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# computers and people

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*FLOCK MIGRATION OF CANADA GEESE STUDIED BY COMPUTER*



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# Automatic Computer Programming Using Ordinary Natural Language: Samples of DJINNI-B

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```
A>TYPE SUBC3.ENG
THIS PROGRAM IS SUBCONTEXT3
ENTER THE COLUMN DAILY.INCOME
THE SUM OF THE COLUMN DAILY.INCOME IS TOTAL.INCOME
PRINT WITH HEADINGS TOTAL.INCOME
STOP
```

---

```
A>TYPE SUBC3.BAS
10 REM  FILENAME: SUBC3.SYN
20 REM SUBCONTEXT3
30 PRINT "PROGRAM SUBCONTEXT3 "
40 REM ROUTINE: ENTCOL FOLLOWING:
50 REM ENTCOL COLUMNVAR
60 REM ZEROS AND READS IN SPECIFIED COLUMN VARIABLE
70 DIM DAILY.INCOME(20)
80 PRINT "PLEASE ENTER A DAILY.INCOME EACH TIME A ? APPEARS:"
90 FOR I9% = 1 TO 20
100     INPUT "? ";DAILY.INCOME(I9%)
110 IF DAILY.INCOME(I9%) = 0 THEN GOTO 130
120 NEXT I9%
130 REM THE END
140 REM ROUTINE: SUM FOLLOWING:
150 REM SUM COLVAR = SUMVAR
160 TOTAL.INCOME = 0
170 FOR I9% = 1 TO 20
180 TOTAL.INCOME = TOTAL.INCOME + DAILY.INCOME(I9%)
190 NEXT I9%
200 PRINT "TOTAL.INCOME","","",""
210 PRINT TOTAL.INCOME
```

---

```
A>CRUN SUBC3

CRUN VER 2.03

PROGRAM SUBCONTEXT3
PLEASE ENTER A DAILY.INCOME EACH TIME A ? APPEARS:
?  100
?  200
?  300
?  400
?  500
?  0
TOTAL.INCOME
 1500
A>
```

**Figure 1: At the top: a procedure in plain ordinary English**
**– In the middle: the procedure in CBASIC produced automatically by DJINNI**
**– At the bottom: a sample run**

In Figure 1 at the top is a sample of a program in five lines of ordinary natural language. These five lines name a program, enter a column of figures, sum the column, and print the total. The name of the column (it could be anything) is in the sample "daily income". The name of the sum (it could be anything) is "total income". The name of the program (it could be anything) is "Subcontext 3". The name of the file which holds the program is "SUBC3.ENG", where the "ENG" refers to "English". The phrase "Subcontext 3" refers to the third one of a set of subcontexts which are certain subareas of programming such as:

- naming a program
- entering information into it
- computing
- entering a series or list
- expressing a condition
- branching
- repeating for a while and then stopping

and so on. All these areas can be expressed in many different ways in ordinary natural language. Many of these ways (and eventually all of them) are (and will be) acceptable to DJINNI, a method of automatic computer programming using ordinary natural language, which has been reported on in "Computers and People" in a number of articles. See the references below.

The middle part of Figure 1 shows the automatically produced program in CBASIC which DJINNI-B produces. This program is compiled in the usual way by the compiler, and it can be run in the usual way by the command CRUN SUBC3.

The bottom part of Figure 1 shows a sample run. Here the figures 100 to 500 are entered at the keyboard. 0 is the signal "no more to enter". The total 1500 of course is correct.

*"Lots of people will no longer need to learn BASIC or FORTRAN or COBOL or any other artificial programming language to tell a computer what they want it to do."*

```
A>
  TYPE SUBC4.ENG

THE NAME OF THIS PROGRAM IS SUBCONTEXT4
ENTER THE DATA NUM.ONE
INPUT THE DATA NUM.TWO
ADD NUM.ONE TO NUM.TWO; THIS IS NUM.THREE
NUM.FOUR IS NUM.ONE MINUS NUM.TWO
THE PRODUCT OF NUM.ONE AND NUM.TWO IS NUM.FIVE
NUM.ONE DIVIDED BY NUM.TWO IS NUM.SIX
PRINT WITH HEADINGS NUM.ONE, NUM.TWO, NUM.THREE
PRINT
PRINT WITH HEADINGS NUM.FOUR, NUM.FIVE, NUM.SIX
PRINT
STOP
```

