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Table of Contents

The Fox of Mt. Etna and the Grapes

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

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

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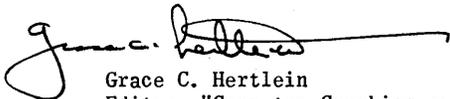
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computers
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The magazine of the design, applications, and implications of information processing systems — and the pursuit of truth in input, output, and processing, for the benefit of people.

Front Cover Picture

The front cover shows Stuart Davis (left), chairman of the board, Great Western Financial Corporation, watching, and visually handicapped Dieter Raeker and Maryann Barrios engaged in computer programming at the company's data center. Some special equipment such as the closed circuit TV reader, blows up letters many times their original size, enabling Raeker to read data printout material. See the article on page 16.

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*Message from
Neil Macdonald:*

WOULD YOU LIKE
A COLLECTION
OF THE PUZZLES
PUBLISHED IN
*COMPUTERS AND
PEOPLE?*

———

IF SO, WRITE US AND
TELL US WHAT
YOU WOULD LIKE.

MAYBE WE CAN WORK
SOMETHING OUT.

Key

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

NOTICE

EDITORIAL

Perspective – II

In this issue we publish a thought-provoking article on "The Impact of Computers on Society", containing a long inventory of subjects to be considered in teaching a course on "Computers and Society" directed to juniors and seniors concentrating in computer science.

This article makes evident again the proposition that in general in our society:

— Too much time, energy and thought are devoted to less important problems and not enough to more important problems.

What is the evidence for this proposition? How do we measure the importance of problems? And if this proposition is true, what should we do about it?

In every society some problems are important, some problems are trivial. The importance of a problem is measured by a number of factors. Among these are:

— The number of people whom the solution will affect and the degree to which they will benefit — the value of the solution;

— To what extent the solution of a problem enables other problems to be solved — its fruitfulness;

— The nature and quantity of work and resources required to solve the problem — the possibility of solution and the cost of solution;

— To what extent a new and better solution can bring improvements over prior solutions — the differential gain; etc.

In many cases nowadays, of course, the possibility of solutions, the cost of solutions, and the degree of improvement of a new solution over prior solutions, are greatly affected by the programmed computer.

In the segment of society called the computer field, a great deal of time, energy, and thought is nowadays going towards such problems as:

— The design of data processing devices using large-scale integrated circuits so that higher speeds and lower costs will be attained;

— The development of new and better computer programming packages so that more powerful methods for solving problems can be more easily used;

— The spreading of the use and application of computers into more and more organizations, so that the advantages of computers can be grasped in more and more organizations.

But in society there are much more important problems — and much harder to take hold of. One of these is the process for gathering data which the people of a society have for solving their problems. In other words, this is the problem of dealing with the stream of information and/or propaganda provided by newspapers, radio, television, etc. This problem is highlighted by such examples as the many contradicting statements issued by the president's men and the president as the weeks went by during the Watergate investigation.

Another of the great problems in that of food for tens of millions of human beings in the underdeveloped countries. This is highlighted by the fact that every year hundreds of thousands of human beings starve to death ("are dying of malnutrition").

Still another of the really important problems is the problem of the lack of control over nuclear weapons. These are now in possession of at least five nations: the United States, the Soviet Union, Great Britain, France, and China. This problem is highlighted by the fact that the nuclear stockpiles of the United States and the Soviet Union are each sufficient to eliminate all human life in the Northern hemisphere.

Computer people, as we have said before, and will say again, are essentially information engineers. They have hold of what C. P. Snow, English writer and scientist, calls the most remarkable machine invented by man while on this earth. To gain the greatest value from our magical pearl of wisdom, we need to look at the engineering of information for human purposes in the broadest possible way.

We need to see both big problems and small problems; we need to be able to tell the difference between them; and we need to devote solid work to the big problems — even if our only reward for a long time is abuse and punishment. We need perspective.

Edmund C. Berkeley
Editor

(Note: A previous editorial "Perspective" was published in the April, 1966 issue of "Computers and Automation".)

MULTI-ACCESS FORUM

THE IBM-USA "GAG" ORDER AND ITS POSSIBLE REVERSAL

Jack Biddle, President
Computer Industry Association
1911 No. Fort Myer Drive
Rosslyn, Va. 22209

A long long time ago -- back in May of 1972, when the case U.S. vs. IBM was still understaffed and little known outside of our industry, IBM asked for and was granted a "Gag Order" that barred IBM and the Government from discussing or commenting upon the pending case. As a result, there was little press coverage or attention paid to the case through-out the remainder of 1972, except for a brief flurry when the Government filed its relief request.

On May 20, 1975, some three years later, IBM sud-denly reversed itself, and asked Judge Edelstein to strip away the gag order.

In a dialogue with Mr. Barr, Chief Counsel for IBM, Judge Edelstein asked, "What has changed your position from the day you came in very exercised and brought clippings from the Coast and complained how serious it was that members of the Department of Justice and others, referring to IBM, were speak-ing upon this case, and upon reliable information -- what's changed? Now [Mr. Barr] what has changed?

"Is it because you liked it then and it served a useful and pragmatic purpose, and now that you accomplished the result, you no longer like it be-cause you would like to do something else?"

Judge Edelstein seemed to sense that Barr had something up his sleeve and refused to grant the request, but left the door open.

As an avid "IBM watcher", I too wondered what IBM might be up to. I reread the transcripts of all that led up to the issuance of Pre-Trial Order #4 and the chronology of events since. I think I now know why the removal of the Gag Order stands as a prime IBM objective.

The, till then, largest antitrust case in Ameri-can history was filed by the Government on January 17, 1969. It lay virtually dormant for more than three years with several attempts by IBM to reach a quiet settlement. The Government had put little in the way of resources on the case, and most of IBM's various delaying actions were successful.

IBM had every reason to believe that they would be able to reach a comfortable negotiated settle-ment with the Administration. The Watsons had made their campaign contributions ... the White House was disinclined to pursue antitrust vigorously. The less publicity the case received, the better the odds that any consent settlement would be closely akin to IBM management's wishes. Thus, the Gag Order.

Unfortunately, for IBM, four events transpired in quick succession during the summer and fall of 1972 that would take the case out of IBM's control and put it before the Courts, where it belongs.

First, the Association of Data Processing Service Organizations and the press succeeded in getting Pre-Trial Order #4 modified to permit access to the record and discussion by non-parties to the case.

Next, the Computer Industry Association came in-to being to represent the non-IBM portion of the Computer and Data Processing Industry.

THE PURPOSE OF MULTI-ACCESS FORUM

- To give our readers an opportunity to dis-
    cuss ideas that seem to you important.

- To express criticism or comments on what
    you find published in our magazine.

- To help computer people and other people
    discuss significant problems related to
    computers, data processing, and their
    applications and implications, inclu-
    ding information engineering, profes-
    sional behavior and the pursuit of
    truth in input, output and processing.

Your participation is cordially invited.

GUEST EDITORIALS

1. From: H. J. Stone
       Iowa City, Iowa

I don't suppose you will publish this let-ter. But I think your editorials as a group are narrow, monotonous, and much of the time far afield from major concerns in the computer field. Since criticism is supposed to be con-structive, why don't you invite and encourage "guest editorials"?

2. From the Editor

We are very willing to publish "guest edi-torials" that are reasonably significant. We invite our readers to send in to us proposed "guest editorials".

Then, the Department of Justice submitted its tentative statement of relief sought if IBM were found in violation of the Sherman Act and,

Finally, settlement of the IT & T case raised a cloud of suspicion relative to possible political interference in Antitrust enforcement.

As a result of these events, the Antitrust Penalties and Procedures Act of 1974 (The Tunney Bill) was enacted into law in late 1974. The die was cast. The US vs. IBM case would go to trial — the industry and the public's interest would be protected.

There are those who believe (and I happen to be one of them) that a fair and impartial trial will result in a finding that IBM in fact, intended to and has successfully monopolized the General Purpose Computer Systems marketplace.

I suspect that IBM management also recognizes that this is a distinctly possible outcome. As a consequence, I believe that IBM intends to attempt to circumvent both the law and the courts by applying pressure on the Administration and the Congress through a well orchestrated public relations, media and lobbying campaign.

With more than $4 billion to work with, no doubt they could convince the American Public to make IBM the 51st State if they wished ..... and there would be no one with the resources to tell the other side.

If this is their game plan, they must first get the Gag Order they requested back in 1972 lifted. In part, they will attempt to use our Association as their excuse while in actuality they are playing for much, much bigger stakes.

IBM has done everything possible to prevent this case from coming to trial. It is now before the courts, and will in due course be decided in accordance with the laws of our nation.

(Based on a report in "On Line", September, 1975, and printed here with permission.)

NUMBLE 7510 — ERROR AND SOLUTION

1. From: Lawrence M. Clark
835 Edmands Road
Framingham, Mass. 01701

The Numble published in the October issue has an error in it. Whoever released that Numble for publication should be reprimanded and reminded that the rules as stated do not allow incorrectness in the data of the puzzle, but only in what is called "the second message".

The second S in line 3 has to be zero if S plus B ends in B, as the puzzle declares. But S cannot be zero if HABIT times S is different from SSSSS or any equivalent. Therefore, let us suppose that the second S in line 3 is a misprint and disregard it.

T times H ends in S; and T times S ends in R. Then all the solutions T, H, S, R are to be found listed in the 18 lines of Table 9 on page 30 of the September, 1975 issue, in the note "Hints for Solving Numbles" by Neil Macdonald. Line 1, containing 2, 4, 8, 6, is quickly shown to be wrong. Line 2, 2, 7, 4, 8, leads to letter O as 9, A as 3, I as 5, and is quickly shown to be right. And the entire message is "Habit has an iron shirt."

2. From the Editor:

Thank you for your letter, and the correct solution despite difficulties. The reprimand has been delivered to me, to whom it belongs, and I promise to try to do better.

MAKING DECISIONS REGARDING NEW COMPUTER PRODUCTS WITH BROAD UP-TO-THE-MINUTE KNOWLEDGE OF TECHNOLOGY

Robert K. Lowry, Chairman of the Board
Technology Marketing Inc.
3170 Red Hill Avenue
Costa Mesa, California 92626

Often in these days of pressure, engineering personnel are either inadvertently pre-empting or deliberately usurping from corporate officials too many decisions which properly should be made at the highest executive levels.

This is especially true for original equipment manufacturers who are in such fields as electronics and computers, and who want to increase or upgrade the automation functions in systems they produce.

Whether or not staff engineers are computer specialists, they often make critical decisions which have a significant business impact on the availability and competitiveness of a company's new end product. Too often, top company managers fail to recognize the possibly disastrous consequences resulting from what appears to be just a design decision.

