decline, or poor precollege instruction? I am told that the ability to read for ideas is sharply increased if the habit of reading is encouraged in the home; that television increases the passivity of those not inclined to read in the first place, but feeds the interest of those who are. I would urge that publishers and librarians work together on this problem.

I would also urge that National Library Week be sponsored by publishers and the American Library Association, and that it begin to emphasize the essential nature of books and libraries to the community and to a civilized society rather than "reading is fun." They might well set up a task force on the problem of book distribution, one of the most archaic mechanisms in the trade, with the objective of speeding up services, lowering costs, and making more money available for books. The now almost universal "Cataloging in Publishing" is a successful result of this cooperation.

We are about to witness the opening of a new Congress, with critical funding questions affecting the library and education communities. The Right to Read effort has some chance of expanded funding under a bill sponsored by Senator Eagleton. Although Congress has failed to pass any general education bills before this last election, some will now argue that expenditures on education are noninflationary. A proposed White House conference on Library and Information Services, already passed by the Senate, could provide a breakthrough toward replacing the Library Services and Construction Act, Higher Education Library Programs, and general revenue sharing, all of which will expire in 1976.

"Guarded Pessimism"

Last week I received a circular from London offering for sale a report on the economic state of book and periodical publishers in the United Kingdom. Its title, if not its content, intrigued me. Publishers, it announced, Nowhere Near Damnation. This seems to me not a bad summary of our problems and our opportunities.

The New York Times carried a two-column story about the price increase by Random House on James Michener's Centennial. It was the story of a nonevent, in that, unfortunately, all publishers have been raising their prices with increasing regularity, paper and printing costs being what they are. Looking for industry comment as a closer, the Times called Mike Bessie, Vice-President of Harper & Row and past chairman of the Association of American Publishers. How did he regard this portent? There was silence on the other end of the phone for a time; then Bessie replied, "Just tell 'em that we publishers look on the future with guarded pessimism." □

Forum — *Continued from page 7*

Communications Commission, seeking a denial or, in the alternative, a suspension of the AT&T Long Lines tariff filing on the Dataspeed 40 "communications" terminal. Representing the interests of the independent terminal equipment suppliers against whom the Dataspeed 40 will compete, the CIA raised the objection that the terminal offering is an attempt by AT&T to enter the computer equipment field under regulatory protections.

The CIA filing states, "The fear which these (independent) suppliers presently perceive from an FCC sanction of the Dataspeed 40 lies in the basic relationship that exists between the giant utility (AT&T) and its wholly-owned suppliers (Teletype and Western Electric)." The petition further states that it is inconceivable to the small independent terminal supplier that AT&T, operating from a protected monopoly position, will enter the computer marketplace and sell its products in a purely competitive environment.

The CIA's argument is based primarily on the following two assertions:

(please turn to page 23)

A Skeptical View of Structured Programming and Some Alternatives – Part 1

Tom Gilb
Iver Holtersvei 2
N-1410 Kolbotn, Norway

"It is fundamental to the correct selection of SP and to its effective use that its contributions be measured continuously. Not just the first time your best programmer uses it, but two years after your average programmers have gotten bored with it, too."

The Newest Religion of the Computer World

Structured programming is quickly establishing itself as the newest religion of the computer world. Programmers who do it like it. Therefore, it must be a good thing. Maybe it is, but I don't know for sure, and I don't think you do either, even though you may be convinced that it is.

There are two things that make it difficult for me to understand the merits of structured programming (SP):

— The fact that it is never really compared with alternative techniques, and the experience data we have is not good enough.

— The fact that it is evaluated by people who seem totally ignorant of the real revolution in programming (increased automation and program quality measurement).

In a letter, recently, addressed to the academic computer science community /1/, I challenged them to show reasonable scientific evidence that SP was better than other methods. The reason that challenge was published was, I assume, recognition that such evidence was lacking. I have received a few answers from academics, none of them offering a shred of evidence. That doesn't mean that SP cannot be proven to have some remarkably fine attributes as a technique. But it does raise my suspicions, and yours too I hope.

In my contact with most of the well-known "authorities" on SP, I have observed good intentions combined with a clear lack of knowledge of the alternative techniques for getting the same types of results as people hope for when using SP. Fortunately, considering that most of these people are professors of computer science, there is not a real total ignorance of all other program-writing techniques which have a bearing on SP. It is just that they refuse to include discussion of other techniques in their writings. /2/

This simplification, one technique at a time, may be useful for academics, but it seems to mislead practical people into a programming religion with only one god and one commandment ("thou shalt not use GO TO").

Is Structured Programming Measurable?

There is a systematic way of finding out if new techniques are worthwhile. Measure their effects. If you cannot measure the effect of a technique at all, why should you bother to use it? If you can measure or get measures of the technique's "goodness," why don't you?