```
A>
  TYPE SUBC4.BAS

10 REM  FILENAME: SUBC4.SYN
20 REM SUBCONTEXT4
30 PRINT "PROGRAM SUBCONTEXT4 "
40 PRINT "NUM.ONE "
50 INPUT NUM.ONE
60 PRINT "NUM.TWO "
70 INPUT NUM.TWO
80 NUM.THREE = NUM.ONE + NUM.TWO
90 NUM.FOUR = NUM.ONE - NUM.TWO
100 NUM.FIVE = NUM.ONE * NUM.TWO
110 NUM.SIX = NUM.ONE / NUM.TWO
120 PRINT "NUM.ONE","NUM.TWO","NUM.THREE",""
130 PRINT NUM.ONE,NUM.TWO,NUM.THREE
140 PRINT
150 PRINT "NUM.FOUR","NUM.FIVE","NUM.SIX",""
160 PRINT NUM.FOUR,NUM.FIVE,NUM.SIX
170 PRINT
```

```
A>CRUN SUBC4


CRUN VER 2.03

PROGRAM SUBCONTEXT4
NUM.ONE
? 20
NUM.TWO
? 4
NUM.ONE                 NUM.TWO                 NUM.THREE
 20                      4                       24

NUM.FOUR                NUM.FIVE                NUM.SIX
 16                      80                      5
```

**Figure 2: At the top: a procedure in plain ordinary English**
**– In the middle: the procedure in CBASIC automatically produced by DJINNI**
**– At the bottom: a sample run**

It is interesting and significant that the five lines of ordinary language that express the desired program: (1) expand into 21 lines of CBASIC; and (2) are correct, right, the first time. This is useful when great efficiency in coding is not needed, as when a program is only wanted for a few cases in all. It is also significant that no knowledge of CBASIC is necessary; DJINNI B takes on that burden. Lots of people will no longer need to learn BASIC or FORTRAN or COBOL or any other artificial programming language to tell a computer what they want it to do.

In Figure 2 at the left is a second example of a program in ordinary natural language in which the directions for computation can be expressed in many, many different ways, all of which can be understood by DJINNI-B. Of course only one form of expression shows in the program as for example "The product of NUM.ONE and NUM.TWO is NUM.FIVE"; but both the following wordings would be acceptable: NUM.ONE times NUM.TWO is NUM.FIVE; multiply NUM.ONE by NUM.TWO, this is NUM.FIVE; and other wordings as well.

We have made a list of some of the objections to the concepts of DJINNI, automatic computer translation with attention to meaning. These objections come from a number of computer professionals and management professionals. One is "natural language programming is impossible". These people regularly do not look at our evidence. Another objection is "you have not shown us a general algorithm; therefore we are not convinced." These people seem unaware of the possibilities of cryptanalysis. Another objection is "we are not interested in an incomplete demonstration; when you have a complete demonstration, come back and see us". Well, before long we should have a much more complete demonstration; but it seems likely that these people will say just the same thing next time. Another objection is "I and all my friends can use BASIC or FORTRAN or COBOL, etc.; nearly everybody can learn a programming language; so why is there a fuss?" These people seem to lose sight of the need for simplicity for most people using computers. Computers should be as easy to drive as a motor car, and natural language programming is part of that.

### References


1. "Automatic Computer Programming Using Ordinary Natural Language: The Vocabulary and Concepts of Djinni-B" by Edmund C. Berkeley, in "Computers and People", Nov.-Dec. 1979, p 16 ff
2. Four more references listed on page 20 in that issue. □

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# computers and people

*formerly Computers and Automation*

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



*Front Cover Picture*

The front cover shows Canada geese wintering in North Central Missouri. Scientists at Louisiana State University using a powerful computer are studying geese migration patterns to find clues to help conservationists redistribute flocks. See the story on page 32.

*Key*

| | | |
|---|---|---|
| [A] | – | Article |
| [C] | – | Monthly Column |
| [E] | – | Editorial |
| [EN] | – | Editorial Note |
| [F] | – | Forum |
| [FC] | – | Front Cover |
| [N] | – | Newsletter |
| [R] | – | Reference |

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**THE "COMPUTER DIRECTORY AND BUYERS' GUIDE": NEWS AS OF FEBRUARY 15, 1980**

The "Computer Directory and Buyers' Guide" for 1978-79 will contain a Roster of Organizations of more than 1500 entries, far more than last time. It will also contain a Buyers' Guide to Products and Services, under some 30 categories, including Computer Dealers, etc.

The data is 99% gathered. The hardware is 100% gathered. The software, under contract, is late by more than 12 months, and is still unsatisfactory.

Editorial

# The Frightening of People by Words

*Edmund C. Berkeley*
*Editor*

"Sticks and stones may break my bones,
But words will never hurt me."

Perhaps in a simpler world this used to be true. But it is certainly not true in these days.

The words that people use to other people can cause incredible suffering, mainly by producing either one of two fears:

1. The fear that someone is going to do something dreadful to all that you hold most dear.
2. The fear that you cannot understand something that you think you should understand and that you can be reproached for not understanding.