Complex Choices

Even after prototypes are built, neither the designers nor management may recognize the advantages which could have been gained by using a different approach — unless a full technical, performance and cost analysis with goals and objectives has been prepared in advance and presented for a management decision. Computer alternatives and trade-offs are often complex; and non-technical executives tend to relegate the decision-making function to staff engineers, often without even realizing the far-reaching implications.

That can extract penalties in loss of market position and loss of profitability. No line executive would relinquish his control over those fundamentals willingly, but many are doing so unknowingly.

Varying Approaches

For a given application there can be a number of different approaches at both the system and implementation levels which might be worthy of management consideration. These may use minicomputers, programmable logic arrays, microprocessors, microprogrammable machines, or hardwired logic; and the effects on software, hardware and support costs have significant product impact. The advantages and limitations of each must be compared by specialists: and the final decisions have to be made by management executives, based on a full understanding of the impact on corporate objectives.

Poor Choices

A wrong decision can result in the end equipment requiring far more computer software or memory than was originally anticipated — adversely affecting the final product and selling price — or could mean that the throughput is constricted, limiting the performance of the system.

Computer Science in China

James W. Kho
Computer Science Department
California State University
Sacramento, California 95819

"Unlike the Western world, China's socialist society has no need for industrial secrets."

Note

In the summer of 1973, the author travelled with a group in the People's Republic of China for 6 weeks visiting research institutions, computing centers, universities, and industrial plants. He held discussions on computer technology and computer science curriculum with Chinese experts and educators at many of these institutions. Major Universities visited include Peking U., Tsinghua U., Futan U. The travel spanned some 15 cities, including Shanghai, Peking, and Nanking. The group included engineers, university professors, and graduate students, all of whom speak Chinese fluently. Significantly, the group was accorded audience with Chinese Foreign Minister Chiao Kuan Hua. Since the visit, the author has maintained correspondence with two university professors in China to keep up with current developments in the field. This report covers computer science curriculum, computing facilities, reference materials, and industrial applications in China.

Introduction

With the warming of U. S.-China relations, I, like many others, visited the People's Republic of China. There were many factors, however, that made my trip quite a unique experience. For one thing, I speak Chinese. In my visit to some 15 cities across China, I had the opportunity to hold discussions with the staff of various universities, hospitals, communes, and industrial plants, as well as with students and members of the Red Guards.

I met with my relatives in many cities including two university professors and a physician. I often travelled unescorted, in one instance for more than a thousand miles, to visit my parents' home town in Amoy. Having the opportunity to live among common people, and the personal discussions we had, gave me a rich insight into their livelihood that would otherwise have not been possible.

Being a computer scientist, I directed my primary interest in looking into the state of computer science and its applications in China. This took me to research and educational institutions, a computer plant, computing centers, and industrial plants. I found the computing staff at each installation to be eager for technical discussions and exchange of information.

Where is China Going?

China is pressing hard for industrialization, and her planners are keenly aware of the need to develop China's electronic industry. In recent years, it was reported that this industry has become a new and comparatively better organized manufacturing unit in China's economy. Electronic goods have reportedly been produced in large quantities for use in scientific research, education, industrial, and medical applications. Production of electronic components, tools, and equipment is said to have increased as much as tenfold over that of the comparable period in 1965 /3/.

While I was in China, it was announced that Peking University and Peking Telecommunications Equipment Plant had jointly produced and successfully tested a third-generation computer with a one-microsecond cycle time. This computer has a word length of 48 bits, a main storage capacity of 131K words, and 22 pieces of peripheral equipment of nine types. Radio Peking cited the computer's advantages of its compactness, speed, and reliability, among others. Plans for its mass production in the near future have been laid down /2/.

But to better evaluate China's rate of development in this field, it is essential to understand the process of rearing and educating, in great numbers, young technicians, engineers, and scientists, and perhaps even more important, what motivates this new crop of talents.

Education in Computer Science

My visit to educational institutions in China took me to universities, colleges, and vocational schools, as well as high schools, elementary schools, and centers for care of the very young. The universities visited included Peking University and Tsinghua University, both in Peking and well known for academic excellence and political activism, as well as Futan University in Shanghai, and Nanking University.

Since the reopening of schools after the cultural revolution /5/, the educational process in China has undergone great changes, and still is in a stage of experimentation. Currently, college education in general is based on a 3-1/2-year period. The academic year lasts 10-1/2 months with a 6-day week and 7-hour day. The discussion here is limited to their computer science programs.

Computer Science Curriculum

Computer science is still not firmly established as a discipline in Chinese universities. It may be a part of the mathematics program, as in Peking University, or that of electrical engineering, as in Tsinghua University. Furthermore, owing in part to the experimentation still taking place since the cultural revolution, no fixed computer science curriculum exists currently in any of the universities I visited.

College students are now recruited directly from workers in industrial plants, as well as the military. Since many have not been in school for years, their freshman year is generally spent in review of basic courses such as mathematics, physics, and general education courses. Computer programming is introduced in their second year. Other courses include theory of computation, calculus, and in some universities, a host of electrical engineering core courses. So-called "special topic" courses are covered in the third year ranging from numerical methods to computer design and system programming.

One of the most interesting features of their computer science programs is what they called "solving problems" in the last half-year of their education. These are usually real problems in industry. For instance, engineering students in Tsinghua University take part in production in some 76 factories in Peking. Problems confronted in the real world become their own, which they work on under the advice of faculty members, veteran workers, and factory technicians.

It became obvious that many of what is considered essential computer science theory courses here are missing in their curriculum. I found no mention of such topics as computer simulation, operating systems, computer graphics, pattern recognition, or artificial intelligence. I believe this is due in part to their current level of development, and in part to the lack of qualified teachers. On the other hand, how many universities here can boast of operational computers, however small, built and developed chiefly by students. Several universities I visited in China can make that claim.

Reference Books and Materials

I was told few textbooks are used and instructors generally passed out notes. Students are expected to do "self-study" and heavy reliance is placed on reference materials.

In a survey of several libraries, I found copies of Communications of the ACM, IEEE Transactions, IBM System Journals, IBM Research and Development, Datamation, as well as various Japanese and Russian technical journals. Among the many books in English at one library, I found several new titles, including one on the IBM System 370.

I do not know to what extent the English literature is used by the students. But English is now considered the single most important foreign language in China and is taught widely in school. Across the country, English lessons are broadcasted over the radio twice each day.

Another surprising discovery is that books by western authors had been translated verbatim into Chinese. For instance, I bought a translated copy of C. P. Lecht's "The Programmer's PL/I" (published originally by McGraw-Hill) in a Shanghai Bookstore. There are also several collections of translated articles from IEEE Transactions, proceedings of U. S. computer science conferences, and IBM publications. I purchased several of these in bookstores throughout China. Most are published by Peking Scientific Publications, with a foreword to readers that they must read with a critical mind and an orientation of applicability to China's industrial needs.

To be sure, there are also computer science books by Chinese authors. These are usually introductory in nature, covering basic principles and meant for wide readership. A glance at the bibliographies reveals references to Russian, Japanese, English, as well as Chinese sources.

The Faculty

On top of free tuition, room-and-board, health care, and allowances, students in China have an additional advantage: the student faculty ratio is around 2 or 3 to 1. This is misleading however since some faculty members rarely teach and others have a light teaching load. Class sizes though are comparable to those of the U. S. One computer science professor confided in me that he spends all his time in helping solve the many problems that industry brings to his university. In fact, students benefit the most from precisely this close association between industry and the universities.

In Peking, there is a close relationship between the universities and Peking Research Institute, including the sharing of manpower and computing facilities. Peking factories and enterprises also regularly provide facilities for educational institutions to study industry and to integrate their learning process and scientific research with labor in production. In fact, nearly 300 such production units are involved in helping 11 universities and colleges as well as 280 high schools.

There is a male-female ratio of roughly 2 to 1 among the faculty. Many of the older professors have graduate degrees from American universities or professional training in Russia. Most of the younger teachers are locally educated. I was impressed however with the interest of some young professors in much of our current research. One faculty member, after a discussion on virtual memory systems, suddenly switched topics and asked me where I stand on the "go to" controversy!

Computing Facilities

Of the university computing centers visited, that of Futan University appears to have the best facilities. The integrated-circuit electronic digital computer was built by students and faculty members of the Mathematics Department, in cooperation with workers from a near-by factory. The construction of the computer took 15 months. It has a 32K-word main memory with a 48-bit word size, and can do up to 140,000 per second.

Auxiliary devices include 2 magnetic drums (built in Kweichow), 2 magnetic tape drives (built in Heilungkiang), 2 paper tape drives (built in Inner Mongolia) and 2 line printers (parts built in a Shanghai factory and assembled locally). There is no card reader and input is done primarily by paper tape. For more details on some of China's computers, see /1/.

Software was produced mainly by 40 mathematics students, and includes an Algol 68 compiler. Students do their programming mostly in assembly language or machine language.

Tsinghua University students have built several small computers since 1956. Some of these have been sold to industry for scientific and industrial applications. Core size is only 4K words and computer's speed is aroung 10,000 operations per second. I was told they programmed in symbolic language as well as a romanized Algol-like language.

Computers and The Industries

While in Shanghai, I had the opportunity to visit

a computer plant, Shanghai Wireless Electric Factory No. 13. The plant was honored with a full-page spread in the People's Daily, an internationally circulated newspaper, in 1972 after it had successfully constructed two computers. It was reported that the plant was formerly a door handle factory where the workers had no previous experience in electronics. With the help of mathematicians and engineers from universities in Shanghai, they built the 709 and the 719, both medium size integrated-circuit computers /4/.

The story may be far-fetched to many Westerners, but Chinese publications have regularly reported this same spirit of patience, daring, and determination for success in China's achievements and road to industrialization. Shanghai Wireless Electric Factory No. 13 has since proceeded into greater production.

Unlike the Western world, China's socialist society has no need for industrial secrets. Engineers regularly visit plants in other cities to get new ideas. There are constant open discussions of technologies and free exchanges of opinions among college students, scientists, plant technicians, and workers. I was happy to join a discussion of the staff at the computer plant one afternoon, and was honored with a tour of their facilities.

However, most of China's industries do not appear to have reached the stage of computerization. In my visit of many factories across the country, I found that much machinery and equipment used in production of a variety of goods, though quite inventive and ingenuous, are still crude by Western standards. But slowly, industrial plants in China are opening their door into the computer age.

I toured a petroleum refinery in Nanking that uses a computer to monitor, analyze, and closed loop control some factors such as temperature and pressure. A teletype is hooked on for direct operator input. However, analysis of many of the graphs produced are still done by technicians.

