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including *Computer Graphics and Art*

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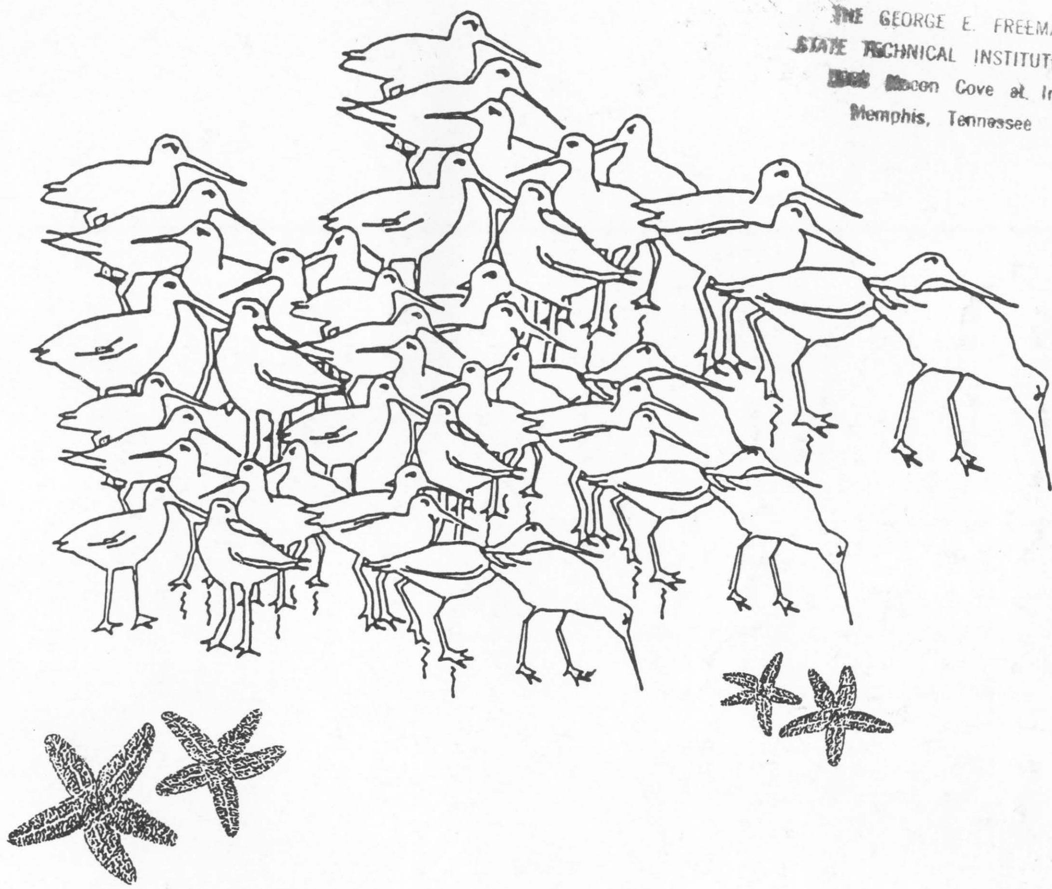

SEABIRDS *by Leslie Kuhn*

The Computer Almanac and Computer Book of Lists — Instalment 38

Neil Macdonald
Assistant Editor

6 EXCELLENT ARTICLES IN "CREATING A GLOBAL AGENDA" BY WORLD FUTURE SOCIETY (List 840901)

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(Source: "Creating a Global Agenda: Assessments, Solutions and Action Plans", edited by Howard F. Didsbury, Jr., published by and copyright © 1984 by World Future Society, 4916 St. Elmo Ave., Bethesda, MD 20814-5089, 346 pp. The entire 30 articles in the book are worth much attention.)

8 ADVANTAGES OF EXCUSES (List 840902)

Sometimes an excuse is necessary.

Sometimes an excuse is true.

Sometimes an excuse is logical.

Often an excuse avoids effort.

Often an excuse avoids labor and work.

Often an excuse makes a day of one's life easier.

Often an excuse delays or cancels a showdown.

A resourceful person can nearly always think up an excuse.

(Source: Neil Macdonald's notes)

8 DISADVANTAGES OF EXCUSES (List 840903)

Often an excuse is not entirely truthful.

Often an excuse is not fully logical.

Often an excuse is not really necessary.

Often an excuse makes a year of one's life harder.

Often an excuse uses up time, breath, and attention which could be spent better.

Repeated excuses exhaust the patience of listeners.

He who excuses himself accuses himself, admitting and acknowledging failure.

Continued excuses from the primrose path that descends to hell.

(Source: Neil Macdonald's notes)

6 APHORISMS ABOUT BELIEFS AND PREJUDICES (List 840904)

Nearly everybody believes what he wants to believe.

In a crisis or emergency, people become ready to believe almost any comforting assertion.

A prejudiced person hardly ever believes he is prejudiced.

People often believe unlikely stories on flimsy evidence, because they want the stories to be true.

We often grab the advantage of a certain argument for ourselves, but refuse to grant the advantage of that argument to others.

(please turn to page 23)

Computing and Data Processing Newsletter

COMPUTERIZED CRIME DETECTION IN GREAT BRITAIN

Based on a report in "Canadian Security" for January, 1984

The search for clues in major crime investigations has been speeded up from days to minutes with the aid of a new computer system that is being used by three British police forces. It has already helped in seven United Kingdom (UK) crime probes, including a rape case.

The minicomputer system is called the Major Incidents Computer Application or MICA for short. It has been developed by two companies, Microdata and ISIS Computer Services, in partnership with Britain's West Yorkshire Police Force. The force's need for faster clue searching in countless statements emerged as a result of a marathon investigation into what became widely known as the Yorkshire Ripper murder case.

Together, Yorkshire detectives and the two companies produced the system in 12 months. It has been "fine tuned" during two major crime investigations and is on trial with two other UK police forces as well as the West Yorkshire force. A fourth force borrowed a prototype system to help in its successful hunt for the killer of a young woman in 1983.

Mr. Jerry Causley, Microdata's managing director, believes the system to be the most powerful and advanced interactive major crime investigation package available anywhere in the world. "We can see no reason why MICA cannot be successfully used by any law enforcement agency in the world. Conversion to a foreign language presents no problems," he says.

Microdata says the system has been designed by front-line detectives for policemen. Statements taken during police enquiries into a major crime together with other reports and messages are entered in English into the computer's memory through a conventional terminal keyboard. The system can have up to 128 terminals. All of them can be used simultaneously to feed statements into the computer.

Thousands of statements taken over the period of a major investigation can then be searched electronically for clues at the command of a policeman. It can scan and report the clues sought in 100 statements of 1,000 words each in just one minute.

For example, if an investigation officer needs to know if a particular type of car owned by a man with a particular accent, grey hair and tattoos was in a particular hotel parking lot on a series of dates, he has only to type in the question on the terminal in English and the answer is immediately displayed on the screen. Such an enquiry would normally take one or more days or even weeks to complete.

The computer also has the advantage of being able to cope with peculiarities of the language. If asked to list all the people with the Christian name Elizabeth, it would automatically list those with derivative names such as Liz, Lizzie, Betty, Bet or Liza.

MICA can be used to handle many different incidents at the same time and in the case of two police forces operating the system, one can search the other's statements for commonality clues with the aid of an entry password.

No specialist technicians are needed to operate the system, which is intended for the direct use of the police investigation team after a few minutes' tuition.

$700 MILLION IN SPARE PARTS JUNKED BY U.S. AIR FORCE IN 1983 VIA COMPUTER SYSTEM

Based on a report in the "Boston Globe", July 7, 1984

From 1974 to 1983, the U.S. Air Force has had computerized procedures that called for automatic disposal of many spare parts, ranging from screws and nuts to airplane doors. The parts have been specified by computer on the criterion "no request during the last 12 months", then classified as scrap, and then shipped out, with "no human involvement". As a result, parts often were sold for scrap, sometimes by the pound, even while warehouses were processing orders for the same items.

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computers and people

formerly *Computers and Automation*

including *Computer Graphics and Art*

Software Design

Computers and Predictions

Computer Misapplications

Computer Acquisition

Computer Applications

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.

Editorial Note: We invite articles on the subject of computers and nuclear weapons. Computers (and the computer people who work to make nuclear weapons work) are an essential ingredient of the nuclear evil.

There will be zero computer field and zero people if the nuclear holocaust and nuclear winter occur. Every city in the United States and the Soviet Union is a multiply computerized target. Thought, discussion, and action to prevent this holocaust is an ethical imperative.

— ECB

Front Cover Picture

The front cover shows a sample of art by Leslie Kuhn, a student in a computer-assisted art class at Calif. State Univ.-Chico, CA. She made a a library, produced by computer, of seabirds, water patterns, and cliff patterns, and produced computer-designed silkscreens and watercolors.

Late News

COMPUTER PROFESSIONALS FOR SOCIAL RESPONSIBILITY PICKET BOSTON NUCLEAR CONFERENCE

At the end of July, about 70 persons, members and associates of Computer Professionals for Social Responsibility, picketed a conference of nuclear weapons makers held at a hotel in Boston, Mass.

On July 30, the *Boston Globe* printed a report entitled *Peril of "Intelligent" Weapons* written by Reid Simmons, Karen Sollins, and Dan Carnese, members of CPSR. It included:

"Autonomous weapons systems with great destructive power are dangerous because they increase the likelihood of failure."