The other day I used to a good friend of mine the word "algorithm". She did not say she was frightened; but she pounced, "Don't use that word to me — I don't understand it."

I explained to her that an algorithm is a kind of procedure, and that she already knew all about many procedures, like driving a car, and tying one's shoelaces, and cooking hard boiled eggs, and adding a few figures by the method she was taught in elementary school, like adding 25 and 37, which gives 62. But she did not relax or let go her opposition or fear. I did not even manage to tell her that an algorithm was "an effective calculating procedure", in other words, a procedure for figuring that works, that actually gives a good answer quickly.

Soon I may use that word "algorithm" again. I am sure she will protest and again refuse to listen to what I am saying. The word frightens her.

The worst of this pattern of behavior is that it is so prevalent. What is it about our system of education in this country that makes this pattern of behavior so common, so accepted, and so "normal"?

Even in my own case there is much in computer literature that the author takes for granted and for which he gives no explanation. For example, I find in the editor's mail a notice of a conference organized and with a slate of speakers, and a list of papers to be given, and the entire key to the conference is VLSI (or some other alphabetic contraction), completely undefined — as if everybody and his brother know what VLSI is. Well, I don't know what it is; I have been in the computer field 40 years; perhaps VLSI means "very large scale integration", but there is no way I can easily confirm the guess, without expense of time, postage, telephoning, etc. So I pass it by, and put it in a pile for "later."

But there are other words and terms being used which produce far more harm. Some of these terms are aimed to divert attention and paralyze thought. They tend to make Congressmen adopt resolutions like the Gulf of Tonkin Resolution. This Lyndon Johnson took before the Congress, and on the basis of lies he told and for the nonsense of "national security", they gave him a blank check which (with its aftermath) was interpreted to produce a ten-year war in South East Asia: over 1,000,000 Asians dead; more than $150 billion dollars spent; over 55,000 Americans dead; and a record of military "schrechlichkeit" (horribleness) including napalm, Agent Orange, tiger cages, precision bombing, etc., that Hitler would have been proud of.

The worst of all the terms is "national security", which has replaced "patriotism", which Dr. Samuel Johnson of dictionary fame called "the last refuge of a scoundrel".

The security of the nation (the people) of the United States doesn't depend on oil in Afghanistan: there is no oil in Afghanistan. It is a poor country filled with arid desert, arid mountains, and passionate tribesmen.

The security of the United States depends on thriving and happy people, not people being ruined with inflation and poverty, problems about energy, and all the rest. We have a hard road to hoe, and some great resources, including computers, and some great lacks, to be worked on intelligently — including: sales of wheat to the Soviet Union for American farmers to profit from; sales of computers to the Soviet Union for American manufacturers to profit from. Other countries — Japan, Germany, France, England — will sell those computers and push American salesmen out of the buyer's door.

How stupid, how crazy, can one get from the deliberate frightening of the American people by the words "national security"? and deliberate lying about "defense" when it means "war of aggression"?

"Those whom the gods would destroy they first make mad."

- Euripides □

# Materials and People

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*"Society will inevitably structure its growing knowledge base so that the human mind will be ever stimulated to understand nature more thoroughly."*

We shall be concerned here with two broad objectives: (a) to illuminate the partnership between man and his materials as it has developed over the centuries, and (b) to highlight society's intellectual approach to the understanding and utilization of materials through science and engineering.

### The Definition of Materials Science and Engineering

For present purposes, we need two key definitions: Materials are the portion of matter in the universe that man uses for making things, i.e., structures, machines, devices, and innumerable products. Materials science and engineering (MSE) involves the generation and application of knowledge relating the composition, structure, and processing of materials to their properties and uses. It is essential to note that MSE is referred to in the singular as a coherent field; it is not properly separable into science on the one hand and engineering on the other. Of course, some parts of this spectrum, when viewed more narrowly, may be regarded as science-dominated whereas other parts are correspondingly engineering-dominated.