In Hangchow, I visited an embroidery plant well-known in China for its picturesque and intricate productions. An elaborate design may take up to four months to complete before master boards are punched in preparation for mass production. I had a discussion with plant specialists who revealed plans for computerizing the design process. Major roadblocks lie in the lack of equipment and computer expertise, which are still relatively scarce.

Conclusion

It is clear that China still has a long way to go to reach the state of development in the U. S. There is a definite need for advancement in her computer technology. But even more so, the rapid developing of new talents is imperative to satisfy the great demands of her industries.

I am often asked how many years, in my estimate, will it take Chinese computer technology to catch up to our current state of art in the U. S. I cannot tell, but as I left the computer plant in Shanghai, I received as a gift a computer print-out proclaiming "Long Live Chairman Mao!" And perhaps the following quotation from Mao himself will give some indication of the direction that China is taking.

"We cannot take the same old road of industrialization that other nations in the world took, always following behind step by step. We must break old norms. On the one hand, we should use the advanced technology already developed, absorb it only after careful analysis and criticism. On the other hand, we should take our own initiative, develop technology directly applicable to our needs. And in the not too distant future, transform our country into a socialist, modern, and strong nation."

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Lowry — *continued from page 8*

We have seen a number of instances where poor selections were made, enough to consider this to be a widespread and growing problem. For example, in a recent case, we were able to reduce the cost of the computer function to about one-fifth what it would have been the way the customer's engineers had originally designed it. The redesign saved thousands of dollars in recurring manufacturing cost.

To avoid mistakes in this category requires the following approach for corporate executives:

— First, when a new product or development is under consideration, isolate those objectives having the greatest marketing and cost impact.

— Second, prepare a cost vs. performance analysis of each possible approach to meeting the corporate objectives.

— Finally, a corporate executive, no lower in level than Division Vice President, must himself become involved in the decisions and trade-offs.

The problem goes not go away by allowing it to slip unnoticed out of executive control. That just increases the risk of unexpected trouble in the future.

THE STORED PROGRAM CONCEPT: ORIGINATOR?

1. From: Erwin Tomash
Woodland Hills, California 91364

The stored program concept is usually attributed to Dr. John von Neumann. Did he originate it?

2. From the Editor

To the best of my knowledge Dr. John von Neumann did not originate the stored program concept, but picked it up from visits to computer laboratories. I believe that the stored program concept (that instructions should be stored in the memory of a computer just like numbers, so that both could be computed) was probably originated by Dr. John W. Mauchly and J. Presper Eckert during their work on the ENIAC computer and its successors. I know that I proposed the concept to Dr. Howard Aiken in 1945 and he rejected the concept at that time as unnecessary and impractical. But he subsequently incorporated the concept in what he called the Subsidiary Sequence Calculator. The concept was in the air in the 1940's and could hardly have been avoided. □

The Computer "Glass Box":

Teaching with APL – Iverson's "A Programming Language"   Part 1

Howard A. Peelle, Director
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"This approach utilizes a computer program more as a glass box than a black box, and seeks to make key computer concepts become transparent to the student."

Introduction

The COMPUTER GLASS BOX is a vigorous new approach to teaching with A Programming Language/1/. In this approach, short and quickly comprehensible computer programs are given to students for their direct viewing. Each program embodies a concept, a procedure, or a relationship and is written as simply and clearly as possible. The inner workings of such a program are visible and, hence, become the basis for learning.

This approach utilizes a computer program more as a "glass box" than a black box, and seeks to make key computer concepts become transparent to the student. The program's formal definition -- expressed in the explicit terms of a programming language -- serves to elucidate and reveal understanding. By observing the structure of a program as well as its behavior, the student attains a clear understanding of many important concepts.

Related Research

The glass box approach represents a synthesis of ideas put forth by three other researchers. Seymour Papert of M.I.T. has recommended that children study procedures actively by using a computer programming language (called LOGO) as a conceptual framework (1). Kenneth Iverson of IBM has persistently stressed simplicity and generality in using APL to exhibit fundamentals in a variety of mathematical and scientific disciplines (2). Paul Berry of IBM first advocated open use of APL as a strategy for teaching in what he called the "functional approach" (3).

Characteristics of the COMPUTER GLASS BOX Approach

In contrast to conventional computer-assisted instruction (CAI), the glass box approach allows the student significant control over his own learning processes. This control is achieved through the activity of programming. Programs can be entered independently by the student via a computer terminal, and their use requires no other pre-stored curriculum material -- as do most CAI applications. Indeed, making the full power of the computer accessible to the learner is the complete opposite of the kind of CAI characterized by programmed instruction, tutorial, or drill-and-test sequences.

This approach is pedagogically suitable for a wide range of educational levels -- from elementary school children to university graduate students. Especially for children who have been held powerless in lock-step educational systems, the use of the computer in this way opens up new worlds of learning -- active learning, learning with power.

Using glass box computer programs, students can proceed to learn during several complementary activities. Specifically, they can:

EXAMINE the program's definition (intuitively)
ANALYZE the program's definition (logically)
PREDICT the outcomes of the program
EXECUTE the program on a computer
SCRUTINIZE the program's behavior
EXPERIMENT with different applications of the program
MODIFY or expand the program
GENERALIZE the program
INVENT new or related programs, and
DISCUSS implications with teachers and peers.

These student-initiated, student-responsible, success-oriented activities differ dramatically from frantic hand-waving about abstract concepts often seen in classrooms.

The ideal glass box program is also expository -- it 'speaks' to its reader, explicating concepts and procedures in concrete terms. Desirable characteristics of such a program are: simplicity, comprehensibility, flexibility, generality, elegance, and provocative implications.

By "simplicity" I mean that a single idea of modest scope is to be taught using a brief program (about 10 lines of APL coding, taking less than 5 minutes to type). By "comprehensibility", I mean using clear, readable commands (usually one per line) with well-chosen mnemonic identifiers. By "flexibility" I mean a program design which is easily modified and which can be used with other programs in modular structuring (nested subprograms with explicit resultants). By "generality" I mean developing mathematical models which can extend to a class of cases. By "elegance" I mean choosing expressions which strike one's aesthetic chords. And, finally, a glass box program is "provocative" when its implications suggest interesting follow-up discussions.

To the extent that these characteristics foster insight and learning, a glass box program is, itself, a pedagogical agent.

Examples of Glass Box Programs

To illustrate this approach, some sample glass box APL programs are described below, with accompanying suggestions for extending their use in teaching-learning settings. The sample programs are chosen from special topics in the following areas: psychology, cybernetics, computer art, and computer assisted instruction.

Psychology

With computer programs suitable for viewing, students may learn some fundamentals of psychology. In studying behavior, for example, consider the following APL program/2/ which models -- albeit crudely -- an emotional reaction.

TEMPER is a program which will, under certain conditions, "get mad at you".

```
    ∇ TEMPER
[1]   EMOTION ← 0
[2]   NEW: EMOTION ← □ + EMOTION÷2
[3]   →MAD IF EMOTION > 10
[4]   →NEW
[5]   MAD: '**!?!**?!!'
    ∇
```

The program begins with zero EMOTION and then encounters a series of numbers, representing 'events' in the life of the program. A low number is low in emotional significance; whereas high numbers are highly emotion-producing.

Each time a number is entered, the program generates a NEW EMOTION based on a simple mathematical model: EMOTION becomes the number just entered plus one half of the previous EMOTION. (In the course of human events, this might be akin to the ameliorating effect of time on emotional burdens, i.e. 'sleeping on your troubles'.)

This process continues until a test condition -- the "threshold" for mad behavior -- is exceeded. The program goes MAD if EMOTION ever becomes greater than 10. (**!?!**?!! is the computer's programmed vernacular.)

NOTE: IF is a sub-program used to facilitate the reading of branching commands. Its definition is:

```
    ∇ BRANCH←LINE   IF   CONDITION
[1]   BRANCH←CONDITION/LINE
    ∇
```

Its syntax is —➤ (line number) IF (condition) It means that IF the condition is true (evaluates to 1), the program branches to the line number (or line label) given; IF the condition is false (evaluates to 0), the program branches to the next line.

To use the program, the student types its name (TEMPER) and then enters a sequence of numbers. For example:

TEMPER

□:

Where a 4 is like "stubbing your toe", 4

□:

6 is like "losing your wallet," and 6

□:

8 is like "missing the last bus." 8

!?!?!!

This sequence produced MAD behavior. **!?!**?!! But suppose one tries entering the same numbers in a different order:

TEMPER

□: 8

□: 6

□: 4

□: →

Here, the program does not display MAD: '**!?!**?!!'. Apparently, (for this model) the sequence 8 6 4 is "tolerable," whereas the previous sequence 4 6 8 clearly was not tolerable!

Again, this suggests an analogy with human behavior: experiencing the most emotion-packed events first and then tapering off may be more tolerable than the reverse.

Other variations of input also suggest interpretation in terms of human psychology. Sandwiching a low-emotion event between two high-emotion events, say 7 2 7, can make the total sequence tolerable; by contrast, the events 7 7 2 and 2 7 7 produce mad behavior.

The mathematics underlying this TEMPER model can be exposed quickly and naturally. For example, after some experimentation with the program, one might wonder: How many 5s can the program take before it 'blows its top?'

TEMPER

□: 5
□: 5
□: 5
□: 5
□: 5
□: 5
□:
.
.
.

THE IMPACT OF COMPUTERS ON SOCIETY:
A Current Course Outline for Computer Science Students

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"Too often the teaching of science for the sake of science, has brought about a Pontius Pilate attitude — of washing one's hands of the results and side-effects of science upon people."

Introductory Note

This article presents a suggested course outline for upper division Computer Science students, both majors and minors. It is based on several years of class-testing and teaching of Computers and Society on both lower and upper division levels.

Background

The teaching of computers and society is somewhat like the teaching of citizenship: it is difficult to accomplish; and there are those who question whether citizenship (or constructive uses of computers) can be adequately taught. This course is an attempt to focus upon specific issues that are considered to be vital concerns for the computer scientist. By focusing upon social issues relating to computers and their applications, the student receives an exposure to concerns that are not sufficiently covered in technically-oriented computer science courses. Of course, teaching of constructive uses of technology does not insure socially responsible professional functioning. This is a personal decision for the individual. But it is highly probable, that such a course, taught during the formative stages of undergraduate development, may leave an imprint upon the young professional's mind, to induce socially responsible behavior, resulting in what Norbert Wiener called "the human use of human beings".