As Myers of IBM shows in his excellent paper on program modularity /3/, it is possible to construct measures of the degree-of-use of a technique, as well as measures of the multiple properties which are a result in the program quality, when precisely that particular degree of the technique is applied. Myers recognizes several things about the problem of program modularization, which are equally applicable to the problem of SP:

— degrees of application of a technique should be measured;

— it may be necessary to construct multiple measures to do so;

— a technique has many possible simultaneous effects;

— these are measurable, too;

— but, he openly gives a list of "side-effects" or attributes for which he does not yet know the effects when using his method.

A Metric for Structured Programming

Let us try to construct a practical measure (a "metric") for at least one dominating effect of structured programming.

If I understand it correctly, the primary objective of all the mechanics of SP is to make program source code easier to understand for program readers. Borrowing some technology /4, 5/ from engineers, I could try to measure SP using a modified "maintainability" metric:

"the probability that a (defined) program source code reader can correctly understand the logic within a given time."

Now that we have a metric, all we need is a practical measuring instrument, giving reasonable cost and accuracy. Fortunately, Gould of IBM has provided /6/ an example of a simple method which I call "bebugging" /7,8,9/ which, simply explained, asks controlled groups of individual programmers to find implanted bugs in different source program situations (for example, "structured" and "not structured"). The ability to find the bugs at all, the amount of wrong guesses, and the time needed provide a clear measure of the goodness of SP or any degree of it.

Using the Metric to Identify Alternatives to Structured Programming

Using this concept of measuring the goodness of SP, we can begin to explore alternatives and combinations. I should like to stress, at the start, that at least a simple form of bebugging measurement can be carried out by even rather small computer installations. The cost of such measures is low compared to the total budget and to the possibility of wasteful effort due to the use of the wrong methods, or loss due to wrong implementation of the right ones.

The maintainability metric stated above is not merely a measure of the probable ease of making changes to the program after it is operational, but it also reflects the ease of working with the program code during initial development. This is important since the coding effort for high reliability software can be as low as 5%, although it is typically about 25% of the total effort, using conventional methods of program production. If better coding practices can reduce the effort during the testing and reworking stages (which are, say, 50% of project cost, at present), then it is clearly of interest.

We can now state the following principle:

— any technique which has a positive effect on our ability to correctly change programs in a given time period is a potential alternative technique, or supplement, to structured programming.

A Simple List of Alternatives or Supplements

If the reader will permit me, I should like to present a list of possible alternative techniques or supplementary techniques, with only the briefest justification. I recognize that many readers will not be fully convinced unless they are given more details, which they can find in the references.

Comments

Comments in programs are a well-established method of improving the source code reader's ability to understand the program logic. Obviously, well-placed and well-written comments can give information about the program logic and its relationship to data and other program logic, which no amount of SP (in the limited sense of simplified logical flow) can ever hope to contribute.

If I had to make a choice between comments or SP, I have no doubt that I would prefer comments as the potentially more powerful tool. Fortunately, I can have both. But the use of comments is not a very exciting subject for our computer science academics to theorize about, so they don't even mention it or give us examples of good practice /2/. The myth of the self-documenting program is not quite dead yet.

Fortunately, there are more practical institutions like TRW-Systems /10, 11/ which have to survive in the real world by making programs actually work. TRW stresses the use of comments and even goes one step further by creating software packages which analyze comments and automatically construct program documentation and updates of documentation by making use of the comments.

"With . . . structured programming . . . the source program itself can provide all the visibility needed, if it is . . . well-annotated with appropriate comments, . . ." /10 (pp. 4-67, A. S. Liddle, TRW)/.

Modularization

Modularization is another well-tried technique for increasing maintainability of programs. Some specialists include modularization or top-down modularization in their concept of SP, thus adding to the confusion. One of the problems is that it took COBOL programmers years to discover what a subroutine was; so when SP came along, they jumped at the chance to get some structure in the programs. I hope the reader is not confused by the terminology which I am attempting to use here. "Structured programming" (the most limited form and most common definition) refers to the structure of the logical flow within a module.

"Modularization" refers to the functional unit of program logic and data definitions which contain that SP logical flow. A module is quite simply "something" which has a defined boundary to the rest of the system, and which has a well-defined interface for communication with the rest of the system. Modularization is a higher level of abstraction than conventional SP (DOWHILE, IF..THEN, no GOTO, etc.), and it deserves separate but integrated consideration.

Dick Canning /12/ in a special analysis of program modularization, particularly in Great Britain where it is more widespread as a software-tool-supported discipline, gives convincing evidence that modular programming gives users what SP also claims to give them. For example, 89% of users claimed "easier maintenance and change," 64% claimed "higher programmer productivity," etc.