CPSR started at Stanford Univ., Calif., has 7 chapters, and about 600 members. One address is CPSR, c/o Walter Hamscher, 545 Technology Sq., Cambridge, MA 02139.

Key

[A]	–	**Article**
[C]	–	**Monthly Column**
[E]	–	**Editorial**
[EN]	–	**Editorial Note**
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[R]	–	**Reference**

Notice

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Editorial

Predictions and Errors

Edmund C. Berkeley, Editor

Few aspects of the world are more wondered about than the question "What is going to happen next?" Let's consider three situations of prediction (and departure from prediction) that range from minor to major:

Computer Entries

In making computer entries from the handwriting of people, written characters are often confused. The figure 1 and the capital letter I for example are likely to be confused. The same is true for the figure 0 and the capital letter O. 2 may look like a Z. 5 may look like an S. 6 may look like a zero 0. 7 may look like a 1. 8 may look like a B. 9 may look like a zero 0. Capital C and capital G may look like each other. Capital D may look like a capital O. Capital Q may look like a capital O. And there are more possibilities of confusion. And we cannot get an unsophisticated optical character reader to distinguish these characters because context (the way these characters occur with other characters) can cause exactly the same handwritten squiggle to appear, depending on context, as one or another of possible choices.

What is going to happen next?

Errors -- and stacks of them. The only cure seems to be to educate or train human beings to use care in the writing of handwritten characters. And if he or she is not motivated to try to do a good job, the outcome will remain a stack of errors.

Marketing

Consider the case of marketing. A person who wants to sell a computer product takes a look at past sales and then draws a curve. With more sophistication he draws three curves, "high expectations, medium expectations, low expectations." With still more sophistication and knowledge, and hints from the grapevine or hearsay, he may be able to make a better prediction still.

What happens next?

Over and over again, what happens differs much from what was forecast. A curve of projected sales does not have the strong physical laws controlling it like the trajectory or curve of a batted baseball.

Only in bits and pieces of the situations that surround us every day can we make good predictions, which will come true. Even "worst case" predictions may fail and produce errors.

The Nuclear Holocaust

Consider the risk of the nuclear holocaust which hangs over the whole world today. The danger is alarming and horrible; it is undoubtedly possible; and it is mathematically inevitable as years go by unless human beings change their present behavior. Yet nearly all people (including computer people) clearly demonstrate by their real world behavior "I can't do anything, and I won't think about it."

Of course, there are exceptions: tens of thousands of people (but less than 1%) all over the world do understand and work to prevent the nuclear holocaust.

What is going to happen next?

Many wars for many reasons have been fought in the world from 1946 to 1984. But the last time nuclear weapons were used for military purposes in war was 1945, when the U.S. dropped two such weapons on Hiroshima and Nagasaki, Japan.

Why have nuclear weapons not been used since then?

At this time there appear to be three main reasons. In the first place, nuclear weapons are excessively destructive; imprecise in the damage produced; with lasting radioactive contamination; and producing illness and disease of friend and enemy alike. Second, their use is subject to escalation: small weapons provoke medium weapons; medium weapons provoke large weapons, and so on, until entire continents are devastated. Third, fear. For the first time in human history, the persons who study and plan nuclear war gradually become convinced that they, their children, their families, their neighborhoods, will all be utterly destroyed also. There is no place to hide; no shelter that works; no fortress that can long resist.

Three star U.S. General James Gavin wrote in 1958 that nuclear bombs could not be used for brushfire wars: "This is the most probable nature of future war: a slow almost imperceptible transition of a bad economic and political situation into internal disorder."

Field Marshal Lord Carver, chief of British Defence Staff, 1973-76, has stated: "At the theatre or tactical level any nuclear exchange, however limited it might be, is bound to leave NATO worse off in comparison to the Warsaw Pact, in terms both of military and civilian casualties and destruction....To initiate use of nuclear weapons ... seems to me to be criminally irresponsible."

General Johannes Steinhoff, former chief of staff, Federal German Air Force, has said: "I am in favor of retaining nuclear weapons as potential tools, but not permitting them to become battlefield weapons. I am not opposed to the strategic employment of these weapons; however, I am firmly opposed to their tactical use on our soil."

Admiral Noel A. Gaylor, former commander in chief, U.S. forces in the Pacific, has stated: "There is no sensible military use of any of our nuclear forces. Their only reasonable use is to deter our opponent from using his nuclear forces."

To sum up, nuclear weapons have become obsolete militarily -- except for the actions of a few men who are insane or fanatic.

The sensible procedure is activity that leads to the resolution of conflicts. In 30 years from 1945 to 1975 Japan and the United States changed from being enemies at war to collaborating countries. For 30 years from 1954 to 1984 Mexico and the United States have been collaborating peacefully. For 100 years from 1884 to 1984 Canada and the United States have made no physical preparations to fight each other.

Since there have been 39 years of no nuclear war, it is reasonable to predict that we still have some more time. Conflict resolution, reconcilement of adversary positions, detente, relaxation of tensions, -- these are the paths to the future. More nuclear armament is feebleminded.

Ω

Friendly Software Design: Elements

Paul C. Heckel, President
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Los Altos, CA 94022

"Things that are done well are not noticed while things that are done badly intrude and are noticed."

This article is based on some excerpts from *The Elements of Friendly Software Design*, an interesting, important, and novel book by Paul Heckel. The book is published by and copyright © 1984 by Warner Books, 666 Fifth Ave., New York, NY 10103, 220 pp, and is reprinted here with permission.

Contents

Software Easy to Use

While I have been writing computer programs for twenty years, my major interests for the last ten years have been in developing software that will be used by people who are not computer professionals and thus need programs that are easy to use. I knew a few techniques, but I didn't understand how to make a program easy to use on a fundamental level. As far as I could see, few other people did, either.

Almost everyone wants their software to be easy to use, or "friendly." Unfortunately, the term friendly does not seem to have any objective meaning. Too frequently it is a term a vendor uses to describe a software product , the same way a soap manufacturer uses the phrase new and improved. It communicates positive associations to the customer more than real substance. I hope that this book will help provide some useful meaning to the term friendly software, both for the customer, who should know what to expect, and for the software designer who wants to make his software friendly but is unsure of how to go about it.

Two years ago I wrote an essay to crystallize my thoughts on what made software easy to use. The essay expanded into a series of articles, an all-day seminar (with several other speakers), and finally into this book. What I discovered on that long and interesting journey is that writing friendly software is a communications task, and to do it effectively you must apply the techniques of effective communication, techniques that are little different from those developed by writers, filmmakers -- virtually anyone who has attempted to communicate an idea over the past decades, centuries, even in some cases millennia. It is the use -- consciously or unconsciously -- of these techniques that makes software successful in the marketplace.

Thinking Like a Communicator

In short, the software designer must learn to think like a communicator and to practice an artistic craft as well as an engineering one.

I have tried to support my premises with several examples, both from computer software design and from other communications crafts. Few of the concepts presented here will be new to professional communicators. What is new is the application of these principles to designing friendly software, and a look at how certain very successful software designs, such as VisiCalc, have used these principles.

What I say may also be of interest to a more general audience -- people interested in computers or the techniques of effective communication. The general reader need not be afraid that this book is too technical. Indeed, such a reader has a distinct advantage over the computer experts in that he has less to unlearn.

Sexism

Some people feel my writing is sexist, since I do such things as use the word "he" when referring to the designer or the user. I find that when I attempt to avoid such usage I am forced into longer phrases ("he or she" rather than "he"), less vivid images ("users" rather than "your user"), and the passive voice. I apologize for any offense my readers who are women may take, and ask each of you to picture in your mind whatever designer and user you desire and not let the specific pronouns I use get in the way of that image.

In these marvelous days of computers I could quickly change all instances of "he" in my manuscript to "she," and similarly "him" to "her." I asked my publisher to publish the book in his and her editions, but he said it would be too expensive.

An Historical Perspective

> If you cannot -- in the long run -- tell everyone what you have been doing, your doing has been worthless.
>
> — Erwin Schrödinger

> It's not how good the technology is; but how it's presented to its users.
>
> — Don Valentine, venture capitalist

Although writing was two thousand years old when the printing press was invented, only an elite few could read, let alone write. The printing press made the written word plentiful and inexpensive, which in turn made the average person literate, and had an incalculable influence on civilization thereafter.

The Art of the Storyteller

Today many expect that the low cost of computers will make the average person "computer literate." It will. But there is a crucial difference between the environment of the printing press and that of the computer: the art and craft of the writer as a storyteller or communicator was in full swing long before the printing press was invented.

The printing press certainly gave writers new and larger audiences, and was responsible for changes in the craft -- it spawned the invention of the modern novel, for example. Yet it did not fundamentally change the task of the writer, a task that was already well developed.

When personal computers were developed, the equivalent of writers did not exist. Some of us were programmers; our expertise was in communicating with computers, an ability substantially different from communicating with people. What we had yet to develop were the skills needed to get computers to communicate with users.

Many have recognized this shortcoming and have talked about making computers and software "friendly." Unfortunately, this too frequently has meant little more than editing some messages, turning, for example, an annoying "Syntax error" into the more "respectful" "Syntax error, Sir."