Pursuit of Pure Knowledge

There has been a long tradition in science of the "pursuit of truth" or pure knowledge for its own sake. This same tradition has permeated computer science. Too often, the teaching of science for the sake of science has brought about a Pontius Pilate attitude of "washing one's hands" regarding the results and side-effects of science upon people.

But computer applications permeate the lives of people to a greater and greater extent. So it becomes the responsibility of computer professionals to consider the social and moral implications of the uses of computers. In regard to this new science, it is to be hoped that the practitioners may exercise superior levels of technical skills, combined with wisdom and humane attitudes.

General Objectives of the Course

1. To expose the upper division technical student to specific contemporary social issues that involve the computer, computer systems and applications.
2. To acquaint the Computer Science major or minor with readings and topics not developed in technically-oriented courses.
3. To develop questioning attitudes regarding social issues involving computers and people.
4. To expose the student to current legislation involving computers in the United States and in the world at large.
5. To identify a set of characteristics as evidence of professionalism.
6. To encourage consideration and practice of humane computer usage that enhances the quality of life.

The suggested text is "Social Issues in Computing" by Gotlieb and Borodin, Academic Press, New York, 1973.

Method of Presentation

The seminar approach is recommended, with text serving as one resource. Since the variety of suggested topics is very generous, a definitive bibliography, coded for user convenience, is given. From experience in teaching such a course, it has proved advantageous to have students identify one or more major concerns of intense interest to them, and to have them thoroughly research specific topics in addition to those covered in the source text. Personal experimentation, interviews, projects, etc., often offer a departure from passivity evidenced by undergraduates in class discussions. Too often the student will read and cite authors, and yet undergo little active thought processes. Encouragement of genuine questioning is necessary, and seeking of personal solutions, rather than relying upon authorities and their ideas. Analysis of subjective reactions and objective ideas and responses is valuable. Formulation of personal, well-thought out syntheses can and should result from such a course. Use of resource speakers is highly recommended to augment class presentations.

Computer Programming by Students

This specific course is intended for juniors or seniors with moderate to advanced computing backgrounds. It involves no programming per se (although students may choose to examine or work on programming projects as part of the course). The course may be used for interdisciplinary students with sufficient computer backgrounds.

Following are suggested topics for reading and discussion:

Computer Users — Specialists and Non-Specialists

The Emerging Elite or the New Technocrats
Specialist Training vs. a Broad Education
Educating Computer People for a Constantly Changing
    Profession
Non-Specialists: Every Man as a Computer User vs.
    the Professional
User-Oriented Systems
Machine Languages vs. Natural Languages
Interfacing with People and Meeting Their Needs
Computing for the People and by the People
The State of the Art vs. Obsolescence of Technical
    Training
The Changing Role of the Specialist

Computers and Applications — Survey

Business, Economics, Trade, both National and
    International
The Computer and the Law — the Government and
    Computers
Social and Behavioral Sciences — Implications,
    Potential
Physical and Natural Sciences — Measuring the
    Measurable
Humanities — Defining the Less Measurable - Present
    and Future Applications
Biomedicine, Medicine, Psychiatry
General Interdisciplinary Uses of Computers
Industrial Applications
War Games and Military Uses
The "Real World" Outside Academia, and Computer
    Applications in the Real World
Comparisons of Computer Applications Surveys
Predictions of Computer Applications (Science
    Fiction vs. Science)
Where Do I Fit? What Do I Want to Do with the
    Computer?

Computers, Education, Instructional Media

Research and Computer Usage (Languages, Systems,
    Techniques)
The Computer in Elementary and High School Education
    and Special Education
Computers and Higher Education — Present, Future
Computers and Instructional Media (Computer Managed
    Instruction, Computer Assisted Instruction, Film,
    Audio/Visual Systems)
Self-Teaching, Peer Teaching and Computers
The Teacher — Present Roles, Changing Systems,
    Future of the Instructor
Education for the Future — Questions, Definitions,
    Implications
Speeding up the Human Processor
Learning for Living — Lifelong Learning
Practical, Broad Goals for Higher Education (the
    "Renaissance Man" for Today)
The Computer as a Medium

Computers and the Study of the Future
(Predictions, Models)

Simulations, Models, and the Future
The Future vs. Today and the Past
Surveys of Simulations — Systems, Languages
Comparisons of Models (Regional, National, World)
Planning Alternative Futures vs. Laissez Faire
    Procedures and Attitudes
Implementing Planning into Legislation and Living
Computers as an Aid in Solving Problems (Regional,
    National, International)
Computers and World Problems (Underdeveloped,
    Developed Countries)
Knowing How and Knowing Why - Getting Beyond
    Technocratic Thought; Integration of Human
    Concerns with Models and Simulations
The Future of Computers and the Study of the Future

Automation, Production, Employment and Leisure

Automation vs. the Assembly Line
Employment and Self-Actualization
Technology, Productivity, Labor
Retraining People — Upgrading Human Capacities
Lowering the Working Hours Per Week vs. Profits
The Work Ethic vs. the Leisure Ethic
Obsolete Professions, Jobs and Changes in Employment
Educating for Leisure, Recreation
Replacement of People by Machines vs. New Jobs
    Created by Technology
Computers and the Humane Use of Human Beings
The Resources of the Earth; Production and
    Employment
New Attitudes Towards Products, Services (Limits
    to Growth)
The Computer and the Art of Living

Computers, Credit Bureaus, the Cashless Society
and Data Banks

The Trend Towards the Cashless Society
New Definitions of Privacy
The Right to Access of Information and Correction
    of Information
The Womb to Tomb Dossier — Implications
The Need to Know and the Collection of Information
Efficiency, Cost-Saving — Considerations of a
    National Data Center
Data Banks — Pros and Cons
Retrieval Systems, Libraries, Archives —
    Practicability, Feasibility
The History of Information-Gathering; Surveillance
Civil Liberties, Kinds of Privacy
Comparisons, Regional, National, International
    Privacy Laws
Pending, Future Legislation
Security of Systems and Protection of Information

Computers, Human Thought and Creativity

Comparisons, Computer Capacities vs. Human (Present)
Comparisons, Computer Capacities and Predicted
    Futures (Man and the Computer)
Definitions of Thinking
Definitions of Creating
Artificial Intelligence, Human Intelligence and
    Learning, Synthesis Formulation
Science Fiction, Fact — Comparisons
Learning Computers, Heuristic, Creative Systems
    and Man's Ego
Thought and Creativity as Processing
Leaps of the Imagination in Man (and Computers?)
The Computer as an Extension of the Mind of Man
Intelligent Computers and Intelligent Humans
The Future of Man and the Mind of Man

Careers in Computer Programming for Blind Persons

Judy Jones and
Louise Eckebrecht
Great Western Financial Corporation
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"I finally came to a point in my life where I had to decide what to do with myself. I thought I'd give programming a try."
—Maryann Barrios

A career in computer programming for the blind would seem highly improbable to most people, especially to those who can see.

But not to a growing number of visually handicapped people who are succeeding today as professional computer programmers, like Dieter Raeker, 41, and Maryann Barrios, 25, working at Great Western Savings and Loan Association's data center in Los Angeles, California.

Great Western was introduced to their computer abilities through a program sponsored by the California State Department of Rehabilitation. The department has contracted with Systems Development Corporation (SDC) in Santa Monica, California, over the past nine years to teach to small classes of visually handicapped people an eight month training course in computer programming.

Strict Qualifications

Invited along with other companies to attend an orientation program, Great Western became convinced of the program's professional operation; later they interviewed and hired these two from a class of ten graduates. There are strict qualifications each candidate must meet before acceptance into the program.

Visually handicapped people do not need to have any prior experience in computers; but the typical graduate of a class has an I.Q. of around 130 and has had two or more years of college. In addition to high scores on a battery of aptitude and reasoning tests, the students must also demonstrate good skills in general orientation and mobility, for they are expected to work as independently as the sighted employees next door.

"There are no special arrangements made for these students during training or on the job," said John Millen, tri-regional coordinator, Services for the Blind and Visually Impaired, California Department of Rehabilitation. "This year's class will cost the State about $53,000; so we must keep our standards high. Our main objective is to get visually handicapped people off the welfare roles and into productive jobs. This way, taxpayers will be paid back many times over through the years."

Maryann Barrios

Maryann Barrios is a Cal State Los Angeles graduate in sociology; she was directed to the Department of Rehabilitation by a friend in computer programming.

"For a number of years I was a governess for three children of friends. I finally came to a point in my life where I had to decide what to do with myself. I thought I'd give programming a try." Ms. Barrios is able to distinguish some objects, although she is legally blind. She is quite open and frank about her handicap; she seeks to maximize all she has to offer.

Dieter Raeker

Blind since six, German born Dieter Raeker's business experience and two years of study at Santa Barbara City College is helping his transition to computer programming. He said, "The blind are forced to think in the abstract for every kind of daily activity. This abstract thinking has been very helpful in learning how to program."

The SDC training course includes the same curriculum that a sighted person would need to complete in order to be able to design, test, and implement programs using computer language. Following are questions that prospective employers ask, and the replies.

Performance of Blind Programmers

Question: Just how well do blind computer programmers perform?

Answer: (by Jim Sigl, an SDC instructor who is also blind and who was the first graduate from the visually handicapped training program in 1966.) "SDC has found that these visually handicapped students use to the fullest and out of necessity their natural talents, especially in memory and logic sequences. Their persistent work habits and dependability also indicate to an employer that they are likely to stay on the job."

Question: How do you treat a blind employee?

Answer: "Just like anyone else. The training classes have the same curricula, the same presentations and the same standards used in classes for

the sighted. The only difference is that the lectures are taped, and a copy is provided each student for his review."

Question: What do I do if he doesn't work out?

Answer: "Fire him. You can't expect to make money carrying charity cases, and these trainees don't want pity or charity.

Question: How do blind employees get around an office and to and from work?

Answer: "After an initial orientation tour, they're on their own, just like any other employee. They're on their own getting to work too; they're fully capable of handling the situation."

Reading the Program Output

Question: How does a blind person read his output?
Answer: "Some of them can read, although the totally blind need help. The students are trained to segment their programs so that logical errors can be located with relative ease. By segmenting their programs, for instance, they know where an error is likely to be; therefore, anyone who can read numbers can check the printout as instructed by the student and locate the offending bug. If necessary, programs are provided that will produce Braille printouts on standard line printers. Also, a new device called the Opticon has been designed allowing a totally blind person to read regular printed matter. An electronic probe is passed over the printed material with one hand while the fingers of the other hand feel the shape of characters by receiving prickly sensations."

Question: How do they read the specifications and attendant documentation?

Answer: "This again is their responsibility. They hire readers, probably on their own time, and tape the documentation, as it is read, for reference."