### Materials in History

Materials have entered into man's existence and development ever since his emergence in the grand evolutionary scheme of things. Certainly, the use of wood, stone, shells, bone, hides, and natural fibers had much to do with the ascent of man from animal-ness to humanness. Primitive man gradually found that such materials, available in nature, could be fashioned into utensils, ornaments, shelter, clothing, even tools and weapons. One can imagine the potential impact on thinking man when he first learned that a soft, formable mud, now known as clay, could be rendered strong and rigid just by heating. It was, in effect, a new type of materials processing, rather analogous to the cooking of food. With the event — the accidental firing of clay — came the dawning of a powerful conception, namely that the materials given by nature can be deliberately changed and improved by man himself for his own purposes. Indeed, a new partnership was thus born between man and his surroundings through materials!

Based on a lecture on the occasion of the 30th Anniversary of the Office of Naval Research, at the International Conference on Materials, Boston, Mass.; reprinted with permission from *Naval Research Reviews,* October, 1978.

### The Profound Influence of Materials on Human History

History records many ways in which materials profoundly influenced social change, and so caused society to depend even further on materials. The very earliest trading centers were probably based on the availability of flint in local regions. Here was a material brittle enough to be chipped into knives, handaxes, and spearheads, and yet was sufficiently hard and strong to cut, chop, and pierce other materials. The trading centers provided an environment for human settlement and cultural exchanges, perhaps even contributing to the origin of agriculture.

Obviously, the rise of commerce and, later, of government stimulated the need for record-keeping. The materials at hand affected the form of writing that developed, and thereby the local culture. The Sumerians of the Tigris-Euphrates Valley had abundant clay to serve as their stationery, and the sharp, rigid stylus that then had to be used for inscribing favored the simple wedge-shaped, cuneiform type of characters which emerged. The Egyptians, on the other hand, had flexible fibers in the form of papyrus reeds which could be matted into a writing surface, and on which they could write with brushes and colored fluids derived from nearby vegetation. These circumstances permitted a relatively sophisticated, hieroglyphic form of writing to develop.

In a similar vein, the prevailing differences in available materials also accounted for the contrast between the mud-brick and the cut-stone architectures of the two regions.

### Iron and Steel: the "Democratic" Metal

To take another example of the interplay between materials and society, the substitution of iron and steel for copper and bronze, starting at about 1200 B.C., brought about far-reaching changes in social institutions. The relative abundance of iron meant that the ruling groups could not control its distribution, as was the case with the more-limited copper. In a sense, iron became the "democratic metal," in that it raised the standards of the common man through its widespread use in tools, household utensils, agricultural implements, and weapons. New craftsmen appeared on the scene who could earn a livelihood and contribute new skills to the advance of society. Chisels became available for stonecutting, drills for bead-making, dies for coining, and then came an enormous jump in productivity with the construction of machines from iron and steel. Even the dynamics of warfare altered dramatically when all the foot soldiers could be equipped with weapons and shields made from the "democratic metal"; in the Bronze Age, only a select few in the armies could have the benefit of metallic weaponry and armor.

Thus, over the ages of civilization, societal dependence on materials inevitably grew more compelling and pervasive — for trade and manufacture, for standards of living, for national security and well-being, and for enhancing the capital wealth of mankind. To some degree or other, this materials-and-mankind connection has been evolving for some hundred thousand years. But during the past few decades, society has begun to regard materials in a sharply different light. This recent change seems almost discontinuous when viewed against the backdrop of history.

### The Global Materials Cycle

Two new system-concepts have arisen in the field of materials. Materials are now recognized as one of the connective tissues of world economies and nations, ranking with such other basic resources as food, energy, living space, information, and manpower itself. That vast materials complex is designated as the global materials cycle. It links mankind and governments directly to the substance of nature.

At the same time, there are strong intellectual and social forces at play which are aligning various branches of knowledge into a science and engineering of materials. The resulting multidiscipline — MSE — combines the great human adventure of seeking deeper insights into matter and of marshaling such knowledge for societal advance. In its broadest dimensions, MSE constitutes a system of disciplines that overlays the materials cycle.