Unfriendliness

No programmer writes an unfriendly program on purpose. If some of us write unfriendly programs it is not because we want to; it is because we do not know how to do any better. While everyone has ideas on what makes software "friendly," we don't really know much about it.

The purpose of this book is to identify the skills of the communicator, to persuade you that they are the appropriate skills, and to help you on your way to mastering them.

The critical problem of making average people literate was to teach them to read -- skilled writers already existed. But in the computer age the major problem is just the reverse -- it is to make the software designer a skilled communicator, not to make the average person computer literate. As any writer knows, the primary task of any communication falls on the originator.

Software that Communicates Well

The point of view taken here is that "friendly" software is software that communicates well. It follows that the place to look for understanding how to make software friendly is in any number of communications crafts, such as:

Writing	Filmmaking
Acting	Sales
Advertising	Playwriting
Teaching	Journalism
Photography	Graphic art
Fine art	Musical composition
Magic	Set design.

Even architecture and industrial design, crafts having to do with presenting physical things to people, use communication principles and will be referred to occasionally here.

The Birth of the Art Form: Filmmaking

> The task I'm trying to achieve is above all to make you see.
>
> — D. W. Griffith

Among all the art forms that can teach us about communication, the most appropriate is filmmaking. Though the origins of most art forms are lost in antiquity, filmmaking began in this century, within the span of our own experience. It illustrates the transition from an engineering discipline to an art form -- a transition we are seeing today in computer software. This transition is now so complete that we find it hard to think of filmmaking as an engineering discipline, yet that is what it was when it began.

Thomas Edison

For several years Thomas Edison controlled filmmaking. He did not see the artistic possibilities of the medium and stubbornly fought against Edwin S. Porter, who wanted to make films that would tell stories. "Eight minutes on a single story," Edison objected, "it won't sell. People want variety. At least four or five subjects on every eight-minute reel."

Having worked for several engineers, I know how Porter felt.

Movies did not flourish until the engineers lost control to artists -- or more precisely, to the communications craftsmen. The same thing is happening now with personal computers. Inexpensive computers have made it easier for software designers to come out from under the control of the engineers, and the result has been a proliferation of independent software companies and better software.

Edwin S. Porter

The earliest filmmakers did little more than point a camera at an interesting event and wind the crank. Films varied from the photographing of theater as seen from a prime orchestra seat to photographed sideshows. A movie was one long shot of continuous action taken by a stationary camera. It was Edwin Porter who first staged outdoor events which he would film. In 1903 he made "The Great Train Robbery," the first film to purposely tell a story. This important film was a big success, but technically it consisted of a series of 30- to 60-second action shots.

D.W. Griffith

If one person can be credited with inventing the film as art it is D. W. Griffith. In 1914 Griffith made "Birth of a Nation," an immediate artistic and commercial success. With this picture filmmaking became what it is today -- the art and craft of using film to communicate to an audience.

To do this, Griffith invented, or was the first to use in an important way, the basic techniques of filmmaking. These are the same techniques that are used today: the closeup, the moving shot, the fade, the cutaway, and the dissolve. (It is difficult to realize just how innovative these techniques were at the time: the first closeup caused panic when shown because the audience mistook it for a "severed head.")

Griffith's basic contribution was his use of editing (montage would be a more descriptive word) -- the ordering of the various shots (long, medium, moving, closeup, panorama) into the finished film. He used crosscutting -- alternating shots from different simultaneous action sequences -- and he varied the lengths of his cuts for the psychological effect they would have on the audience. He slowly decreased the length of the average cut, for example, to slowly increase the audience's anxiety. In the concluding sequence of "Birth of a Nation" he crosscut between scenes of the heroine besieged in the cabin and scenes of the rescuing riders several times, using twenty-six different cuts including long shots, medium shots, closeups, extreme closeups, and moving shots, all of this in only one minute of screen time. In doing this, Griffith not only communicated the action to the audience more effectively than had been done in the past, but he created interest, excitement, and tension. By today's standards the acting may be mediocre and the technical quality poor, but the editing is still first-rate.

Before Griffith, the average film was one eight-minute-long reel. The films were made in less than a week -- scripted on Monday, shot on Wednesday (with no rehearsal), and shipped on Saturday. They cost only a few hundred dollars to produce and were shown in nickelodeons to the lower classes; the middle and upper classes disdained such crude entertainment.

Writing History with Lightning

"Birth of a Nation" was two hours and thirty minutes long, took six months to make, and cost the enormous sum of more than $60,000. Millions of people of all classes paid the extraordinary price of two dollars to see it. It grossed fifteen million dollars and was the first film shown at the White House. (Woodrow Wilson said it was like writing history with lightning.)

The effect this film had on motion pictures -- both as an art and as a business -- was revolutionary. After Griffith's opus, serious films had to be at least an hour long and use Griffith's filmmaking techniques. Having worked for Griffith, even as an extra, was all one needed to get a job in motion pictures, and such people became the major source of directors and filmmakers during the twenties and thirties. Making a film was no longer a one-week affair; it was a major undertaking lasting for months.

Since Griffith and "Birth of a Nation," we have seen many advances including sound, color, a more natural acting technique, and various special effects. Still, none of these techniques changed film fundamentally. Griffith wrote the bible on how to make films, and though the filmmakers who followed might have split into different schisms and interpreted his bible differently, none rejected it.

Emphasis on HOW It Was Presented

The fundamental change that Griffith brought to filmmaking was a shift in emphasis from what was being presented to how it was being presented -- from an engineer's craft to an artist's. Filmmaking was never thought of in the same way again.

Significantly, some of the first people to recognize the possibilities of the new medium were communicators in other media. Henry Dreyfuss, a set designer, and Raymond Loewry, a graphic artist, became two of the earliest industrial designers. An important pre-Griffith filmmaker was a magician -- George Melies. This was not an accident. Two of the primary skills of a magician are communications skills: showmanship and the creating of illusions in the minds of the audience. Griffith, who admitted that he learned much from Melies, was himself an actor who always wanted to be a novelist.

Friendly Software: A New Form of Communication

Friendly software design is in much the same state that filmmaking was at the time of "Birth of a Nation." The existing audience has been limited until recently to programmers, specialists, or data entry clerks. But now the audience is becoming much broader.

To make our products useful to new audiences, we have to identify and develop the software equivalents of the filmmaker's techniques -- closeup, moving shot, editing, and so on. We already have some of these techniques -- menus and cursor control, for example -- but just having them is not enough; many of Griffith's techniques were first used by others. Even more important, we have to learn how to use our techniques to communicate more effectively to our users. We can only do this by changing our perspective of software design from what the software does to how it does it -- from an engineer's perspective to an artist's.

People use various terms to describe aspects of making software friendly: human factors, ergonomics, user friendly, cognitive engineering, and user psychology; to name a few. I will use the term "friendly software design."

VisiCalc

The closest thing we have to a "Birth of a Nation" in designing friendly software is VisiCalc. Unlike "Birth of a Nation," VisiCalc's main appeal is to a limited marketplace (generally people who do financial planning). But is has an important similarity to this seminal film: although other financial packages existed, VisiCalc became an instant and unexpected success. During the three years of Apple's strongest growth, 1979-1982, VisiCalc (at $100 to $250 a copy) was responsible for at least half of the

(please turn to page 26)

Problems, Solutions, and Methods of Solving —Part 1

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"Problems play an essential role in the progress and teaching of science."
– George Polya

Problem Solving

The basic mission of a computer is to solve problems. But if we start thinking about problems in general, solutions in general, and methods of solving in general, we arrive at some interesting and important conclusions:

- The problems that computers can solve are far fewer than all the problems that human beings are faced with;
- The types of solutions that possibly can issue from a computer are far fewer than the types of solutions that possibly can issue from a human being;
- The methods of solving problems in general, if reasonably classified and counted, number altogether less than one hundred; and
- Just one of these general methods is "calculate or compute the answer" using any device such as a computer or a human mind or a pair of dice.

Home Accounting

An interesting example of problem solving is reported in the following quotation from a columnist in the Montreal Gazette in June 1984.

[Beginning of quotation]

I once asked an accountant, who uses a computer in his work, if I should get one for for my home.

"For what?" he asked.

For my cluttered financial records, my checking account, taxes, all that stuff.

"No," he said, "just go to an office supply store and buy a ledger for $2. When you write a check, put it in the ledger. When you put money in your checking account, put that in your ledger. Then you add up one column and the other column, and you'll know if you have more money coming in than going out. Throw your receipts in a drawer for tax purposes. That's all there is to it."

I told him that was what I already did.

"Then you are about as efficient as most people ever have to be."

[End of quotation]

George Polya

The emphasis on problem solving in recent years comes largely from the work and influence of Dr. George Polya, mathematician, former professor at Stanford University in California, and author of "How to Solve It" and other books. The January 1973 issue of the "American Mathematical Monthly" published a letter by Polya to an unnamed chairman of a mathematics department, in which he says:

> As you may know, I am especially concerned with problem solving ... That the role of problem solving in mathematics is not understood by nonmathematicians and not duly appreciated by outsiders is not surprising ... but I heard lately that such lack of understanding and appreciation led to denying a promotion to a member of your Department. I feel there is a serious matter of principle involved ...
>
> Problems play an essential role in the progress and the teaching of science ... Problems play an important role on all levels of mathematical instruction ... Problem solving is a perfectly acceptable and respectable professional activity for a mathematician and can favorably influence his teaching ... If it is true what I heard that your colleague's promotion was refused because he "only" solved problems, and did not publish, such a decision is unwise and unjust.