Question: Can they work as maintenance programmers?

Answer: "Yes. The student can be sufficiently sighted to read existing programs or he can have the programs and documentation taped."

Coding and Flow Charting

Question: How do they code their programs?

Answer: "The program is initially designed using numbered statements and coded in Braille. If the student is going to keypunch his own program, he may record it at his desk and send it over to a keypunch installation. Some keypunch operators prefer the clarity of a typed program in lieu of the squiggles done on a coding machine."

Question: How do they make flow charts?

Answer: "The totally blind use numbered statements that reflect program sequence. A finished flow chart can be made from a series of typed, numbered statements by a clerk simply drawing the appropriate boxes around the statements."

Special Devices

Special equipment to aid students who do have some vision is provided free by the State and accompanies the student to his new job. Examples are Dieter Raeker's closed circuit TV reader, which blows up a printed letter many times its original size, and Maryann Barrios' magnifying flash light. Also there is no charge to the student for taking the course.

"We usually place most of our graduates in jobs said Mr. Millen. "We were most pleased that Great Western was the first to hire from our graduating class this year."

The barriers are lifting. Visually handicapped programmers are opening the eyes of the sighted and raising the hopes of the blind by tackling and successfully handling sophisticated work such as computer programming, and proving their capacity as productive members of society.   □

The Social Responsibility of Computer Professionals and Scientists

Science for the Sake of Science? or Society?
Cause and Effect
Personal Definitions of Social Responsibility
The Information Engineer
Identification of Characteristics of a Professional
Theory vs. Reality in the Attitudes of a Professional Person
The Practical Aspects of Being Socially Responsible — Beginning and End
Comparisons of Codes of Ethics with Other Professional Groups
The Association for Computing Machinery, Social Responsibility: Dream, Tokenism, or a Reality
Social Responsibility in Developed Countries, Underdeveloped Countries
Ethics, Money, Success — Can We Have All of Them?
Social Responsibilities of Education, Industry, Government
The Responsibilities of Every Person; Albert Einstein's Ideas

Computers, Technology and Man's Future in the World

Is Technology a Panacea for the World's Ills?
Definitions of the Major Problems of the World? Nation? Region?
Inter-Relationships between Developed and Underdeveloped Nations
Computers and the Distribution of the World's Goods
A World Ethic in a Cybernetic Age?
Technology and the Basic Needs of Man vs. the Quality of Life: Questions
Computers, International Science and Global Affairs
The Democratic Process and Society and Computers
The Environment of the Earth, Man and Computers
The Cybernetic Renaissance — Potential for Mankind and the Earth
What Is My Role in the Future? Significance vs. Insignificance of the Individual
The Man-Machine Symbiosis — Questions and Implications

Evaluations of Students

Each instructor will have varying ideas of evaluations. Recommended: Varied forms of student processing, oral, written, research, project, etc. Not Recommended: True/false questions, multiple choice questions; just one form of student reaction (for example, all response written papers). Recommended: Both individual and group work. Emphasis on thinking, speaking, writing, questioning, debating, interviewing, first-hand investigation, in addition to reading.
                □

Industrial Mathematics: A Course in Realism

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"An industrial mathematician cannot afford to be just a mathematician: he must also be a scientist."

Introduction

There is an anxiety experienced by most mathematics majors as they approach graduation and contemplate a career in industry. The basic cause for this anxiety is the desire to foresee this environment in which they hope to exist as an industrial mathematician. During the academic year 1972-73 at the University of Pittsburgh, a course, Industrial Mathematics (M111), was designed to relieve this anxiety to some extent by exposing the student to a simulated industrial environment. I take this opportunity to report on its seeming success as well as some views on preparation of industrial mathematicians.

What Is "Industrial" Mathematics and What Is The Primary Function of an Industrial Mathematician

Contrary to popular belief, the primary function of an industrial mathematician is not just problem solving! I once heard a colleague, when asked by a student what a mathematician does, make the statement that pure mathematicians prove theorems and applied mathematicians solve problems. I do not accept either as a close approximation to reality if one considers them literally. An industrial mathematician does much more than solve problems.

E. H. Bareiss /1/ says "mathematics is an art, a language, a tool and a means of accounting." A metaphor might be that mathematics is an existence-uniqueness theorem, a differential equation, a computer algorithm and an analysis of heat transfer. Barreis continues . . . "From the point of view of the professional mathematician, the art of mathematics ranks most prestigious, followed by language and tool. Accounting (or accountability) is often not considered mathematics at all. From the standpoint of industry, the order of importance is reversed, for the art has often no necessary connection with the physical world and is therefore of little immediate value, whereas the language and the tool clearly have value, and, without accounting our techno-society could not exist."

I assume that each member of the class in industrial mathematics has a preconception of what mathematics is, and submit that the above quotes serve to distinguish "industrial mathematics" from mathematics as most seniors are conditioned to envision it. Perhaps modern industrial mathematics should more aptly be called scientific computing, which Garrett Birkhoff /2/ defines as "the art of utilizing physical

intuition, mathematical theorems and algorithms, and modern computer technology to construct and explore realistic models of problems arising in the natural sciences and engineering."

A question related to: "What is industrial mathematics?" and one which is somewhat easier to answer is: "What is the primary function of an industrial mathematician?" M. S. Klamkin /3/, delineates five aspects or stages of the "evolution and dispatch" of an industrial problem:

1. Recognition
2. Formulation
3. Solution
4. Computation
5. Explanation

I recommend that the reader refer to /3/ for an elaboration of these stages of "problem solving." It is precisely these five aspects of an industrial environment which are simulated in M111.

The Uses of Mathematics in Industry

The uses of mathematics in industry are as varied as the number of industrial mathematicians themselves; so no single course could hope to survey more than but a limited few applications (undoubtedly biased by the interests of the instructor). Only one real world problem is analyzed by an M111 class during the fifteen week term; however, great care is taken to introduce the student to all the ramifications of being asked to "solve" such a problem.

The primary goal of M111 is the exposure of each student to a simulated industrial environment and the specific mathematical problem or use of mathematics discussed is but a means to this end.

Let me conclude this section with some truisms that are worthy of the readers' consideration and which are subtly revealed during the M111 course:

1: An industrial mathematician cannot afford to be just a mathematician, he must also be a "scientist."
2: An industrial mathematician normally works in a group with two or three other mathematicians or scientists. (Bareiss calls this the team approach.)
3: An industrial mathematician spends considerable time communicating his ideas and findings in writing and orally.
4: An industrial mathematician is often viewed and justified as a parasite on more product-oriented scientists and engineers.
5: An industrial mathematician may be hired primarily to fulfill the function of an economist, physicist or engineer, if he is so qualified.
6: An industrial mathematician, just like any other

human being, experiences moments of ecstasy as well as moments of frustration and boredom.

7: Not all aspects of "problem evolution and dispatch" are glamorous. Different aspects appeal to different people.

8: An industrial mathematician is a buffer between the physical scientist or engineer and the computer.

Industrial Mathematics Course Ingredients

The following ingredients are suggested as a guide to a realistic course in industrial mathematics:

(1) A class of problems is chosen which contains some new mathematical material for the students, is of sufficient depth to consume fifteen weeks of concentrated effort and is amenable to illustrating the five aspects of problem evolution and dispatch. A realistic model also allows for varying of problem parameters.

(2) The class works as a team under the supervision of the instructor to recognize, formulate, solve, compute and explain the problem.

(3) Explicit assignments are made to each student according to his capabilities. Some students undoubtedly contribute more to the team than others—such is reality.

(4) Computer implementation of an algorithm on a realistic level is essential. The problem is not rigged to give pathological or "textbook solutions." It need not require sophisticated mathematical techniques for solution, but must be sufficiently complex, so as to require careful and skillful analysis and development to avoid catastrophic results.

(5) Problems which are of current industrial (research) interest are highly desirable in that they tend not to yield easily to "clean" textbook solutions and also tend to generate more enthusiasm and a sense of real accomplishment on the student's part when he realizes he is treading over "virgin territory" or at best "roughly mapped terrain."

(6) Progress reports, one page in length, are written by each student at appropriate stages of development and some class time is allocated to a critique of them.

(7) Guest speakers from industry, with varying expertise, greatly enhance the course.

(8) One-third to one-half of the class periods are spent in the discussion of specific problems the students encounter and approaches to resolve them.

(9) The class is split into groups of 4-5 students to handle specific tasks such as programming a particular subroutine. Each such group then reports orally to the entire class on their progress and approach to their task.

(10) Documentation, to include the physical problem, mathematical model, algorithms, computer program and sample problems is the primary concern during the last few days of the term.

Sample Course Modules

M111 was taught twice during academic year 1972-73 at the University of Pittsburgh, in the Fall Term to 9 students and in the Winter Term to 20 students. The students were primarily seniors, mathematics ma-

jors and computer science minors. In general terms the two problems considered were:

1. Fall Term: Reduction of Cinetheodolite Data

Cinetheodolites are angle-measuring instruments used to determine the trajectories of rapidly moving aerial targets or missiles. Two or more cinetheodolites are placed at known positions on Pitt Field and record, on 35 mm film, azimuth and elevation angles to the missile for various values of time. They are synchronized with the Student Union clock so that for each time value, each cinetheodolite determines a "line of sight" to the missile. Due to errors, these lines of sight do not intersect, and the most likely missile position is determined by the method of least squares. That is, given a set of observed azimuths and observed elevations, one seeks perturbations such that the lines of sight determined by observed azimuths and elevations modified by the perturbations intersect in a unique point and such that the weighted sum of the squares of the residuals is a minimum.

After some discussion of the cinetheodolite system and data collections and film reading procedures, two mathematical models were formulated. Each yielded approximate mathematical solutions.
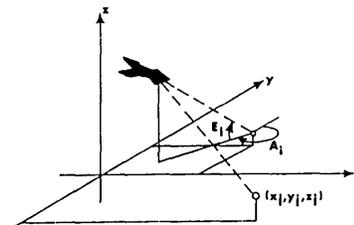
Figure 1: Cinetheodolite data are azimuth A and elevation E to the target for each time value.

Using trigonometry, linear algebra and calculus the mathematical solutions to these models were determined and the necessary computer programs were written and debugged.

Several examples were designed to illustrate the programs and models. A 50 page report was written to document the project.

Sample Problem: The following camera co-ordinates and observed azimuth and elevation data are given for a fixed value of time.