IBM has merged the concepts in its consistent reference to "top-down structured programming." But that is confusing the issue. Top-down is a specific way of handling modules during design and implementation. There are just as many modules, and they are just as large as before, but the design and coding/testing sequences of the modules are rearranged in the "top-down design and implementation environment." But this shouldn't confuse us. There are three independent concepts: SP (logic flow simplification), modularization, and top-down. They may all contribute some good things, and they may well be combined. But they are essentially independent techniques, and if we confuse them and don't examine them separately for effects, then we will never be masters of our tools.

If a program is written as a monolithic giant, as many COBOL programs are today (paragraphs provide very weak boundaries for a module), then SP brings a form of organization to the program. But if ordinary modularization principles are applied, so as to give well-defined functional modules, small in size, well-commented, with a single exit and entry point (SP did not invent that idea, as some seem to think), hierarchically organized, then what additional (measurable!) benefit can we expect to get from SP, in relation to its cost? There is a cost, you know, in training, software, additional compile time, and effort to write. The question is not "does it have a positive effect?" but "does it give a better benefit/cost ratio than other techniques?"

Myers, in his paper "Composite Design" /3/, is, in my view, one of the few authors who has made this clear distinction and who has tried to tackle the multi-dimensional problem of understanding how to control different degrees of modularization.

We must keep in mind that simplistic thinking about programming techniques can be dangerous when the scale of a project or program is large or where the long term availability of the system is critical. At that point we must cease using "mythodology" about our techniques and begin to master their complexities, using methodical and quantitative thinking which fortunately is the characteristic of much of the emerging technology from IBM, TRW, and others.

Metrics

When did you last formally define the maintainability of your programs or your data bases? Did you include a practical measuring method for ensuring that the system delivered, had those qualities of ease of maintenance, portability, etc., which we all agree are probably a good thing? Do you know how to specify such program quality goals? Others do. /5, 10, 4/ Do you know of practical ways of measuring attainment of these quality goals? Others do. /10, 11, 8, 9, 4, 6/

A good technique, unmeasured, is likely to turn sour.

It is fundamental to the correct selection of SP and to its effective use that its contributions be measured continuously. Not just the first time your best programmer uses it, but two years after your average programmers have gotten bored with it, too.

When clear goals are set for program quality, when people are motivated to achieve those goals, when the achievement of the goals is accurately and objectively measured, you have a fair chance of getting there. Otherwise, you are out of control.

If I had my choice between effective use of metrics (for such things as program maintainability) and SP, I'd choose the metrics and the measuring tools. SP is only a technique. One of many possible roads to good systems. Certainly not the only road or a necessary road. If I lose my map and my compass, I might never get there. My program user will never see my SP, but he will surely notice if my program doesn't work or if it takes too much time to change to his new needs.

Metrics are not a direct replacement or alternative to SP, but they are indirect alternatives or supplementary techniques since the correct use of them is very likely to contribute to program maintainability at least as effectively as SP.

Let me illustrate by means of a simple metric application:

"The maintainability of program B shall be 98% probability of random-program-bug correction within 2 seconds."

It sounds impossible at first glance, doesn't it? If we had said, "within 2 hours" or "2 days," we might have had a chance at achieving the goal, perhaps using SP and other techniques.

Now, it is clear that no amount of SP, however elegantly conceived, will bring us closer to achieving this goal. It is, by the way, for an air traffic control system, and you might be sitting on the plane which is on a collision course when the bug strikes. So you should care.

Why is it that we cannot solve this maintainability problem with SP?

You got it, didn't you? Your programmer can't even put down his coffee cup in two seconds. In fact, if there is any technique which will satisfy these design goals, it doesn't include any human reaction. It must be fully automatic correction of bugs. SP won't help, because SP is a technique for helping people repair programs. Machines don't really appreciate SP the way we do.

Now if you want to limit your program quality to the attributes which people can give it, stop reading this article and go back to playing with your DOWHILE constructions. If you want to break out of that strait jacket which limits your ability to use computers for important applications, read on! You might learn how to repair programs in a few milliseconds.

Before we leave the subject of metrics, I would like to point out the TRW-Systems Groups book, <u>Characteristics of Software Quality</u> /10/, which fully recognizes the importance of controlling program design and implementation by means of well-defined, multi-dimensional metrics which are capable of fully automated (i.e., by other programs or software development tools) measurement.

Several of the other techniques on the list that follows (dual code, bebugging, and test path analysis, as well as data base diagnosis) are related to the use of metrics since they are, among other things, measuring instruments for problem areas connected with program maintainability and production.

Bebugging

We mentioned the use of bebugging earlier in this paper. Harlan Mills, who is well known in connection with SP, refers to it as "intentional, but random, seeding of errors in a program in order to calibrate the error-finding process itself." /13, p.236/

There is a thin but interesting literature on this subject /6, 7, 8, 9/, and it is by no means fully explored. Gould and Drongowski of IBM used it in their study of computer program debugging /6/, and it is clear from their work that this is a practical tool for measuring the degree of maintainability, by humans, of programs. We can measure both inert program qualities and human capabilities.