We could add to Polya's statements that problems play an important role on all levels of instruction, in all branches of knowledge, and that if a person cannot solve reasonable problems in a branch of knowledge that he has studied, then he certainly has not learned it.

The Limits of Computerization

The great bulk of all problems for human beings are not susceptible to the magic or sorcery of computers. Though the applications of computers number over 5,000, the human being is:

- a very unusual animal;
- the product of more than 600 million years of evolution, whereas computers have evolved for less than 200 years (and some people would say less than 50);
- an intelligent language-user with more than 100,000 words to use;
- the possessor of a general-purpose, multiple-sensing, conveniently-organized, tool-using body, hitched to the thoughts inside a human brain; and
- a problem-solving machine of extraordinary power in regard to more than 20,000 applications.

It will therefore make sense for us to take a look at certain important or interesting or typical problems for a human being and at the methods for problem solving in general that human beings use. Now and then some possible or sensible computerizations may be clear. The first three problems we shall consider are: the problem of living; the problem of dying; and the problem of an occupation. Nobody can assert that these problems are unimportant.

The Problem of Living

The problem of living is preeminent in the life of every person. In the old days, if one was a pioneer in the forests of New England, the first task was choosing a plot of land, clearing the ground, and building a house: a small one-room house of solid logs, with a dirt floor, a hole in the roof for smoke to escape from a fireplace indoors, no windows, only one door. Such were the houses at Plymouth Plantation, Massachusetts, where the Pilgrims who arrived from England in 1620 started to live, work, plant crops, keep chickens and goats, raise a family, guard against intrusions, suffer sickness, and go to church on Sundays. They came to a new world with a particular old-world culture, a general way or technique of living, which included for example knowing how to plant grain to grow wheat and how to swing an axe to cut a log -- a collection of problem-solving methods.

In the new days of the 1980's, the population of the planet Earth has become more than 4 billion people living in more than 150 nations, with more than ten thousand cultures. The number and kinds of problems encountered in the many existing cultures of the United States now have become far greater than in 1620. The sources of self-proclaimed guidance are also far more. But whether to believe these modern day oracles, or not, is often a succession of puzzles, a collection of problems, rather than a collection of problem-solving methods.

The Problem of Dying

Another problem which most of us think of occasionally while young, more often when middle-aged, and very often when we become old and weak, is death. No matter how one lives, there comes a time when one inevitably dies and yields up one's living space (lebensraum) to those who come after.

Yet some of the remarks of certain distinguished men as they were dying have come down to us and show great fortitude and peace of mind. For example:

- Siward, born a Dane but Earl of Northumbria in Great Britain, c. 1066:

  "Lift me up that I may die standing, not lying down like a cow."

- George Washington, 1799:

  "It is well. I die hard, but I am not afraid to go."

- Socrates, Greek philosopher, as he drank the hemlock, 399 B.C.:

  "Crito, I owe a cock to Aesculapius."

Dying is an unusual, once-only activity for a person; and it is not open to us to practice it, so as to improve it. But it is a key activity in the living of species, and it guides and controls evolution on a time scale of a millennium and longer.

A much more practical aspect of dying is making a will. A surprising number of persons give serious trouble to their families by not choosing to make a will nor revising their will after important happenings.

The Problem of An Occupation

Another major problem that now faces each one of us all our adult lives is:

- What occupation will enable me to earn my living day after day and year after year?

It used to be that the productive modes of living were hunting and gathering, then sowing and reaping, then commerce in many forms, then early industry as existing a hundred years ago. So productive occupations for people were fairly stable during a short working life. "What was good enough for my father is good enough for me." But those days have gone forever. This human world has gone through a point of no return.

Occupations expire. The human work of blowing molten glass into the shapes of bottles is taken over by an automatic machine that makes glass bottles. The work of running 3,000 elevators in 1,000 buildings is taken over by a 1,000 automatic elevator system. Even the most generous capitalist employer cannot afford to pay 100 employees when only 10 can perform all the work needed.

Nearly every occupation in the U.S. nowadays is currently at risk of transformation or disappearance from great changes springing from computers, communications, new technology, international competition, and more economic factors. But it is also in danger from greed, fanaticism, the philosophical collision between "I must help myself" and "society must help me", and more social factors.

Computer programs that aid young people graduating from high school to choose an occupation exist. They express the views of guidance counselors and are equivalent to access to a large file of static occupation descriptions. But in a rapidly changing society with rapid change in technology, the advice from such a program is only partial and becomes out of date rather quickly.

1. The Principle of No Action

Perhaps the first natural method of problem solving in general is the Principle of No Action, the principle of doing nothing. The principle comes associated with many verbal responses to any call for doing something:

- I am not interested.
- I don't want to.
- I can't do everything.
- I don't care.
- What happens makes no difference to me.
- It is none of my business.
- I have not the time.
- I have not the money.
- I have not the energy.

The principle of no action has some arguments in favor of it. Responding favorably to all of a large number of appeals for help is not possible for anybody. In addition, no action for a short time followed by a deliberate action later is an efficient mode of dealing with many problems. As a technique for defense, no action at all -- freezing to complete stillness -- is a sensible method used by deer, rabbits, and other animals. The method is also useful when a man walking through bushes encounters a rattlesnake.

The principle of no action has many arguments against it.

- It makes for laziness.
- It promotes abdication, drawing back from duty and obligations.
- It reenforces fatalism, "God's will be done."
- It invites surrendering to evil: "see no evil, hear no evil, speak no evil."
- It leads to addictions -- to alcohol, drugs, narcotics.
- It cannot be applied to the problem of living; living requires action.
- It cannot be applied to the problem of an occupation; employment requires action.
- It cannot be applied to the problem of improvement of one's self, or one's family, or one's world: improvements require action.

A normal blending of the two principles of action and no action occurs in living: action (and work) when one is awake, and no action (and no work) when one is asleep. In the old days, work required all of six out of seven days each week, from sunup to sundown. But in the new days of a 40 hour work week, and often less, the habit of action (plus modern health) is filling people's weekends with leisure activities, sometimes even more strenuous than work.

2. The Principle of Feedback Control

Another important principle of problem solving in general is the Principle of Feedback Control. This is the use of successive signals or information about the output of a process, machine, or system in order to control or guide the system. This kind of process occurs both in living systems and nonliving systems, and in the human design of countless machines and systems.

A simple example is picking up a pencil to write with. You reach for the pencil in a tray at your desk, take hold of it, and start writing. But just try this simple little operation with your eyes shut. Immediately you have to fumble and grope, make use of your memory of where that pencil was, and hope that what you pick up is the pencil you intended. With your eyes open, the procedure of picking up the pencil is hardly worth a thought.

Feedback is sometimes treated as a subject that belongs to engineering and supposedly needs to be treated with the mathematics of calculus and differential equations. But the situation is so common in the ordinary real world that human beings have an intuitive understanding of feedback.

Feedback is regularly classified into positive feedback and negative feedback.

If an increase in the output has the effect of producing an increase in the input (and a decrease of the output has the effect of producing a decrease in the input), this behavior is called positive feedback. It results in more and still more output -- growth and still more growth -- and an out-of-control or runaway process, until external limits are encountered. Or it results in less and still less output, until finally the process, system, or machine stops completely.

If an increase in the output has the effect of decreasing the input, and a decrease in the input has the effect of increasing the output, this behavior is called negative feedback. It results often (but not always) in a self-correcting or self-regulating or stable process. (This condition is called feedback control.) Or it may result in an oscillating or hunting process in which the swings eventually die down or continue steadily or become wider and wider -- more and more extreme -- until external limits are encountered.

Examples of Positive Feedback

Rabbit Population. An increase in the number of rabbits results in more rabbits being born, and this results in a still greater increase in the number of rabbits. The rabbit population displays positive feedback.

The Long Neck of Giraffes. A long neck in giraffes enables them to eat leaves high in the trees, and confers a survival advantage. A still longer neck will enable eating still more leaves still higher in trees. The long neck displays positive feedback, on an evolutionary time scale.

Wealth. If "the rich grow richer, and the poor grow poorer", then each of the states (being rich, being poor) displays positive feedback.

A Log Fire in a Fireplace. The behavior of a log fire in a fireplace neatly illustrates: (1) positive feedback, because part of the heat of the fire is fed back to cold wood, heating it and causing it to catch fire; and (2) a critical point (or critical mass) because above a certain point the fire expands, burning better and better, and below that point the fire wanes and goes out. One log by itself won't burn. Two logs together will hardly burn. Three logs arranged in the right way will burn nicely. Four logs together will make a hot roaring fire.

Examples of Negative Feedback

A Population of Caterpillar Parasites. An increase of caterpillars leads to an increase of parasites killing them. The increase of parasites, however, leads to a decrease of caterpillars. The decrease of caterpillars leads to a decrease of parasites. The decrease of parasites leads to an increase of caterpillars. So the population of parasites of the caterpillar displays negative feedback.

Dynamic Balancing of a Broom. I can balance a broom (heavy end up) in the palm of my hand, by moving my hand quickly in whatever direction the broom starts to fall, until it starts to fall in another direction; and if I am skillful, I can, with effort, balance that broom upright for several minutes.