Camera number	Camera coordinates			Observed	
	x	y	z	Azimuth	Elevation
1	4000	5000	1000	237.0364	0.0
2	1300	1200	0	255.9639	38.9539
3	1300	−1200	0	107.0361	38.9538
4	2800	1700	5	219.3633	21.8942
5	2800	−1700	5	136.6367	21.8942
6	200	2500	0	287.7447	20.8553
7	1600	100	10	190.4622	58.4325
8	−2000	−800	15	15.9314	17.6014
9	− 600	700	0	336.3706	29.7953
10	1050	90	0	245.9453	84.1217

The 'best' approximation to the position of the target or missile for this time frame was computed to be

$$x = 985.4284, \quad y = -0.2429, \quad z = 1004.4879$$

2. Winter Term: Finite Difference Solution of Steady Heat Flow

Heat Flow through a thin sheet of metal gives rise to a temperature distribution which is position dependent. The governing laws of physics for steady state reduce to a second order elliptic partial differental equation (PDE) which can rarely be solved in closed form. Finite difference methods are implemented to approximate the PDE at a finite number of points in the problem domain.

Depending on the shape of the sheet of metal, one coordinate system may be more natural than another. Quite often the given PDE can be transformed via a change of coordinate systems to an equivalent PDE with domain the unit square. The class formulated such transformed heat flow problems on the unit square.

A finite difference model was developed and programmed. The resulting program HEAT utilized block Gaussian elimination with up to 625 mesh points. The output included an approximation to the solution of the PDE at each mesh point, along with a CALCOMP plot of a piecewise bilinear surface which passed through this set of data. This plot then represented graphically a "good" approximation to the temperature distribution of the transformed problem. Finally a plot of the approximate temperature distribution of the original problem was generated.

Sample Problem: A sample partial differential equation was solved numerically by HEAT with maximum mesh point errors as indicated below. See Figure 2.
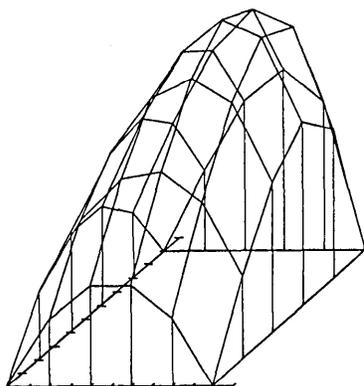

Figure 2: The finite difference solution over a uniform 4 by 4 grid

Sample Problem: Another partial differential equation was then also solved numerically over the square, using HEAT with a 24 by 24 finite difference grid with a minimum mesh point relative error of 0.61%. See Figures 3 and 4.
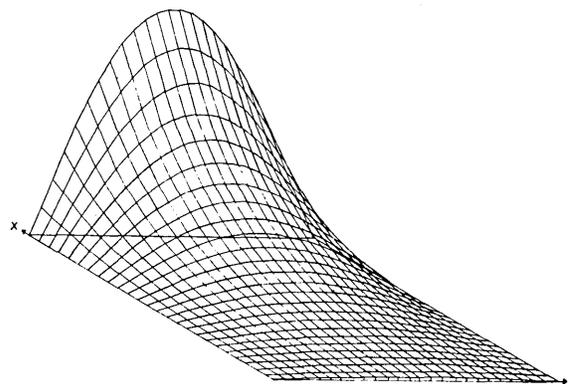

Figure 3: The finite difference solution to the transformed problem with a uniform 24 by 24 grid.
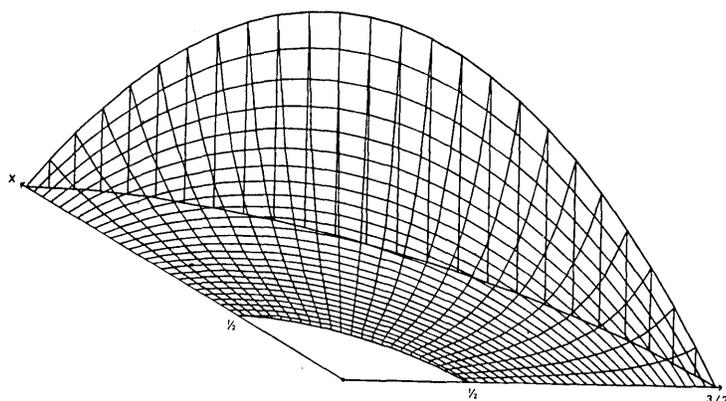

Figure 4: Approximate temperature distribution generated from the finite difference solution in Figure 3 by inverting the coordinate transformation.
Note that the surfaces in Figures 3 and 4 represent the same function relative to different coordinate systems.

During academic years 1973-74 and 1974-75 other material used dealt with:plate bending; network analysis of a steam generator;and diffusion of electrons in fluorescent lamps.

References

1. E. H. Bareiss,"The college preparation for a mathematician in industry," American Mathematical Monthly, 79 (1972) 972-984.
2. Garrett Birkhoff,"The numerical solution of elliptic equations," Regional Conference Series in Applied Mathematics, SIAM, 1971.
3. M. S. Klamkin,"On the ideal role of an industrial mathematician and its educational implications," American Mathematical Monthly, 78 (1971) 53-76. □

Peelle — *Continued from page 13*

A sequence of 5s builds up EMOTION to higher and higher values, but never reaches 10. This process parallels the well-known geometric series 1, 1/2, 1/4, 1/8, 1/16, 1/32 ... the sum of which converges to 2. Exploring in this way, a student may gain some insight into the nature of infinite series in an active and interesting (at least less abstract) setting.

Some simple modifications of the TEMPER program students might make are to: (2) change the threshold, e.g. from 10 to 25 for higher tolerance, or to ?25 (a random number) for unpredictable behavior;

(b) modify the model, e.g. from EMOTION + 2 to EMOTION + 3 to express stronger 'forgetting'; (c) adapt the program for use by others, e.g. inserting conversational statements such as 'ENTER NUMBERS FROM 1 to 9' or even 'CAUTION! THIS PROGRAM MAY BECOME EMOTIONAL...', and (d) make the program dynamic, e.g. automatically resetting EMOTION to 0 after an emotional catharsis.

Possible extensions of TEMPER include: (a) writing related programs, such as a version with multiple emotional dimensions like ANGER, FEAR, and LOVE, and (b) writing companion programs, such as two TEMPER-like programs which interact with each other so that one's output is the other's input.

Using Employee Polls to Achieve Better Productivity

Woodruff Imberman, Vice President
Imberman and DeForest
Consultants to Management
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Chicago, Ill. 60604

"Plant managers are usually reluctant to undertake corrective programs because such programs do not result in the immediate profit improvements they like to show."

The Multiplication of Management Problems

There is no question that as our current inflation proceeds, labor pay demands will continue to sky-rocket, and management problems will multiply. The problem is how to offset those rising costs by boosting productivity. At year end 1974, output per man hour in the private economy was 3.7 per cent below a year earlier — while compensation per man hour was 9.8 per cent higher. What to do?

One avenue of salvation has occurred to many company presidents — to try to achieve increased productivity through better employee cooperation. This has led many companies to paper-and-pencil questionnaires — commonly called Employee Attitude Surveys — to uncover areas of employee dissatisfaction.

Our 3-year study of 127 companies that had used such Employee Attitude Surveys in order to improve internal relations produced some surprising results.

In brief, we found that 98 companies concluded the Surveys were "of little value"; 12 companies reported the Surveys "of some limited value"; and 17 companies found them "of immense value". The charts indicate some of the gratifying results achieved by the 17 companies: cuts in costs (of all kinds), improved shipment schedules, better utilization of machinery and equipment, better quality, lessened turnover, fewer formal grievances, decrease in scrap and spoilage, and, of course, greater profits. The special stars on each chart cover the Attitude Survey program periods.

Gold Mine for 17 Companies

How is it that 17 companies found a gold mine where 110 companies found little or no pay-dirt?

For answers, we studied 42 companies that found Attitude Surveys "of little value" and compared their experience with that of 17 companies that found Surveys "of immense value". The contrast was very instructive. A typical case might be cited here to illustrate what actually happens.

Sample Case Study

In the office of Henry Wadsworth, president of the Upper Tooting Corp., were three division vice-presidents, seven plant managers and the corporate

industrial relations director. Subjects to be discussed: labor unrest, how to prevent a strike over a new contract in two plants, how to avoid unionization of a third plant, how to determine employee attitudes in all eight company plants. In the background were other troublesome factors: productivity lag, some material shortages, the emergence of some price-cutting in the industry, and some order cancellations.

The meeting quickly established agreement on one point: employee morale was bad. Evidence cited by one division vice-president: in one union plant some employees were wearing "Strike NOW" buttons, although the contract renewal was seven months away. A plant manager described behavior in his non-union plant: high (and expensive) labor turnover, rising percentage of quality rejects, grumbling over cost of living (even though wage rates were "certainly competitive"), and nobody coming to his office despite his well-publicized "open door" policy. Also, he had "heard" from two foremen that union membership cards were being passed around.

The corporate industrial relations director talked about the swelling number of unsettled grievances piling up at several union plants. Productivity had been declining for the past eight months.

Theories and Excuses

One vice-president attributed his trouble to the union desire "to show its muscle" in preparation for next year's negotiations. Another vice-president talked about spontanious protests springing from intraunion conflicts between the ins and outs.

A plant manager talked of opposition to the new work standards in his non-union plant, although he was "sure" the standards were entirely reasonalbe. Another plant manager talked about the possibility of minority "resentment" because of the lack of minority supervisors. He said he could find no minority employees "qualified" for such promotion.