It is equally clear that this same basic method can be used to give us estimates of remaining bugs in a program, and of the future effort needed to improve program quality to a higher level of reliability. "Reliability," in this case, is the probability of encountering random bugs in a given time period. Experience curves for various situations (SP being one variation), based on historical rates of moving up the reliability curve from say 50% to 96%, will be our guide to such estimates. Naturally the accuracy of the instrument is determined by the number, and representativeness, of the bugs inserted. The efficiency of the bugs (automated bebugging and reliability calculation?) and measuring their removal. The motivational aspects of the programmer

(please turn to page 23)

National Science Foundation — *Continued from page 15*

Like Tuning a Television

In the human brain, clusters of a thousand, ten thousand, or more neurons act together to perform a function. Working with cell clusters this size, neuroscientists run into the problems of different things going on at the same time, circuits overlapping, and the same kinds of neurons doing different jobs. Computers bog down in the combinatorial explosion when programs try to keep track of all possible interactions. While computer programs work linearly, "the brain is highly nonlinear," Holland emphasizes.

"It's like tuning a television; you can't get the best picture by setting one knob, then adjusting another and another. You work them in parallel. Well, the brain is like a TV set with ten billion knobs. To get the best picture of it we need nonlinear equations. We need to design computers that handle simultaneous inputs, and we're just learning to do this. We need programs that can take human-like shortcuts, that can learn from experience. A child learns by mistakes and builds its own programs as it learns. Until we can design programs like that we won't be able to simulate the human brain."

At present, the gap between the two approaches for doing this — the artificial intelligence school and the analytic school — is very wide. "It is so wide," comments Cowan, "I don't know if they'll ever meet." Lighthill sees a place for both approaches if "the sin of taking insufficient trouble to master experimental facts is carefully guarded against."

Cowan estimates it will take 60 years to "get a good feel for what goes on in the brain." Holland thinks computers will learn to correct programmed mistakes and take instructions "like an intelligent assistant" in 30 years. But, he adds, this capability will probably be limited to specialized knowledge in one area. "The complexity is really discouraging," says a neurobiologist. "It will be 50 to 100 years before we begin to deal with things like how information is stored and retrieved from the brain."

Is the Human Brain Too Complex?

Is it possible that the human brain is too complex for the human mind to understand? Does an epistemological problem apply: Can anything ever fully encompass itself? Most researchers are not concerned. While they admit that man may never understand every detail of what goes on in this unique organ, he will continue to reach new levels of knowledge on which to build. "It may be that no one will ever know what goes on in the brain down to the last detail, just as no one probably understands every detail of the workings of the Department of Health, Education, and Welfare," Reitman observes. "That does not mean that the brain — or HEW — is a total mystery. I believe it is possible to get a good functional knowledge of the one, as we have a good functional knowledge of the other."

"I see no argument that convinces me that an understanding of the brain is not possible," Holland comments. "The brain doesn't have to understand the whole brain at the same instant. A television set doesn't produce a complete picture all at once; it builds it up, a piece at a time, by scanning. We may be able to scan the brain and get a picture of the system we want to understand without having to know the whole process that is going on at one time."

"You don't have one brain trying to understand the brain," Cowan declares. "You have all the brains of all the people who worked on it and will ever work on it. Brain researchers accumulate knowledge the way scientists in other fields do. And I see nothing in the brain that is not accessible to scientific research." □

Biddle — *Continued from page 11*

uncertainties during the interim would be great. There would be a loss of user benefits during this period, not to mention a retardation in technological development, and the possible loss of several otherwise viable competitors to IBM — all of which can be avoided by an earlier settlement.

Another alternative is to hope for some relief as a result of the outcome of private litigation. Once again we are faced with the problem of a long wait. Based on the Telex precedent, the cases that are coming to trial this fall could be resolved in favor of the plaintiffs in two years or less. However, one of the greatest drawbacks to relying on industry relief from private antitrust actions is the inequity in the distribution of recompense.

Perhaps the only other alternative is to leave IBM unscathed, a solution I consider to be the worst for the country. From the user point of view, it would mean continued monopoly prices and the slowest rate of change; from the competitive point of view, it would mean severe disillusionment to entrepreneurs; from the investor point of view, it would mean the slowest rate of growth and an idle surplus of cash; from the public point of view, it would mean the institutionalization of an industry with a clear overconcentration of power, resulting in an even greater credibility gap. I cannot help believing that the end result would be the imposition of regulation over the entire industry, an alternative which more than any other would inhibit a great leap forward in technological growth and development.