### Characteristics of the Materials Cycle

There is a materials cycle. In highly simplified form it is this: Raw materials are taken from the earth by mining, drilling, and harvesting. These materials (ores and minerals, coal, crude oil and natural gas, rock, sand, timber, crude rubber, etc.) are processed into bulk materials (metals, chemicals, cement, lumber, fibers, pulp, rubber, electronic crystals, etc.). They are then refined into engineering materials (alloys, ceramics and glass, dielectrics and semiconductors, plastics and elastomers, concrete, building board, paper, composites, etc.). Then the engineering materials are fabricated and assembled into structures, machines, devices, and other products for societal use. And after these materials have thus performed in their various applications, they are discarded and become waste or junk, either to enter the circuit again and again by recycling, or to return to earth whence they came. In this perspective, the materials cycle is a closed cradle-to-grave system.

### Quantity

The materials cycle is an enormous enterprise. About $15 \times 10^9$ tons of raw materials are produced annually in the world, with some 1/3 of it being consumed in the United States. Very roughly, 50 to 60% of this incredible bulk is in the form of nonfuel materials (metallic materials, nonmetallic inorganic materials, and organic (nonfood) materials) and 50 to 40% is in the form of fuel materials (petroleum, natural gas, and coal). Not only is the United States a net importer of raw materials, but (a) such net imports as a percentage of the nation's total materials consumption is rising, and (b) both the population and the per capita usage of raw materials are climbing more rapidly outside the United States than within. Clearly, then, the materials cycle plays an interconnecting role in the foreign as well as the domestic affairs of most countries around the world.

The materials cycle is, of course, driven by societal demand which exerts a pull on the circuit. The flow of materials depends on what people and institutions are willing to pay for; and so value increments in the form of labor, energy, cost of capital, etc. are added to the materials as they move around the loop. Table 1 illustrates this build-up in value for the world production of aluminum in 1963. The price (column 2) of the mining product (bauxite at $8/ton) increases by a factor of 125 in moving through the various processing steps to become wrought semifinished shapes and castings (at $1000/ton). While the weight of product is being reduced to one-fifth (column 3) between these two stages, the total value of product (column 4) is becoming 25 times greater in traversing this section of the materials cycle. Column 5 shows the value added at each of the intermediate steps. To indicate another example of the same trend, the total raw materials consumed in the United States per year (1974) amounts to about 5% of the GNP, but processing to the stage of engineering materials and their fabrication increases the overall value by a factor of 4. It has been estimated that approximately 20% of the workforce in this country is engaged in this part of the materials cycle, again giving direct evidence of the penetration of materials into human existence and quality of life.

### Strong Interactions

At virtually every point around the materials cycle, there are strong interactions among materials, energy, and the environment. For example, the energy required to produce a ton of refined copper as a function of the grade of copper ore varies. As existing mines become depleted, more and more energy is consumed to handle larger and larger quantities of rock and gangue per unit of valuable product obtained. At the same time, there will be increasing problems in disposing of the rejected matter, thus throwing further burdens on the landscape. Indeed, almost all materials processing affects the environment in one way or another, injecting social costs into the flow of materials around the cycle.

**Table 1.** Value Added to Aluminum at Various Stages of Processing in the Materials Cycle (1963)

World Aluminum Production

| Process | Product (Price) | Tons (M) | Value ($M) | Increase In Value ($M) |
|---|---|---|---|---|
| Mining | Bauxite ($8/ton) | 30 | 240 | 240 |
| Ore Refining | Alumina ($75/ton) | 12 | 900 | 660 |
| Smelting and Refining | Aluminum Ingot ($450/ton) | 6 | 2700 | 1800 |
| Fabrication and Casting | Wrought Shapes and Castings ($1000/ton) | 6 | 6000 | 3300 |

M = Millions

**Table 2.** Annual Energy Consumed in Certain Materials Production

| (1) Rank | (2) Material | (3) Annual Energy (Billion BTU's) |
|---|---|---|
| 1 | Steel slabs, grey iron, and steel castings | 3800 |
| 2 | Primary aluminum | 1100 |
| 3 | Portland cement | 688 |
| 4 | Ammonia | 586 |
| 5 | Primary copper | 221 |
| 6 | Glass containers | 216 |
| 7 | Chlorine (gas and liquid) | 199 |
| 8 | Quicklime | 182 |
| 9 | Phosphorus | 147 |
| 10 | Oxygen and nitrogen (gas and liquid) | 111 |
| 11 | Sand, gravel, crushed stone | 104 |
| 12 | Primary zinc | 92 |
| | | 7446 |

The close interplay between materials and energy is particularly evident in the U.S. economy. About one third of the energy consumed by American industry goes into the value added to materials in their production and fabrication. The twelve largest consumers of energy among the primary materials industries in the United States, aluminum and copper, involve electrical processes and are energy intensive. Materials such as sand, gravel, and stone are of low energy-intensity; relatively little processing is necessary to convert the parent raw materials into engineering materials for final use. Steel is of intermediate energy intensity, but its large tonnage puts it at the top of the list in Table 2 as a total energy consumer.