Light Car, Fast Highway, and Strong Cross Wind. A driver of a light car is traveling at high speed on an express highway, and there is a strong cross wind from the left. There is a sudden gust of wind, and he turns strongly into the wind. The gust suddenly stops; he finds himself about to go off the highway to the left onto the median strip. He turns very sharply to the right, but because of his speed, he goes off the highway to the right into a gully, turning upside down, and crashing. (Accident story, often true.)

Examples of Feedback Control

Automatic Home Heating System. The ordinary automatic oil furnace system that heats a home displays feedback. If the thermostat set in the wall of the living room signals "too cold", the burner flame in the furnace is turned on, the boiler heats up and produces steam, the steam heats the radiators in the living room, the living room grows warmer. Finally, the thermostat changes to "too hot". This signal is sent to the furnace, the burner flame is turned off, the radiators grow cold, and finally the thermostat changes once more to "too cold". Then the cycle repeats.

Water in a Tank. The ordinary mechanism of float, lever arm, and valve in a water reservoir tank applies negative feedback to the inflow of water, when filling the tank. As the water rises in the tank, the increasing volume of water presses upward on the float. The rising float by means of the lever arm gradually closes the valve admitting water to the tank, and finally shuts off the flow. The more water in the tank, the less water is admitted.

Human Body Processes. The human body is a system that regulates its temperature, its blood pressure, and its concentration of various substances in the blood by feedback mechanisms. We get too warm on a hot day, our sweat glands produce perspiration, the evaporating water cools us off, and when we become cold again perspiration stops. People do not usually know the chemical details, but the system works. Dozens of different kinds of mechanisms are used by animals for dealing with the problems of heat and cold. A certain desert rat solves the problem of getting thirsty by converting nuts and seeds into water and other compounds.

Some Principles Regarding Feedback

The concept of feedback is completely general, and can apply anywhere.

No feedback is possible without:

- a process, machine, or system
- input and output
- the lapse of time
- a difference between actual output and a possible or "desired" output
- effects by this difference upon the input.

Fast correction of an unwanted deviation is regularly better than slow correction.

Appropriately varying correction of an unwanted deviation is regularly better than on-off correction.

The development of the mathematical theory of feedback becomes control theory.

Negative feedback is a mode of adaptation. It operates in many situations. It requires no consciousness to operate. It acts on individuals, species, and nonliving systems.

Feedback control is often similar to the method of drawing lessons from experience.

Feedback is the method by which a species adapts to a niche in the environment.

Every imperfect system produces errors. The systematic use of small errors to correct the working of the system is the basic principle of feedback control.

Any system will run wild without feedback. The problem is how to catch mistakes while they are still small.
— Kenneth Olsen, 1968

A well-adjusted person discards methods that do not work.

Some Proverbs

Positive Feedback.

Dangers by being despised grow great.
— Edmund Burke, 1792

How great a matter a little fire kindleth!
— New Testament

If the blind lead the blind, both shall fall into the ditch.
— New Testament

Give him rope enough, and he'll hang himself.
— John Ray, 1678

Pride goeth before destruction, and a haughty spirit before a fall.
— Old Testament, c. 350 B.C.

A state without the means of some change is without the means of its conservation.
— Edmund Burke, c. 1794

He that will not apply new remedies must expect new evils.
— Francis Bacon, 1597

(please turn to page 27)

Railroads and the Computer: Ideal Marriage

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"Every child who has ever received an electric train for Christmas learns quickly enough that if he opens the transformer too far and runs the toy train too fast, it will jump the track at the curves; all track systems, toy and real, have the same problem."

"Superelevation"

"Superelevation" is a multi-billion dollar word. It joins "defense", "missile", "nuclear", "navy", "Third World" and many others at the top of the high priced list. In the context of its use here it relates to railroad systems. It is equally as costly in the highway business. Its improper application is the cause of what used to be known as the "Firestone" factor, the rapid burnout of rubber tires on flat curves. In the railroad business it, or the lack thereof, has brought about the degradation of a once-great railroad system and the certain destruction of the rail passenger business in North America.

Freight Operations

Freight operations, with their very heavy cars, very long trains and slow speed, destroy track. The average speed of all operating freight trains in the USA is 20.1 mph. We have a moving warehouse industry calling itself a railroad network that grosses about $35 billion per year in more than one and one-half million trundling cars. It is in the black, but because it runs its business on the "debit side of the ledger" it must pay approximately $10 billion per year in interest to the banks. It could be doing much better in more ways than financially.

Every child who has ever received a set of electric trains for Christmas learns quickly enough that, if he opens the transformer too far, and runs the toy train too fast, it will jump the track at the curves. All track systems, toy and real, have the same problem. They need to be superelevated with precision at all curves.

The Design of a Railroad

In the railroad business this is a complex matter. The system is governed necessarily by a pre-programmed set of speeds that varies along the route from start to finish, and that same regime of speeds must be followed for every train at all times, for efficiency, safety and profitability.

This all begins with the owner. He must tell his civil engineers the elapsed time he wants between each set of stations along the route. The engineers must convert that time factor to a set of speed data and then must design the entire track system for that set of speeds. The flanges and wheel treads take care of the straight and level track because they are cut on a conical section, i.e. they are bevelled. Where they approach a curve the rails have been laid in a spiral, i.e. one begins to go down and the other begins to go up, relative to each other. The rails and flanges guide the car into the curve and begin to tilt the car in the spiral. In the curve itself the banking of the track matches the centrifugal force generated at the design speed. The force vector produced by the train's speed and by gravity combine to pass through the center of the car vertically (vertically from the traveler's point of view, although not vertically with respect to gravity). This is the role of superelevation and when the rate of speed and the track design match, the wear and tear on the wheels and the track is minimal. When it is not, track that is manufactured to produce 700 to 800 million ton miles of service will be worn out before 100 million ton miles, as much of the track has been destroyed by the present system. Then why do the railroads do this?

Before we look at that question there is one more item to consider. Freight cars with a 92 ton load or more cause immediate metal fatigue on the rails. With the passing of each wheel, of each car, of each train the rail undergoes some plasticity and the wear is extreme. More than 90% of the box cars on the tracks today are designed to carry loads of 92 tons and more. As a result the wear on tracks and wheels is excessive.

Ownership

There are few if any railroads today that are owned by anyone who knows anything about superelevation, etc. In fact the Interstate Commerce Commission, that has been regulating the railroads since 1887, not long ago published a manual in which they admitted that neither they nor anyone else in the U.S. government knew who owned the railroads. In practical terms there is no one who tells the engineers to go out and set up the track system properly, and there is more to the story than this.

World War II: Maintenance and Profits

During WW II the railroads did a tremendous job. In 1944 they carried 910,295,000 passengers, an all-time high, on top of carrying 737,246,000 ton miles of freight traffic. While they were doing all that work manpower was short and they had to let much maintenance go. By the time the war ended they were confronted with an enormous backlog of maintenance, the need to re-build the system, higher wage demands than ever before and the need to make long range plans for profitability. Faced with these massive problems they chose to give freight carrying the priority and to squeeze as much money out of that business as quickly as they could. They permitted the passenger system to decay.

They decided to make cars much bigger for much heavier freight loads. They chose to make trains much longer now that they had the power and the drawbar strength. Longer trains and heavier cars meant only one thing. The trains had to run slower. As an old engineer said to me years ago, "The work-boards were hit with a blizzard of notices to flatten the track, i.e. remove much of the superelevation, on all of the curves."

Slow trains do not develop enough centrifugal force to run up through steeply-banked curves safely and the tremendous head-end pull of the locomotives produces a strong in-ward force vector across the arc of the curve toward the chord. This extra force itself adds to the heavy wear on track.

Passenger Service

As this massive 200,000 mile network was being redesigned to carry slow and heavy traffic, it literally pulled the track out from under the excellent passenger services that had existed up to about 1954. The passenger trains were forced to run slower on flat track and they became uncomfortable and unreliable. Coupled with the fact that the owners all but stopped ordering new cars, the future of passenger services was certain: there would be none, despite some government effort to the contrary. Amtrak serves fewer than 500 communities in a rail network that reaches 45,000,000. Even the Amtrak experiment at a cost of more than $10 billion over the past decade or so represents no more than a terminal case existing on a life support system.

The Japanese High Speed Rail Passenger Service

Then over the horizon a new system was born, overseas. The Japanese set in motion a second generation of high speed rail passenger services. These bullet trains of the Shinkansen system are renowned for their speed. They are more than that. They are assuredly safe, on time, reliable and profitable. They are truly the railroad system of the future.

They are unique for other reasons than those listed above. The Shinkansen is a total system and it makes full use of computers.

Automated Computerized Maintenance

Imagine huge maintenance shops where sixteen-car trains are worked on simultaneously, as trains, not as individual cars. As they enter the shop the train is separated into two eight-car units. Then a computer-controlled system of jacks rises from the floor and lifts entire trains of eight cars together, and perfectly level. As this is being done, a huge cable is connected to a multiple plug and more than 1,100 on-board items are connected for tests and checking to a computer. This is truly second generation rolling stock maintenance. Twenty-four hours later that entire train is back in revenue service, as good as new.