The early resolution we propose would be in the form of renovation. It isn't a tearing down, but rather a rebuilding. The interim period of restoration would not exist for all time, but would serve as a transitional period. While specific restrictions would be placed over what IBM can and cannot do, many of the restrictions would last only until such time as the industry is on its way to a healthy, competitive environment. And that solution would allow all of us to get on with our business. □

Forum — *Continued from page 19*

— The Dataspeed 40 is a data processing product which cannot be provided by AT&T on a regulated basis.

— The Dataspeed 40, even if not found to offer pure data processing services, is nevertheless a hybrid service, and the commission rules regarding hybrid data processing services offered by common carriers have not been complied with in the proposed transmittal.

In conclusion, the CIA petition noted that the call for regulatory reform has been sounded in the nation, with the agencies being asked to adopt competitive market solutions to problems. □

Gilb — *Continued from page 22*

finding bugs in this measured environment are quite different from the conventional, measured situation. I'd choose bebugging before SP; but we can have them both, too. *(To be continued in next issue)*

Computing and Data Processing Newsletter

COMPUTER MODEL HELPS HAWAIIAN SCIENTISTS TO HARNESS VOLCANIC ENERGY TO SUPPLY ELECTRICITY

Dr. Paul Yuen
University of Hawaii
College of Engineering
Honolulu, HI 96822

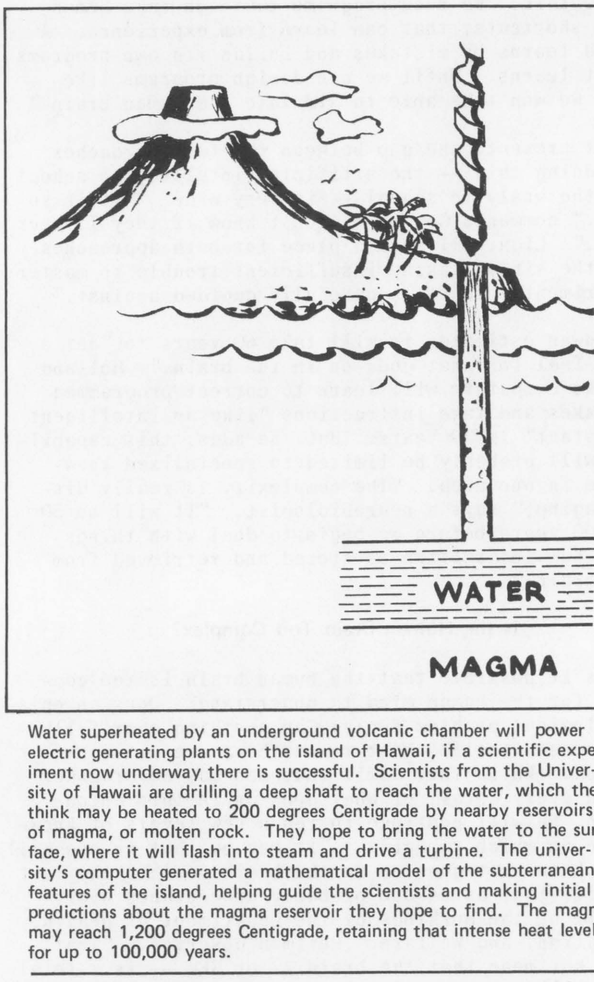
Scientists at the University of Hawaii hope to harness the intense heat of an underground volcanic chamber and use its energy to power an electric generating plant. They are drilling a shaft more than a mile deep on the island of Hawaii, largest in the chain, where they hope to locate water superheated by magma, or molten rock. Helping guide them is a computer-generated mathematical model of the subterranean features of the island.

If the experiment is successful, the water will be brought to the surface of the earth, where it will flash into steam and drive a turbine. The initial plant would produce about 10 million watts, enough to supply electricity to more than 2,500 average homes. If the geothermal project works, additional plants would be built to increase the power to 50 to 100 million watts, doubling the island's electricity supply.

"Hawaii is volcanic in origin, and the Big Island volcano is still active," said Dr. Paul C. Yuen, associate dean of the university's College of Engineering. "We hope to reach water heated by magma somewhere around 6,000 feet. We believe the water could be replaced as quickly as we bring it up, by more water filtering through the porous rock."

Mechanical Engineering Department and Hilo College faculty members used the university's computer to create the mathematical model of the island's subterranean features, based on current geological information and basic heat and mass transfer theory. The system analyzed the model and made initial predictions about the magma reservoir the researchers hope to find. Little is known about the interior of the island, however, and further applications based on the model depend on information from the hole being drilled.