On the other side of the coin, materials are crucial for making energy available in the first place. In addition to the obvious indispensibility of fuel materials for producing energy, one finds that essentially all of the advanced energy-conversion technologies are presently materials-limited in terms of efficiency, reliability, safety, and cost effectiveness; included in this category are gas turbines, nuclear reactors, solar energy, magnetohydrodynamics, coal conversion, high-energy-density batteries, and fuel cells.

The materials cycle also affords an analytical framework for dealing with perturbations in the availability of materials at various points around the cycle, whether with reference to the world, to a country, an industry, a company, or a factory. The flow of materials anywhere in the cycle can be sensitive to economic (e.g., cartels), political (e.g., embargoes), and social decisions (e.g., environmental constraints) made in other parts of the circuit. Materials shortages, when analyzed in this context, are usually found not to be due to scarcity in the earth, but rather to dislocations in the cycle which interfere with the expected arrival of materials at any given point in the usual amounts and at reasonable prices. For example, shortages may arise, not because the earth is running out of the material in question, but because a certain processing or transportation capacity has become inadequate somewhere in the circuit.

### Metals and their Abundance in the Earth's Crust

Still another view of the world materials picture is that the annual production of various metals is plotted against their crustal abundance. Without any overall planning or directives, society has tended to produce (and use) more of those metals which are more prevalent in the earth's crust, and many vice versa. The metals are being produced at the very same rate per year in proportion to their respective abundances, even though the absolute tonnages may differ by many orders of magnitude.

Needless to say, all these manifestations of the materials cycle will have direct bearing on the evolution of national materials policies, both in the industrialized and in developing countries, inasmuch as by its very nature, the materials cycle intertwines the supply and demand sectors of the materials field. Although the materials flow around the loop can be drastically and unpredictably disturbed by events lying outside the domain of materials, nevertheless scenarios can be played out within the materials cycle to prepare for appropriate countermeasures. Some of these possibilities are stockpiling, recycling, and substitution.

### Materials Science and Engineering

We have already defined materials science and engineering (MSE) and, as a body of knowledge and inquiry, its relation to the materials cycle. The central theme of MSE is to relate the microscale structure of materials to their macroscale properties and then to their eventual performance in service, and to make this spectrum of knowledge relevant to society in connection with materials processing and manufacture for cost-effective application.

MSE can be viewed operationally as a knowledge-generation-and-transmission system which links basic research and fundamental science to human needs and the pull of society. In this way, MSE provides a matrix or connective tissue for those disciplines and subdisciplines which shed light on materials; it does not replace any of these branches of knowledge. Thus, MSE constitutes a multidisciplinary field which promotes interactions among otherwise separate disciplines; it exposes society — however circuitously — to the opportunities opened up by fundamental knowledge concerning materials, while, reciprocally, basic science is being exposed to the materials-related demands and experience of society. This two-way conduction of scientific and empirical knowledge is an important attribute of MSE that has developed only within the last few decades.

The brief historical perspective given in the previous section has shown that materials technology in one form or another has been practiced and advanced for thousands of years. Among craftsmen, artisans, and artists over the ages, there emerged a fine experience-based appreciation of the property/processing/performance relationships of materials; this was manifested, for example, in the utility of pottery, textiles, tools, and weapons, as well as in the beauty of jewelry, decorations, art, and architecture. Yet, throughout such remarkable achievements in materials technology, even through the Scientific Revolution of the 17th century and the Industrial Revolution of the 18th and 19th centuries, almost nothing was contributed to the understanding of materials by the scholars and intellectuals. Materials were too complicated, too unpredictable, even too dirty, for the philosophers and scientists of the day to deal with. The hands-on workers already knew that materials had functional, even aesthetic, properties which could be brought out by processing to serve the market place or an imperious patron; but explanations were lacking.