No Locomotives

There are no locomotives on these trains. Each car is powered by small electric motors designed into the axle area. Every axle is turned by a motor and all are controlled and monitored by a computer to assure maximum operational efficiency at all times.

Central System Control

Or, go up front with the engineer/driver and note that he controls the rate of speed of the train precisely throughout the trip. At the same time a command computer in Tokyo is monitoring all trains in the entire system. The driver demonstrates its complete effectiveness by moving the throttle lever forward. The trains speeds up and almost immediately a telephone rings. The driver answers and the throttle moves automatically backwards to create the assigned cruise speed under the control of the computer in Tokyo. The driver informs Traffic Control that he was simply demonstrating the system.

The scheduling, a most intricate function, is done with the aid of computers as are almost all other facets of this entire business. This is truly the ideal application of high-technology in the railroad business and of high-technology in the computer business ... synergistically.

Personnel Cost: 18%

The bottom line tells the story. Whereas in the American railroad system the cost of personnel represents approximately 60 percent of gross expenses, in the Shinkansen high speed rail passenger system the total cost of personnel is no more than 18 percent. No wonder the system is profitable! Then, why not have such a system in the U.S.A.?

Today, if this all-new high speed rail passenger system were to be introduced into the U.S.A. it would have new road bed and a new track system. The slow, heavy freight system is not compatible with this high speed regime and the lax state of tolerances in the U.S. track network could never support such an operation in safety. Instrumentation has been placed on the wheel sets of cars operating on U.S.A. track and have, with some frequency, measured moments of lateral acceleration in excess of 15,000 pounds. No passenger service can be operated on track that is that far out of line.

Only Dreams in the United States

Many cities, regions and states are working on dreams for such new services. They are fine dreams, but no more than that. The high speed rail passenger system is a most demanding, complex and high-technology industry that must be designed and operated by experienced experts. These experts do not exist in this country today.

Their day will come, because the people of this country need high speed rail systems. Transportation creates commerce, and this country needs revitalization and reindustrialization to replace the overemphasis on armaments. The automobile, motorbus and aircraft systems of transport are oversaturated and will not be able to meet the demands of the year 2,000. The only system that has that capacity is that of high speed rail and the technology is there to be used by those who have the good sense to go after it on a private, entrepreneurial basis. That is, after all, the American way.

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Berkeley, "Cryptography Problems Being Solved at Sandia National Laboratories" – *Cont'd. from p 25*

"In spite of the contention of certain eminent scientists that mathematics is a science that has nothing to do with observation and experiment, the history of the Theory of Numbers has been chiefly made by those who followed methods closely allied to those of the student of natural science. ... It is hardly likely that any theorem of importance in the Theory of Numbers was ever discovered that was not found in the first place by observation of listed results. ... Every investigator is familiar with the fact that a table constructed for one purpose almost always suggests other directions in which research may be profitably conducted."

The Theory of Numbers has drawn investigators magnetically for more than 2000 years. The names of Euclid, Eratosthenes, Mersenne, Fermat, Gauss, Riemann, Lucas, and many others sparkle in mathematical history. Perhaps the reason is that the distribution of primes is an unending puzzle, just as the natural numbers are unending. For example, here are four prime numbers 22271, 22273, 22277, 22279, which resemble 11, 13, 17, 19; how far do these quadruplets go? No one knows; but the guess is they continue unendingly.

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Avoiding Oversights in the Computer Acquisition Process

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—Part 2

"If master planners were given the single task of system acquisition plus appropriate time (and pay), they would probably uncover their own oversights after several acquisitions revealed the flaws."

Part 1 of this article appeared in the July-August 1984 issue.

Issue 7: Pitfalls in the Benchmark Process

Deficiencies in the benchmark process should be noted. Benchmarks are the most widely-used method of comparing computer performances. Benchmarks are run at the vendor's expense in a controlled environment while hardware monitors and sensors report the machine performance to critical observers. Benchmarks are often required for the two or three finalists in the RFP.

Benchmarking is usually an honest attempt to remove subjectivity and to evaluate competing systems using actual jobs from existing shop programs. Benchmarks are definitely superior to MIPS ratings, but several factors can muddy the process in unexpected ways.

The first is benchmark costs. Few bid writers inquire about the hidden cost of benchmark runs, although they ultimately pay the bill for it. If $20,000 or $50,000 or $100,000 could be deducted from the computer price in trade for not benchmarking and if other alternate studies of performance could be achieved for much less money, benchmarking might be discarded as a costly, avoidable exercise.

Benchmarks are not cheap, and vendors write the cost of your benchmark (plus some others) into the price of each computer. Vendors do not win a sale every time they benchmark, and since they recover none of their expenses on five or six no-win benchmarks, they write the cost of five or six benchmarks into each computer they sell.

These costs include travel expense for their staff and yours, technical staff salaries, computer CPU time for program prep, hardware staff to configure the machine differently for your specs, and competitive analysis to predict how competitors will fare on the benchmark -- all multiplied by four or five. This activity often costs $30,000 to $130,000; but if five vendors are competing for a bid, they each may inflate the computer price by $150,000 to $1,000,000 to recover their no-win costs.

Vendors view competitive benchmarks as an opportunity to lose a bid because of the high risk of accidental oversights. Mistakes can be corrected easily under normal circumstances; but in a benchmark, mistakes produce negative exposure in the presence of customers. Formal, legal protocols prevail, and vendors cannot easily recover image or explain failures in this strange environment. Vendors set up benchmarks because they have to do it -- everyone else is doing it -- but it is a costly process that produces nothing of lasting value.

A second pitfall, rarely noticed, is the impossibility of benchmarking future software systems for which the new equipment is being purchased. Computers are ordered to accommodate more users, new programs, new solutions, and new applications. Since future software systems do not yet exist, benchmark comparisons are of necessity based on old programs, old systems, and old solutions.

A third benchmark bias is called the "incumbent vendor advantage", especially if the proposed system is compatible with the old system. Other vendors face a hasty benchmark experience -- a few weeks in which to grasp the purpose of your programs and to make estimates about how to make foreign instructions execute efficiently on their computers. The incumbent doesn't have this problem.

Thus, your programs may not run as well as they might if the vendors had more time or more knowledge of your programs. Each competing vendor has just enough time to get the programs running; little time for tuning, recompiling, and refining. The incumbent has an advantage.

Sometimes vendors must inform prospects that certain features of the benchmark process cannot be handled on their computers in the way it was done on the old computer. Old algorithms may not fit the newer architecture. The buyer must then approve exceptions, variances, or compromises. Since these changes were not part of the evaluation plan, final comparisons may be suspect. Trite remarks about comparing apples with oranges may cloud the results when exceptions are granted.

However, the buyer has little choice but to grant variances. This flexibility is necessary, but it further weakens the arguments for conducting such an expensive exercise under the guise of scientific measurement.

An alternative to vendor benchmarking does exist. It is much less costly and may be more effective. First, if possible, negotiate a cost reduction if benchmarking is avoided. Try for it, at least. Then, send two of your best staff members to other sites where a proposed machine is already operating in an environment which is similar to yours.

Your staff may not even need to compile test programs at the visited site. Rather, they may spend time learning how new solutions to problems similar to yours have been solved on larger, newer equipment under newer operating systems, newer data base systems, and with the latest vendor utilities. Acquisition is a time for humble, open examination of how the rest of the world has varied from your norm (or rut).

Questions about stability, reliability, and throughput can be analyzed at the visited site across many months of their experience, quite apart from the artificial environment of benchmarking where uptime and stability are artifically controlled. Rather than simulating 100 users multithreading through a data base, for example, buyers should visit and spend considerable time in a real, live, productive data base shop where 100 users are pounding the system day after day.

This type of analysis is under the direct control of you and your staff, and they can adapt their questions to match the surprises of new system styles and innovative approaches. Their reports should be detailed, lengthy, and precisely tailored to the aspirations which led your institution to issue a bid.

If the vendor cannot find a site with systems like yours, why consider them? If the vendor does take you to a successful site whose activities parallel yours, perhaps,you should purchase software from the visited site. Since 1978, approximately, if your staff is writing code instead of buying code, your institution is losing money under your direction.

Vendors should be willing, sometimes, to invest five to ten thousand dollars sponsoring site visits if they avoid a fifty thousand dollar no-win benchmark option.

Issue 8: Vendor Low-Balling

How can a bid be written to prevent unethical vendors from proposing small, inadequate machines whose lower prices could undercut more qualified vendors? If a statement such as "machines rated lower than 1,000 KOPS may not be bid" is not a valid rating for power or throughput, are there other strategies which may be used to guarantee adequate performance after installation?

Milestone measurements can be identified as checkpoints after installation -- moments in time when the throughput of the new equipment is compared to the displaced computer. These milestones can be defined as wall clock time required to access 50,000 records and print a report within a specified user load, or any other simple measurement can be defined as the criteria for meeting some improved production goal.

Milestone snapshots can be written into bid specs and into contracts as guards against three guys in a garage bidding a jury-rigged microcomputer as the solution for a ten million record data base.

Issue 9: Top Management Involvement

After reviewing bid responses and selecting a vendor, the director of data processing must approach management with recommendations. Using overhead transparencies, flip charts, or chalk boards, we attempt to convince presidents, trustees, consultants, and office managers that a certain choice is wise, reasoned, cost-effective, and appropriate.