Magma is thought to reach about 1,200 degrees Centigrade, retaining that instense heat level for about 25,000 to 100,000 years. Water normally boils at 100 degrees Centigrade, but the superheated water,



Water superheated by an underground volcanic chamber will power electric generating plants on the island of Hawaii, if a scientific experiment now underway there is successful. Scientists from the University of Hawaii are drilling a deep shaft to reach the water, which they think may be heated to 200 degrees Centigrade by nearby reservoirs of magma, or molten rock. They hope to bring the water to the surface, where it will flash into steam and drive a turbine. The university's computer generated a mathematical model of the subterranean features of the island, helping guide the scientists and making initial predictions about the magma reservoir they hope to find. The magma may reach 1,200 degrees Centigrade, retaining that intense heat level for up to 100,000 years.

subjected to great pressure in the ground, will stay in liquid form at about 200 degrees until brought close to the earth's surface, where it will flash into steam.

Researchers from the university's Hawaii Institute of Geophysics had forced electricity into the ground through electrodes spaced around the island. Because hot water is an excellent conductor of electricity, they were able to "map" potential hot water reservoirs by plotting the different patterns of conductivity. They used these maps and other geophysical information to select the site for the first well, near the east coast of Hawaii.

Electricity produced by geothermal energy in Hawaii should be cheaper than that supplied by standard generating methods, in which water is heated by burning fossil fuels. Rates there now are among the highest in the world. The scientists hope the project will supply heat energy for other purposes as well, such as paper and wood processing and heating greenhouses.

The university's computer is an IBM System/370 Model 158.

BRINGING ARABIC INTO THE COMPUTER AGE

Michael Shelton
The Montreal Star
241 St. James St.
Montreal, Quebec, Canada

"At last it's beginning to look as though Syed is the new Gutenberg."

Henry Strub leavens this immense claim for his partner by adding with a twinkle . . . "and I'm the printer's devil."

It probably took this mixture of ambition and humor to bring their brainchild so far in such a short time. What they have found is the means to bring the Arabic language out of the 15th century into the age of the computer. They are doing it, naturally, with an electronic device. The first will roll off the production line in the next few days.

Until now no machine has been able to render Arabic perfectly in type. And written Arabic must be perfect to encompass the rich range of nuance and meaning. Although more than 250 inventions are on the market already, they all demand some modification of the script. Because these people are loath to accept such compromises, it is still necessary for many messages to be transmitted in English or French and then translated.

The potential is mind-boggling. At least 575 million people in a great swathe of the globe from West Africa to the Indonesian border with Papua-New Guinea use the Arabic script. The 22 countries that make up this region are currently setting up a digital communications system linked by three satellites, similar to Canada's own Anik satellite system. Two are already in place over the Atlantic and Indian oceans. A third is to be positioned over the Sahara.

The Arab nations are spending a total of $5 billion. Iran, which is modernizing at breakneck speed, has earmarked another $6 billion of its oil money over the next few years to up-date and expand its own telecommunications network.

It is hard for the Western mind, accustomed to its own method of printing on paper, to realize the difficulties that face other cultures. For instance, several thousand Chinese ideograms are required to do the work of the 26 letters of our alphabet. No solution has yet been found to the Chinese problem, except to latinize the written word. (But who knows? Maybe some Chinese visionary has the answer and is laboring through suffocating layers of bureaucracy and commercial timidity!)

Arabic, Farsi, and Urdu have a similar problem to Chinese, though not nearly so difficult. Being much older than the Western languages, they are much richer. It is said that an English newspaper reader requires a vocabulary of 3,500 words. Arabic requires 8,000. Their written word was also much more developed by the time Johann Gutenberg invented movable type.

The 14th, 15th, and 16th centuries saw Arabic calligraphy reach a peak of artistry which is still revered today. Our 19th century copperplate is but a poor imitation. Unfortunately, this calligraphy does not mix well with modern technology.

The shape of each letter depends on the one before.

Dr. Charles Adams, professor of Islamic Studies at McGill University, explains that although Arabic has only 28 letters, Persian and Urdu 32 each, the ideal keyboard for typing or setting type should have four different variations of each letter.

"In some cases there should be even more," he adds. "But for practical reasons there are only two forms for each letter on the standard keyboard. Even then the typist or printer has to make a number of decisions about how to use them before employing a letter."

Now Professor Syed Hyder, head of the computer science department at the University of Montreal, has the answer. As engineer, mathematician, linguist and artist as well as a computer expert, Dr. Hyder realized some years ago that Arabic script had to be viewed in two dimensions rather than the one straight line you are reading now.

First he described it in terms of mathematical linguistics and then programmed the result for a computer. From there he transferred the program to the same sort of minute silicon chip that gives instant answers on a pocket calculator and, he wired it to an electric Arabic typewriter.

With this device, no bigger than a matchbox, converting the signals sent through the machine, the typist merely chooses the correct form of that character according to the next key that is pressed. The processor makes its decisions in milliseconds.