METAL FASTENERS
(1968 = 100)

Tonnage Shipped

Output Per Man-Hour

Overtime Man-Hours

⭐ = Survey Period
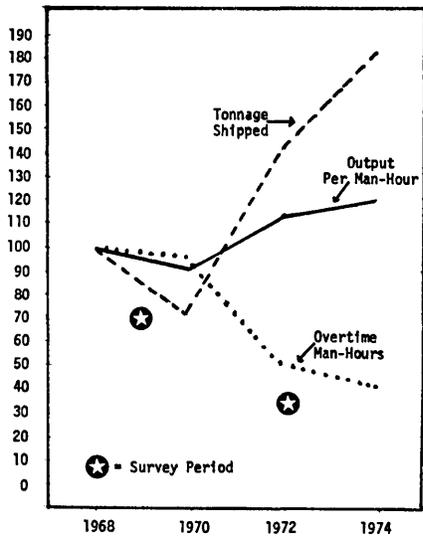
INDUSTRIAL CHEMICALS
Overtime & Output Per Man-Hour

Output Per Cent

Overtime Man-Hours

Output Per Man-Hour

Overtime Man-Hours

⭐ = Survey Period
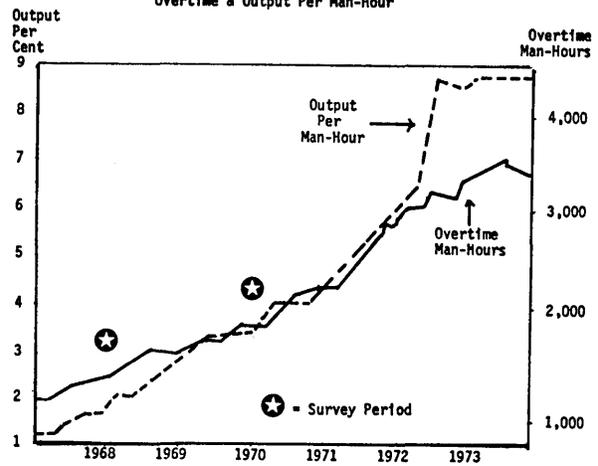
COMMUNICATION EQUIPMENT
Net Profit on Sales & Quality Rejects
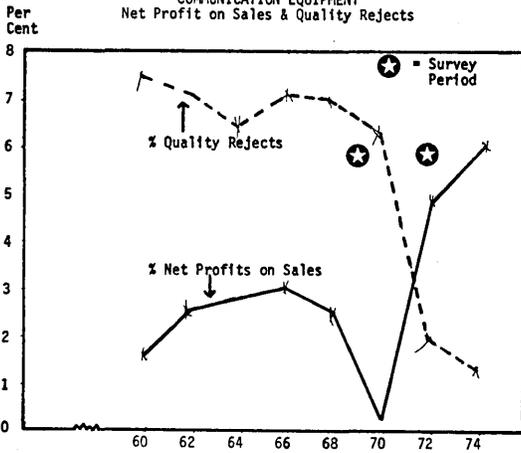
Per Cent

⭐ = Survey Period

% Quality Rejects

% Net Profits on Sales

PAPER COMPANY
1967 = 100

⭐ = Survey Period

CAPACITY

OUTPUT

ON TIME SHIPMENTS

%

PLASTICS PRODUCTS MFG.

Grievances

Net Profit On Sales

Formal Grievances Filed (Aver. Per Month)

Net Profit on Sales

⭐ = Survey Period

FOOD PRODUCTS

Per Cent

⭐ = Survey Period

Turnover Rate Per Month

Output Per Man-Hour % Gain Over Previous Year
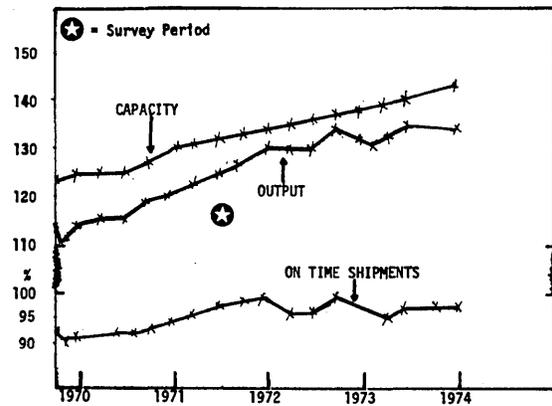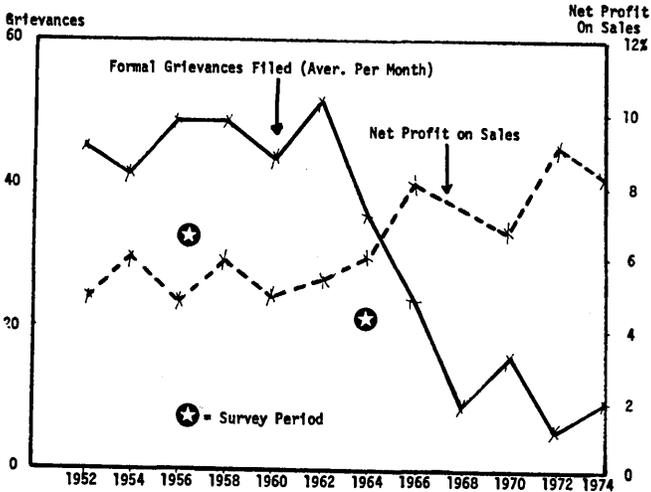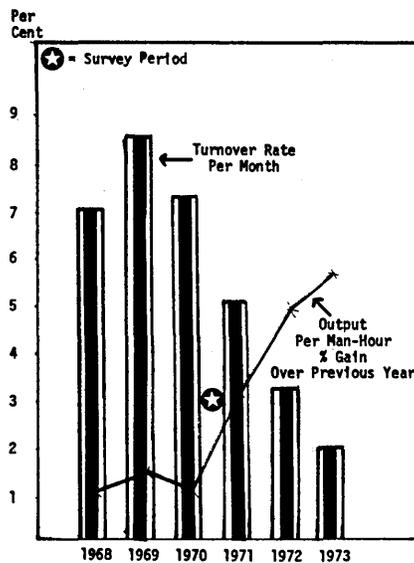
The industrial relations director discussed wage settlements and declining productivity — shaking his head over their "outrageous" character.

Some Financial Facts

To appreciate the full picture, some financial facts might be in order. The firm was a multi-plant operation producing computers, computer components, and electronic calculators. Its current asset to current debt ratio was 2.25 times. Net profits on net sales: 4.30 per cent. Net profits on net worth: 10.68 per cent. Net sales to inventory: 3.6 times. Inventory to net working capital: 86.1 per cent.

In short: not bad, but not great. Improvement was possible — if a strike could be prevented at two plants, if further unionization were avoided at a third plant, and internal improvements were brought about in all plants. But how?

At dinner that night, the president and the industrial relations director decided to use an Employee Attitude Survey in all eight plants. This would give them "a fix" on the state of employee morale, would enable them to ascertain what employees were dissatisfied about, give the company some direction on how to avoid a strike at two plants, avoid unionization at a third plant, and determine why employees were not cooperating wholeheartedly with management on improving productivity and cutting costs. Survey cost for eight plants coverting approximately 2,800 hourly employees (including foremen and middle management) was $16,800, or about $6 per head.

Employee Attitude Surveyors Began . . .

A month later, a firm preparing such general Surveys was chosen, questions for the paper-and-pencil Survey were roughly fitted to the company, questionnaires were prepared for distribution, and operation "Tell Management" began.

Three months later the final results were tabulated, broken down for the entire company, broken down for each plant, and broken down by departments. All the technical bases were touched by the Survey managers. What was the result?

It was found, for example, that in the two union plants (with threatening strikes) there was mixed dissatisfaction with company policies — referring to incentive rates, profit-sharing plans, sickness benefits and holidays. There were also complaints about harsh, abusive and tyrannical supervisors; lack of proper tools; favoritism in discipline. The company was said to be too miserly even to paint the washrooms.

In five other plants (both union and non-union) the feelings were somewhat different. Some gripes were directed at the pay scales, but major gripes dealt with dissatisfaction with maintenance, poor management credibility, foreman favoritism on job assignments.

In the one non-union plant on the verge of going union, the major complaint was pay and fringe benefits, pressure on the job (from some foremen), "tight rates" and inability to reach anyone in management to voice complaints about food vending machines, toilets, parking lot, etc.

. . . and Packed Up Their Tent and Went Away

Having laid all this out with coefficients of concordance and rank order correlations in a thick computer print-out, the attitude surveyors packed up their tent and went away.

The management group now faced the crucial point: what do we do now that we have this data? How do we go about making corrections? The road to correction was never indicated in the elaborate computer print-out. What to do specifically was never spelled out.

Moreover, the computer did not touch on the areas of human activity in which there are no quantitative answers — employee feelings, sentiments, emotions and ideas about their jobs, their supervisors, their company. These are the elements that normally create pressure in the boiler. In union plants, these elements cause employees to vote to strike. In non-union plants, the same elements cause employees to vote for a union.

In the Upper Tooting Corp. case, the contract proposals were subsequently rejected by the two union plants and a costly 4-week strike eventuated in both cases. In the non-union plant, a petition was filed for an NLRB election three months after the survey was completed, and the union won by a small margin. The margin was enough to bring in the union and a union shop.

But Surveys are Valuable to Some Employers

This actual case (barely disguised) is not cited to deprecate Employee Attitude Surveys. In 17 companies they were found to be valuable beyond estimation but in most of the other 110 cases, the Surveys did more harm than good since they set up expectations in the minds of employees that something will be done to eradicate the (sometimes imaginary) grievance-causing conditions. In many instances, this disillusionment expressed itself in distrust of superiors, organizational sabotage, production apathy and turnover. The companies wound up disenchanted with Attitude Surveys.

Actually, it was the companies' inability to discern the specifics and (sometimes plant managers' reluctance) to apply the remedies that were at fault.

Three Basic Steps

In the 17 companies that reported Attitude Surveys "of immeasurable value", we found that they used three basic steps (with many variations).

First Step: A morale survey was made in all company plants seeking to uncover the differences from plant to plant (or from department to department) in employee attitudes on company policy, quality of supervision, satisfaction with work standards and environment, pay and fringe benefits, perception of plant and corporate management, tools and equipment, and so on. Such a survey should be designed so that the questions pin-point problem areas.

The Fine Art of Making Corrections

Second Step: Making corrections where corrections are necessary, saying "maybe" where such replies are appropriate, and learning how to say "no" without arousing resentment — these are all ticklish matters and vital to success. This requires follow-up face-to-face interviews with key hourly personnel to get down to the nitty-gritty: which foremen are harsh and abusive? what is wrong with the sickness benefits? where is more preventive maintenance needed? why isn't the manager's "open door" policy effective? what's wrong with the vending machine food? why is management's credibility questioned? and so on.

These interviews are usually done by people experienced in interview techniques and whose know-

ledge of industry practice is broad and deep. Their advice on where and when to supply corrections is invaluable. In some cases, company executives had been trained by consultants to carry out the interviewing and corrective functions.

This finding that poor follow-up is largely responsible for the failure of many Attitude Surveys corroborates with the experience of Dr. David Sirota who points out:

> . . . As simple as it may seem, the soundest diagnostic technique consists of going directly to an organization's employees and asking them what's bothering them . . . Managers must seek out from employee opinion surveys hard evidence and take nothing on faith or on clever admixtures of various opinions on various subjects. Again, the point is best put simply: Find out what the problem is before butting in — and find out from the horse's mouth.
> ("Opinion Surveys: The Results Are In — What Do We Do With Them?", Personnel, American Management Association, Sept.-Oct., 1974.)

One interesting aspect, in our experience, almost always emerges in recommendations on corrections. On the management side, plant managers are usually reluctant to undertake corrective programs because such programs do not result in the immediate profit improvements they like to show. (Does a repainted lunch room or washroom or paved parking lot produce an immediate boost in Return on Assets?). Hence, without corporate pressure, plant managers may drag their feet on corrective actions.