Considering the difficulty of ordinary dialogue, the task of presenting logical arguments for million dollar computer purchases in five-minute commercials to top management (whose only involvement is to be sold on and approve this purchase) has to rank low in chances of success.

The absence of top management involvement throughout the acquisition process explains why so many unexpected obstacles are encountered at the last minute. Lacking technical appreciation and never believing that the issues can be as complex as data processing directors claim them to be, emotional responses suddenly arise from top management.

Board members who have friendships with certain vendors may begin to question and probe. Office managers who detest change may openly debate your intelligence. Presidents who equate biggest with best may doubt the capabilities of any vendor smaller than the biggest.

Management involvement throughout the bid process is not only critical, it is mandatory if directors hope to obtain management backing. Without continuous management involvement, bids will be thrown out, debates will be reopened, new consultants hired, credibility questioned, empire building suspected and critical acquisition windows will be lost.

Use every organizational device and every available communication medium to keep management involved through the entire acquisition period. Let other activities slip, if necessary, to give priority to this critical, often-overlooked issue. The quiet detachment of top management during the acquisition process is the kiss of death. Years of study and analysis can fall in a minute under the final, superior insights of isolated top management.

Issue 10: Underestimating the Scope of the Task

The task of professional computer acquisition ought to be a full-time job. It is a full-time job where buildings and skyscrapers are involved. Computer system architects who plan the future of their institution's most valuable asset (its information) carry the unpaid titles of planner, blue-print maker, materials buyer, and system designer -- all this while keeping the data centers running smoothly.

Directors who hope to mastermind acquisitions while sustaining other responsibilities such as personnel, staff work assignments, project management, vendor relations, down-time sleuthing, and plant management should consider their legal and personal vulnerability.

If the institution cannot provide adequate time and resources to the system architect, you must consciously decide whether you want the honor of such responsibility without the freedom to execute the task professionally. Recommend outside consultants to guide the acquisition if the responsibility is greater than the resources for conducting it honorably.

Some directors, when forced to carry these responsibilities as a sideline task, retreat to a safe hiding place. They fix the bid early to win the system which is safest for them, rather than best for the institution. That way, if the project fails and they chose a credible vendor, there is only a single jeopardy. After all, if that well-known vendor couldn't do the job, who could have predicted it? But if it fails and they also choose an unconventional system, the director faces double jeopardy -- and a likely change of employers.

Bid writers who play safe in this way, or who are motivated by self-concern, should not write bids. They have already selected their gear, and they should seek permission to buy it. Sham bids waste institutional money.

Consultants also may operate out of self-concern, but, like architects, their records can be traced and their neutrality established from their past behavior. Check their track records.

Issue 11: Outside Consultants

Although our normal ego assures us that we are adequate for all tasks and challenges, there are some surprising arguments for turning the whole acquisition process over to an outsider. The consultant's fee schedule will, at least, establish your worth or put the scope of the project into perspective.

A. Larger Viewpoint: The professional consultant has coordinated acquisitions for many institutions at many levels. Plans which did not execute well will be known and understood as models to avoid.

B. Industry Experience: The consultant probably has a broad and personal knowledge of the computer industry as well as mainframe integrating experience. Sources of software, superior business systems, and future hardware options will be known to the planner.

C. Cost Avoidance: The fragmented loss of in-house staff time is avoided. Committees and special assignments for individuals reduce their normal productivity.

D. Cost Savings: Knowledge of money-saving strategies often recovers more than the consultant's fee.

E. Timely Results: Full attention can be given to the delivery of the published plan. The task will not drag on for years; it may be completed in 60 to 90 days.

F. Independent Auditing: Outside viewpoints are valuable in the acquisition process. Parochial habits and policies are made visible.

G. Priority Arbitration: Conflicting viewpoints and disputed priorities can be presented fairly to the consultant for discussion and recommendation.

Issue 12: Conflict of Interest

This is probably the most damaging oversight and also the most difficult to admit. By analogy, architects who own stock in steel companies might be less likely to recommend wooden windows and doors. Similarly, directors of computer sites who manage six system programmers, for example, are not likely to order a computer which requires no system programmer.

If your hallmark is "strong staff of job control language experts" or "well known for expertise in communication and network programming", then you hardly qualify as an independent guide for computer acquisition. The possibility of recommending a computer which requires none of these skills hovers near zero. If such conflict exists, admit it and disqualify yourself.

The problem is that institutions would vote every time in favor of slightly more expensive hardware if they could reduce staff costs in the long run. But only the bravest or most ethical data processing director will inform management that such options exist because it is a vote against loyal staff, and there always seem to be too few of them anyway.

For this reason, the vice president of information systems or whoever is selected to manage the acquisition process should be an officer in the institution. Unless this person shares in the financial well-being of the institution and cares deeply about the larger institutional profit line, he or she will be forced to cast lots in the safety of the computer shop team, perpetuating jobs, and the systems which secure that team, along with their costly ways of doing things. That's the kind of objectivity an institution might pay extra to avoid.

Ethically, the goal of the acquisition manager is to find innovative solutions to the future information needs of the institution, solutions which promise greater throughput across many years with decreasing staff effort. It is appropriate to compare the cost of purchased application packages against in-house program development. Do highlight the possibilities of reducing staff, which some computer vendors should be able to demonstrate.

In Summary

Done honestly, you won't get sued. Done well, you may resume your old tasks again. Ask yourself, "If I do a professional job in leading this acquisition cycle, will someone recognize its worth, its effort? Who will praise this corporate contribution?".

If the answer is "no one", then urge the hiring of a consultant to manage the acquisition. Avoid setting yourself up for a thankless task. On the positive side, most institutions will recognize the enormity of the task and should support you with sympathy -- or praise. If praise, your window for promotion is opening wide.

Ω

CACBOL – *Continued from page 2*

A mind builds up elaborate defenses to protect its cherished beliefs.

(Source: Neil Macdonald's notes)

Ω

Cryptography Problems Being Solved at Sandia National Laboratories

Edmund C. Berkeley
Editor

"Code developers want to use numbers that are probably safe from factoring by unauthorized persons but numbers not longer than probably necessary."

This report would not have been possible without the considerable and much appreciated help given me by Dr. Gustavus J. Simmons, Head, Applied Mathematics Dept., Sandia National Laboratories, Albuquerque, NM 87185, and other persons there. Any misstatements or errors are however entirely due to me. – ECB

Prime Numbers

Recently, because of modern applications in cryptography, computer security, and passwords, there has been a resurgence of interest in centuries-old problems having to do with prime numbers and numbers that are products of two large prime numbers.

A prime number is a whole number that is not divisible exactly by any other whole number, except itself and 1. The numbers 1, 2, 3, 5, 7, 11, 13, 17, 19, 23 are the first ten prime numbers. The other numbers, 4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 22, 24, 25, are the first fifteen composite numbers. Each composite number can be factored into primes (not counting 1 or itself) for example, 18 = 2 x 3 x 3. 2, 3, 6, 9 are factors of 18. The cofactor of 2 is 9. A cofactor of 3 is 2.

Factoring

Factoring may not sound hard, and it is not hard for small numbers and numbers that are listed in certain tables. In 1913 D. W. Lehmer published a table of 133 pages listing all prime numbers from 1 to 10,006,721; this monumental precomputer accomplishment was reprinted in 1956. But the factoring of large numbers, aside from easy composite numbers like 1 with 37 zeroes after it (10 to the 37th power) -- which is approximately the number of grains of sand if the earth were all sand -- can be extremely difficult.

If you want to factor a number, say 11,111, and you have a list of prime numbers in sequence like Lehmer's list, you can try as a divisor each prime number in the list one after the other up to 103, (because the next prime, 107 multiplied by 107 gives 11449). Sure enough, when you reach 41, you find that 41 divided into 11,111 is exactly 271. So you have factored 11,111. But clearly the work of successive testing of many divisors mounts enormously as the number to be factored becomes large. The difficulty of factoring can be correlated with the difficulty of deciphering an enciphered message.

Large Numbers

The factoring of large numbers of 50 and more digits is of new interest because of their use in what is called two-key encoding techniques. These are used in:

- electronic fund transfers;
- automatic bank teller machines;
- smart credit cards;
- access to remote data bases;
- direct debiting sales systems; and elsewhere.

Code developers want to use numbers that are long enough to be probably safe from factoring by unauthorized persons but numbers not longer than necessary. Currently the team at Sandia can factor numbers of about 75 decimal digits using 10 to the 12th power basic assembly language operations: add, shift, XOR (a logical masking operation), etc. A common measure of security adopted by several large organizations (in Great Britain, Japan, U.S.A.) is 10 to the 18th power basic operations. Currently 10 to the 12th power operations is roughly a day's time on a computer of the Cray class. One organization considers that 10 to the 24th power operations will remain a secure hurdle for the next dozen years.

Four World's Records

New general purpose factoring routines that take advantage of an extremely fast and capable computer (the Cray 1-S) have enabled the Sandia team to set four new world's records.

(1) In 1983 Dr. James A. Davis and Diane B. Holdridge set a new world's record for the longest number factored by a general purpose factoring routine: a number 63 decimal digits long. This number had been published as the "hard composite cofactor" of 11 to the 93rd power plus 1.

(2) Then in December 1983, the same two people factored a 67 digit number. It is a number that begins with the digits 1164 and is called "the 9th number" on a certain list.