Dr. Adams of McGill comments: "I think it should be fantastic commercially speaking. It ought to speed up the work of a typist by a considerable factor. There will be 30 to 40 per cent fewer movements for the fingers to make and a lot fewer choices of character outline."

Dr. Hyder made his prototype in 1970. Although he was the son of a judge in Pakistan, had academic qualifications from Lahore, McGill and Ann Arbor, Michigan, he found it difficult to get his idea accepted. (Accepted, that is, with his name attached to it.)

Enter Henry Strub. This Swiss-born design consultant is well known in Montreal academic and artistic circles.

"The trouble with Syed was that he got so excited telling people about his processor that he was apt to tell them how it worked," he said. "He attended a lecture of mine about four years ago. When he started to tell me about his invention, I realized how important it might be and told him not to say another word.

"The invention is securely under patent now. We got the key one from the U.S. a few days ago. It patented not only the machine but the idea, which is something new.

"If anybody tries to get at the program in the processor to steal it, the chip just burns out."

PSYCHIATRISTS STUDY THE USE OF COMPUTERS TO HELP MENTAL PATIENTS

Joan Hollobon
The Globe and Mail
444 Front St. West
Toronto, Ontario
M5V 2S9, Canada

Psychiatrists seem nearer to being able to predict danger in the quiet, unobtrusive individual who seems nonviolent, but later blows up, killing himself or other people.

Ruth M. Bray, a clinical psychologist at the Clarke Institute of Psychiatry, describes computerized tests being developed there that may take the "clinical intuition" out of assessing such people. The test is based on another way of interpreting the Rorschach test.

The Rorschach test, named for Swiss psychiatrist Hermann Rorschach, is defined as a test "to disclose conscious and unconscious personality traits and emotional conflicts through eliciting the patient's associations to a standard set of inkblots."

Dr. Bray explains this interpretation of the test can reveal a tell-tale "constellation of personality traits" that predicts potential danger with a high degree of accuracy. It has been tested with only 15 patients, in conjunction with extensive clinical assessment by psychiatrists and social workers.

Analyzing the Rorschach results by a computer produces consistency of interpretation, getting away from subjective opinions and "clinical intuition." However, the test requires further study.

Kenneth Jarvis, secretary of the Law Society of Upper Canada, said computers should be used to store information on potentially dangerous patients released into the community, so they can be followed up properly.

He said many of these patients are all right as long as they take prescribed medication, but at present no one checks to make sure they do. If such information were stored centrally by computer, patients could be notified to return for a check-up, and if they did not turn up, the computer could put out an alert.

CITY-IN-A-COMPUTER HELPS PEOPLE TO CLARIFY URBAN PROBLEMS

Andy Washburn
News Bureau
University of Southern California
Los Angeles, CA 90007

Apex City, a small community near Los Angeles, has big problmes. New jobs are badly needed, but a proposed industrial development that would provide them would also increase air pollution. A large housing project, while boosting the tax base, would bring in extra children to overcrowd the school system.

Fortunately for the city officials, developers, and Apex residents who face these and other problems, their community exists only within a computer. They can make important decisions without actually spending millions of dollars or affecting thousands of lives. Furthermore, they can see the results of their decisions the same day, not the years they would have to wait in real life.

"Apex is simply a game — but a very sophisticated one with a very serious purpose," said Dick McGinty, director of the Center for Multi-disciplinary Educational Exercises at the University of Southern California, in Los Angeles. "It is designed to help participants study urban problems and learn how many decisions made in a community can affect everyone in it. USC's computer analyzes the decisions and how they interact, and updates the status of the community so participants can work through several years of a city's life in just a few days."

Apex participants have included undergraduate and graduate students, government representatives on the local, state, and federal levels, community action groups such as the Sierra Club and League of Women Voters, and representatives of businesses such as real estate development companies and large oil firms. All are assigned roles of people involved in a community, including city and county officials, developers, and members of civic and pressure groups. They are free to act as they wish within the bounds of the roles, so the player representing the mayor, for instance, could be liberal or conservative, activist or "do-nothing."

It takes at least 30 people to play Apex, and the optimum size is 60 players, but USC has run the game with as many as 120. A typical game will stretch over five consecutive days, with morning and afternoon sessions. As the game starts, the players make decisions based on the roles they play and the initial information they are given. Developers, for example, might push to have areas rezoned for their pet projects. County planners might promote passage of bond issues for expansion. City officials might seek to have new highways built.

At the end of each session, when each person or group has decided on a course of action, the game director collects their decisions. The information is fed into the university's computer. The system analyzes the information and updates the status of the community and the players for the following session.

Since each group's decisions can affect the standing of all other groups, there are immense numbers of possibilities. The system can handle a total of variations represented by the number 155 followed by 63 zeros.