On the other hand, the unions (but not the members) tend to sneer at corrective measures because union leaders thrive on maintaining an adversary system in dealing with management. So it takes some considerable finesse to effect the corrections needed without offending plant managers and union officials.

Internal Training for Foremen

Third Step: Since criticism of foremen is so common in these Survey findings, provision for foremen training has to be made. This training seeks to improve their interpersonal skills rather than their technical knowledge of the machinery and equipment. Can they win cooperation, build trust, improve morale? Can they manage people without being abusive, harsh and tyrannical?

So foremen training has to be provided — not just any generalized training available through standard university or trade association courses. Custom-tailored training must be designed — training keyed to the personnel problems and situations existing in that plant.

Outside courses get at a foreman only by taking him away from his job; inside courses can teach him in the best place of all — in the plant where the foreman works and which is directly related to his work. That is more effective than education outside.

Even if a training course is relevant to the man's job, he still faces what is known as the re-entry problem. He may have learned a better way in a training course, but will his plant management let him disturb the even, set tenor of their ways? Usually not. For these reasons, management training of plant managers and middle managers is essential to a well-functioning and effective foremen program.

Raising Employee Morale and Winning Cooperation

Given the three steps outlined — a carefully designed Attitude Survey, follow-up interviews on the specific trouble spots, coupled with a corrective program, and finally, foremen and middle management training — some companies have been able to harness a well-functioning cooperative work force to the achievement of company goals. The charts indicate some of these fine results.

Without these three steps, we found no successful use of Employee Attitude Surveys in our research covering 124 companies.

We are now entering a period of lessened consumer demand, a heightened pressure for price curtailment, an increased need for higher productivity and lower costs. This refers not only to labor costs. There are other costs also: manufacturing costs, material costs, capital costs, distribution costs, packaging costs, research costs, and other costs. Any technique that enables a company president to ascertain how improvements can be made in any of these costs while at the same time improving employee morale is a wonderful thing to take hold of.

Numerous examples of the many ideas flowing from employees in the course of follow-up interviews appear in the article, "The Low Road to Higher Productivity" by this author in the January 1975 issue of the National Industrial Board's The Record. (Single copies are available free to any executive by request to the author.)

The Employee Attitude Survey can be a step in a process of uncovering cost saving opportunities — but it is only the first step. What follows afterwards determines the ultimate success of the entire process.   □

Peelle — Continued from page 20

In the area of cybernetics, students can be introduced to some sophisticated ideas by using simple computer programs. The analysis of scenes, for example, is an important part of research in robotics. In designing machines that "see", it is important to know what types of scenes can be computationally distinguished. Consider the two scenes below:

SCENES

(1)

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********
*
*
*
********
       *
       *
       *
********
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(2)

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********
*      *
*      *
*      *
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********
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Computing and Data Processing Newsletter

FOR THAMES ROWING CLUB, A COMPUTER DOES THE TIMING

William C. Goodwyn, Jr.
TRW Electronics
10880 Wilshire Blvd.
Los Angeles, California 90024

At the Head of the Thames River, England, the British are using a computer in a sporting event: a computer is now handling all the timing information for rowing races on the Thames River, including the annual" Head of the River" race of the Thames Rowing Club.

The computer installation permits the time for each boat to be displayed on a chathode-ray tube screen for use by public address announcer, and on monitors throughout the public area.

The installation includes an "intelligent terminal," a printer, and associated hardware, made by TRW Datacom and tied in to a host ICL 1904A computer.

Once times are entered into the computer, the intelligent terminal permits a variety of stored data to be compiled and displayed for use by the announcer and other officials. This includes the time for each event of a given team, the average times for a boat over a number of events, the fastest time of the day, etc. A similar installation was supplied for the summer Olympic games in Munich in 1972.

In addition to displays on the video monitors, the system produces printed results on a continuous basis.

COMPUTERIZED ELECTRON BEAM MACHINE MAKES ADVANCES IN THE FABRICATION OF INTEGRATED CIRCUITS

Simon Dressner
Bell Telephone Laboratories
Mountain Avenue
Murray Hill, N. J. 07974

A major advance in the fabrication of integrated circuits has been achieved here by the development of an Electron Beam Exposure System, known as EBES. By using a beam of electrons to generate the microscopic patterns from which integrated circuits are manufactured, EBES can produce integrated circuit master pattern masks faster, more reliably, with fewer defects, and at lower cost than masks made by existing photographic systems.

Bell Labs received a United States patent on the system in August. EBES has been used routinely at Bell Laboratories to produce master masks.

Integrated circuits are chips of silicon about the size of a match head, each of which may contain thousands of transistors and other components. They are an integral part of many types of electronic equipment — including telephone apparatus and telecommunication equipment — as well as many consumer electronic products. Their intricate circuit structures are patterned by photographic techniques, using copies of the master mask for mass production.

Integrated circuits are becoming more complex, more densely packed with devices, and larger every year. Pattern generation is one of the important

limiting factors in integrated circuit technology, but EBES now makes possible the routine production of master masks of a quality that was previously possible only at great expense.

The automated, computer-controlled EBES uses an electron beam to write the intricate, microscopic integrated circuit patterns. Electron beams are superior to light beams used in conventional mask-making processes. Because electrons have a smaller equivalent wavelength than light, a much "sharper" writing beam can be generated. The EBES electron beam is focused to a spot 20 millionths of an inch in diameter. Even smaller spot sizes can be used, but with a corresponding increase in the time and hence the cost needed to produce the mask.

EBES writes its intricate pattern on a chromium-coated glass substrate covered with a film of chemical "resist" which is sensitive to the electron beam. The unexposed portions of the resist and the under-lying chromium are then etched out by chemicals, leaving a negative mask pattern of chromium on glass.

The new resist, developed by Bell Laboratories' Materials Science and Engineering Division, is a key to the rapid production capacity of EBES. The resist is more sensitive than any previously available, while satisfying many practical production requirements.

The electron beam system can write the microscopic pattern of a single integrated circuit chip over a larger pattern area than conventional optical cameras. This simplifies the mask-making process for very large chips and makes possible substantial cost savings. The mask blank is mounted on a movable stage positioned to an accuracy of a millionth of an inch. The stage moves continuously while the pattern is being written, making the exposure faster and more accurate than if the stage stopped for each exposure, as do the sequential optical cameras presently used in the integrated circuit industry.

Circuit design instructions on magnetic tape are fed into the EBES computer, which controls both the electron beam and the movable stage, so that the mask-writing operation is entirely automatic. □
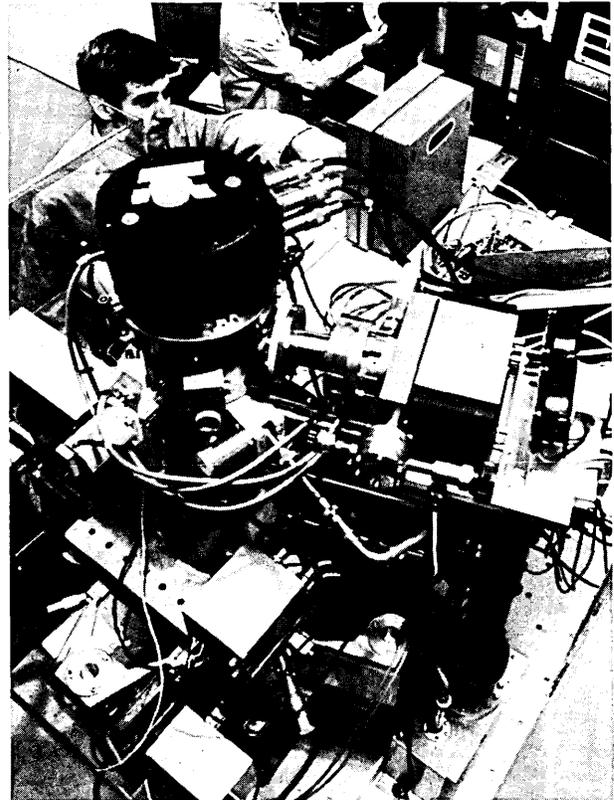
The Electron Beam Exposure System
at Bell Telephone Laboratories

Peelle — *Continued from page 24*

One scene is "connected"; the other is not connected. Note that the same line segments comprise the two scenes, but that they are in different positions.

Suppose one of these two SCENES is PICKed at random. Call it MYSTERY.

MYSTERY ← PICK SCENES

Further suppose that you are permitted to PEEK at small portions of the MYSTERY scene -- which we call "microscenes" -- but you are not told where the microscenes came from. For example,

```
PEEK   MYSTERY        PEEKING at MYSTERY is like
                      using a flashlight to il-
                      luminate small unidentifi-
****                  able places on a much larger
*                     unknown scene.
*


     PEEK   MYSTERY



****
```

PEEK MYSTERY

*

***

After a period of probing, the question arises: Can you determine which scene it is that you are looking at?/3/ (The answer is postponed so that the reader may ponder this question.)

The APL programs which facilitate exploration of this question in scene analysis are simple:

∇ *MYSTERY ← PICK SCENES*

[1]   *MYSTERY ← SCENES[?2;;]*

∇

This program will PICK one of 2 SCENES at random for the result called MYSTERY.

∇ *MICROSCENE ← PEEK SCENE*

[1]   *MICROSCENE ← SCENE[(ι4)+(?10);(ι4)+(?10)]*

∇

This program will PEEK at some two-dimensional SCENE and produce a random 4 by 4 portion for the result called MICROSCENE.
                                        (To be continued)

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 7511

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

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 7511

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 7511

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

SOLUTIONS

Maximdij 7510: The rose is the mother of the thorns.
Naymandij 7510: Make diagonal of 5's.
Numble 7510: Stars shine always in a clear sky.

CORRECTION: In Numble 7510 (October, page 27) the third line should be TOSBER and the fifth line should be INIIBS. See Forum page 8 in this issue.

Monthly magazine, first issue May 1975:

"People and the Pursuit of Truth"

*Some of the articles in the May, June, July
and August 1975 issues already published:*

**The Assassination of President Kennedy: The Involvement
of the Central Intelligence Agency in the Plans and the
Coverup** / Richard E. Sprague

The "Oswald Window" *(with two photographs)* / Neil
Macdonald

**Substantial Evidence of Conspiracy Ignored by the Warren
Commission** / Mark Allen and others

**Chile and Central Intelligence Agency Intervention, 1964–
1973** / Hortensia de Allende

**The Coverup of the Coverups: The Protectors of the
Assassins** / Richard E. Sprague

**Zapruder Film Frame 413: Does It Show a Rifleman on the
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