(3) Then in Feb. 1984 they factored a number of 69 digits, which was the "hard composite cofactor" of 2 to the power 251 minus 1. The other two factors are 503 and 54217, which have been known for more than a century. The 69 digit number has three prime factors of length 21 digits, 23 digits, and 26 digits.

(4) Then in March 1984 they found exactly two prime factors of the decimal number consisting of 71 ones, one 30 digit factor:

24157 31423 93627 67357 69574 39049;

and one 41 digit factor: 45994 81134 78868

46310 22172 88952 23034 301839.

Some Reflections

Now if you, the reader of this short report, will just multiply the first number by the second, and time yourself, you will find that a sequence of 71 ones results. Then you can compare your time with the Cray XMP computer at Los Alamos National Laboratory, where the multiplication took about 1/100 of a second to execute on the central processor. A fairly easy method for a quick bookkeeper mind would be to construct by addition a table of the multiples 1 to 9 of the first number, and then to select partial products according to the digits of the second number, using quadrille ruled paper for alignment, and then to add the columns (71 of them) noting the carries in a separate line. Certainly, this would take less time than programming a computer for multiple precision arithmetical multiplication, if the program were not already on tap in the software library.

Of course, finding in the first place the two prime factors of the number consisting of 71 ones was a feat like climbing Mt. Everest in 1953, something never done before. And on March 8, 1984, it took 9.5 hours on the Cray XMP computer at Los Alamos National Laboratory with the cooperation of the Sandia group. The updated factoring algorithm appears not to have a name at this time but it might be called "streamlined vector piping". As Sir John Hunt, leader of the 1953 Everest expedition said, "To solve a problem which has long resisted the skill and persistence of others is an irresistible magnet in every sphere of human activity."

The Theory of Numbers

Here and there in the world of the natural numbers (which is called the Theory of Numbers) there exist special methods of factoring large numbers. Hardly anyone would be impressed however with finding one factor of the large number consisting of 70 ones or 72 ones: the number 11 would factor both of them. In the case of a number consisting of 69 ones or 72 ones, the number 111 = 3 x 37 would factor both of them.

The following factors would apply to many large numbers consisting of only ones:

Number of Ones	Factors	Product
3	3 x 37	111
4	11 x 101	1111
5	41 x 271	11111
6	3 x 7 x 11 x 13 x 37	111111
7	239 x 4649	1111111
8	11 x 73 x 101 x 137	11111111
9	3 x 3 x 37 x 333667	111111111
10	11 x 41 x 271 x 9091	1111111111

Question: What are the factors of the number consisting of eleven ones? I can't investigate it easily on my handheld 8-digit calculator, which won't give me remainders. And I don't have access these days to good libraries, where the answers may be listed in a table in a journal. And I don't know enough yet about the programming of my microcomputer to produce easily a program for factoring the number consisting of 11 ones. (I miss my DEC PDP-9 which died at the age of 12 from a power surge in 1980.)

Observation and Experimenting in Mathematics

D. W. Lehmer made some very interesting remarks at the end of his introduction to the table of prime numbers from 1 to 10,006,721. *(please turn to page 19)*

Heckel – *Continued from page 11*
Apple computers sold (at about $3,000 each). While VisiCalc no longer represents the state of the art, it was a significant advance in its time. Like "Birth of a Nation," VisiCalc focuses our attention on the underlying principles rather than the latest techniques.

The reason that VisiCalc (and to a lesser extent Word-Star) has proved successful is that its design was "friendly" on a fundamental level. Things that are done well tend to be transparent and are not noticed, while things that are done badly intrude and are noticed. That is why a generation of designers have been able to improve VisiCalc, but few have been able to since make a quantum advance anything like it.

Formulas, Assumptions, and Problems

Chance favors only the prepared mind.

—Louis Pasteur

Most of us like a formula that we can follow to get ensured results. Failing that, we like a well-defined problem whose solution we can optimize. This is particularly true for those of us who are engineers. We expect a problem's parameters to be given. We don't question them. In college we learn Newton's law and Maxwell's equations, and find that a few powerful formulas explain mechanics and electronics. In school we are graded on how well we apply these laws; in industry we use these and similar laws to solve a wide variety of problems. Once we have found the correct way to solve a type of problem, we rarely look at such problems in a different way.

Unfortunately, we tend to expect other things to be explained by unambiguous formulas or recipes -- if only we can find the right ones. Following this approach, when we are faced with a complex problem we make simplifying assumptions to make the problems manageable. But having done that, we tend to forget the assumptions, casting the real problem adrift while we concentrate on solving the simplified one we created. All too often we get the right solution to the wrong problem.

The User's Knowledge

Sometimes a designer is asked to design an application that assumes the user knows nothing. Not only is this unrealistic, it indicates a basic misunderstanding of the principles of effective communication. The good communicator finds out what knowledge the intended audience possesses and starts there, leveraging that knowledge to effect the communication. A writer can only use a word or image effectively if the reader has some familiarity with it.

How much knowledge we unconsciously take for granted is illustrated by something that happened to a friend of mine. His newspaper delivery boy rang the bell every time he delivered the paper. Annoyed, my friend put up a sign asking him not to ring the bell; the paper boy still rang it. My friend put the sign over the door bell. This time the paper boy pushed a hole through the sign to ring the door bell. My friend called the newspaper company to complain -- only to find that the delivery boy could not read.

The User's Environment

The test of a user interface is to get users to try it. The misunderstandings that the user has should spur the designer to change the user interface.

It is easy to fail to recognize a source of problems. For example, one program used a standard office filing system as a user interface metaphor. When a secretary used it, she destroyed a file she had just made by making another file and giving it the same name. "But," she explained, "in my office I can have two files with the same name." Ω

Newsletter – *Continued from page 3*

(How stupid can the designers and supervisors of a computer system get?)

The Air Force junked $700 million in spare parts in 1983, and a "significant" amount of those could have been used, according to Thomas E. Cooper, assistant secretary of the Air Force for research, development and logistics.

"Time and time again, we came across instances that on maybe the 13th month, a requirement for that item came up, and we would look and the shelf was empty, and we would have to go reprocure it," Lt. Gen. Leo Marquez, deputy chief of staff for logistics and engineering, said. "I know it doesn't make a whole lot of sense, but that is the way the system works."

In many cases, officials said, salvage dealers would sell items back to the Air Force, still in their official boxes or wrappings, at many times the salvage price. Ω

Berkeley – *Continued from page 16*

Those who cannot remember the past are condemned to repeat it.
— George Santayana, 1906

Negative Feedback -- Appropriate Response.

He who suffers remembers.
— Cicero, 63 B.C.

The burnt child dreads the fire.
— John Ray, 1670

He who has burned his tongue does not forget to blow on his soup.
— G. Cahier, 1856

Negative Feedback -- Exaggerated Response.

A dog once scalded fears cold water.
— G. Maurier, 1550

He who hath been bitten by a serpent is afraid of a rope.
— John Ray, 1678

I am a shipwrecked man who fears every sea.
— Ovid, A.D. 13

Feedback Control.

A stitch in time saves nine.

Better a little chiding than a good deal of heartache.
— British proverb

An ounce of prevention is worth a pound of cure.
— T. C. Haliburton, 1843

The burned hand teaches best. After that, advice about fire goes to the heart.
— J. R. R. Tolkien, c. 1940

A wise man makes a mistake once, a fool many times.

The faster you learn, the better you do, the more you gain.

Arguments about Feedback

The principle of feedback as a method of understanding and solving problems does not really have arguments against it. A law of nature is that many processes have the property of feedback. It remains for human beings to understand the law of feedback and take advantage of situations where it can help, and avoid situations where it can hurt. In the same way we deal with the law of gravity.

This brings us to the end of Part 1 of "Problems, Solutions, and Methods of Solving." We plan that additional parts will be published in subsequent issues of "Computers and People". Ω

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 programming 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.*

NAYMANDIDGE

In this kind of puzzle an array of random or pseudo-random digits ("produced by Nature") has been subjected to a "definite systematic operation" ("chosen by Nature"). 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 must display some kind of evident, systematic, rational order and completely remove some kind of randomness; the operation must be expressible in not more than four English words. (But Man can use more words to express the solution and still win.)

NAYMANDIDGE 8409

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

MAXIMDIDGE

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, plus a few more signs. To compress any extra letters into the set of signs, the encipherer may use puns, minor misspellings, equivalents (like CS or KS for X), etc. But the spaces between words are kept.

MAXIMDIDGE 8409

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, expressed in numerical digits, is to be translated (using the same key) into letters so that it may be read; but the spelling may use puns or deliberate (but evident) misspellings, or may be otherwise irregular, to discourage cryptanalytic methods of deciphering.

NUMBLE 8409

A = E

```
          F I R S T
        *     L A Y
        -----------
        I S Y T L S
      L H I L T S
    T T Y F E I
    ---------------
=   T I F T F G G S
```

22044 11204 2X4XX 34

Our thanks to the following person for sending us solutions: T.P. Finn, Indianapolis, IN – Numble 8407, Maximdidge 8407.

SOLUTIONS

MAXIMDIDGE 8407: Hope is as cheap as despair.

NUMBLE 8407: The deaf must trust.

NAYMANDIDGE 8407: Column 16, over 6.

NAYMANDIGE 8407

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