Players take their roles seriously, devoting considerable time to behind-the-scenes bargaining or public wrangling. City officials, for instance, often seek extra protection against air pollution before granting permits to build factories, while industrialists sometimes threaten to pull their businesses out of town if taxes are raised. Apex theory ties into application; it acts somewhat as a basic civics course in how a community operates. Some people have seen what other jobs would be like during the game, and based on that have changed their vocations.

Apex was developed at USC in conjunction with the University of Michigan. It is played with an IBM System/370 Model 158 computer. □

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.)

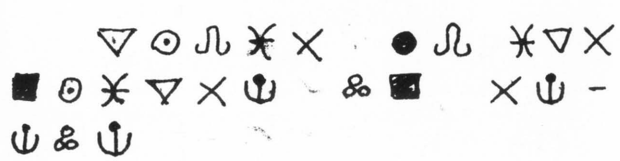
NAYMANDIJ 765

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

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 765



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 765

```
                        S T I L L
                    x   W A T E R
                    -------------
WMR = PSD             S B W E R T
                    P I E B W E
                  B M D O L T
                B I S E S O
                L R A M P
                ---------------------
            =   E E L B A O A I T

                98821  04403
```

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

SOLUTIONS

MAXIMDIJ 764: Enjoy the sunshine when the sun shines.

NUMBLE 764: There is no medicine against death.

Our thanks to the following individuals for sending us solutions: T. P. Finn, Indianapolis, In.: Maximdij 763, Numble 763 — Ronald C. Graves, Ashland, Mass.: Naymandij 763, Maximdij 763, Numble 763 — Gus Strassburger, Decatur, Ga.: Naymandij 763, Numble 763.

COMPUTER GRAPHICS AND ART

FIRST ISSUE NOW PUBLISHED!

COMPUTER GRAPHICS and ART is a new international quarterly of interdisciplinary graphics for graphics people and computer artists. This new periodical is aimed at students, teachers, people from undergraduate and graduate institutions, researchers, and individuals working professionally in graphics. Its topical coverage is broad, embracing a variety of fields. It is useful, informative, entertaining, and current. Our goal is excellence, and to achieve this objective, we invite our readers to participate actively in the magazine, and to advance the state of the art of computer graphics by communication, sharing, and dissemination of ideas.

We invite you, your colleagues and students to help us achieve this goal.

Partial Table of Contents — Vol. 1, No. 1

List of Coverage for Up-Coming Issues

- Applied Arts and Graphics
- Architectural Graphics
- Cartography Systems
- Computer-Aided Design
- Computer Assisted and Managed Instruction Utilizing Computer Graphics
- Computer Graphics in Physics, Chemistry, Mathematics, etc.
- Computer Programs for New Applications
- Display Systems and Graphics
- Fine Art and Media Explorations
- Graphics in Business
- Hardware Systems and Graphics
- Interactive Graphics Languages and Systems
- Languages for Computer Graphics and Graphics Primitives
- Software Systems and Graphic Requirements
- Statistical Packages and General Graphing
- Syllabi for Computer Graphic Courses

— — — — — — — — — — —(may be copied on any piece of paper)— — — — — — — — — — —

To: *COMPUTER GRAPHICS and ART*
Berkeley Enterprises, Inc.
815 Washington St.
Newtonville, Mass. 02160

( ) Please enter my PERSONAL (U.S. and Canada) subscription to CG&A ($10 per year).
( ) Please enter my FOREIGN PERSONAL subscription to CG&A ($13 per year).
( ) Please enter my LIBRARY/DEPARTMENTAL subscription to CG&A ($15 per year).
( ) Enclosed is my PERSONAL CHECK AND/OR PURCHASE ORDER for CG&A.
( ) Enclosed is $2.50 for a sample copy of CG&A (applicable toward a subscription).

FULL REFUND IN 30 DAYS IF NOT SATISFACTORY

Name____________________
Title____________________
Organization____________________
Address____________________

HERE IS YOUR OPPORTUNITY FOR FEEDBACK TO US:

( ) I hope to submit for publication in CG&A material on the following topics:____________________

( ) I am interested in reading materials by the following authors:____________________

( ) I am particularly interested in coverage of the following subjects:____________________

( ) I would like to receive materials on other Berkeley Enterprises, Inc. publications: ( ) *COMPUTERS and PEOPLE* ( ) *The COMPUTER DIRECTORY and BUYER'S GUIDE* ( ) *People and the PURSUIT of Truth* ( ) *The Notebook on COMMON SENSE and WISDOM* ( ) *WHO'S WHO in COMPUTERS and DATA PROCESSING* ( ) Books

( ) I am interested in: ( ) black and white computer art reprints at low cost (a bonus for subscribing to CG&A) ( ) 77 page FORTRAN IV art manual ( ) 45 page interdisciplinary graphics bibliography by G. Hertlein

( ) Additional Comments (attach another paper if needed):____________________