### Thinkers and Doers Joining Forces

It was only during the 20th century — mainly during the past few decades — that thinkers and doers joined forces in the field of materials. What finally forged into place was the scientific link in the chain — the coupling of internal solid-state structure to external properties. Materials were discovered to contain an inner hierarchy of many structural levels, with sufficient complexity to offer a foundation for their outwardly revealed properties. Microstructure was disclosed by optical microscopy, substructure by electron microscopy, crystal and molecular structure by x-ray diffraction, atomic structure by excitation spectroscopies, and nuclear structure by high-energy bombardment. This internal architecture of materials furnished a new framework in which, at long last, explanation could be added to practice and understanding to empiricism; and so modern MSE could be born.

Waves of scientific knowledge then began to flow from left to right in a multidisciplinary conduction band and, countercurrently, waves of experienced knowledge flowed from right to left. The resulting turbulence of ideas and excitement proved to be highly catalytic, and erupted into a diversity of new man-made materials: synthetic fibers, high-strength and high-temperature alloys, new ceramic and dielectric materials, optical glass, nuclear fuels, semiconductors, superconductors, synthetic diamonds and rubies, composite materials, amorphous metals, and a remarkable variety of plastics.

It is worth emphasizing some salient features of this interactive process.

### Interactive, Interdisciplinary Activities

In the COSMAT (Committee on the Survey of Materials Science and Engineering) study, several material innovations were examined in considerable detail. It appears that the two-way flow of information in MSE is most productive when the mixing of understanding and need are so closely intermingled that cause and effect are difficult to distinguish one from the other. In the main, however, the initial impetus in the MSE system seems to arise more frequently from "societal pull" than from "scientific push."

Another prominent factor in such material advances is the operation of MSE in an interdisciplinary mode. Because of the multidisciplinary nature of MSE, the field lends itself to specifically-coupled combinations of disciplines which are deliberately brought together to serve a mission-oriented purpose. This interdisciplinarity requires, at least temporarily, that the participants place primary emphasis on the overall group objective rather than on their respective disciplines. And yet, as COSMAT has noted, each such discipline contributes importantly to the total effort by making available its own concepts, viewpoints, techniques, and lore.

The successful linkage of structure, properties, and performance in MSE should not be construed to mean that properties can be predicted from structure, and performance predicted from properties; expectations of this sort lead not only to unknowns but also into the realm of unknowables. In general, structures do not "speak up" and tell us the properties they have, and certainly not the properties that make materials useful to mankind. In contrast, we have to approach the structure with prior knowledge about some property gained from curiosity or experience originating outside the structure, and then — with a leap of the mind — try to deduce which level(s) of the internal architecture will "resonate" with the property in question. In the resulting interplay, there is a reciprocity between structure and properties in which each reflects the other, and each contributes in its own way to understanding the other.

## Unknowability from Structure Alone

To all intents and purposes, the structure itself stands mute about properties until it is asked the right questions. A striking case in point is the double-helix structure of the DNA molecule. This structure is beautifully complex, but it does not "come alive" until we address it with some independently known properties of life, e.g., does the DNA structure have the ability to reproduce, and can it encode sufficient genetic information to determine what kind of a cell to grow into?

This unknowability about properties from structure alone has its counterpart in the property/performance interrelationships. The performance of materials invariably encompasses many more parameters and dimensions than can be contained in the information derived from measured properties alone. Consequently, we must recognize that the successful operation of MSE does not depend on fundamental predictability in going from the more elemental to the more complex, but rather on the symbiotic interplay among structure, properties, and performance, i.e., with knowledge freely flowing back and forth among them and each reinforcing the others toward the better understanding and utilization of materials.

## Some Examples of Materials Science and Engineering in its Interdisciplinary Mode

Ten case studies were reported by COSMAT to illustrate how MSE functions as an interdiscipline. Brief summaries are included here to document the aforementioned characteristics of MSE.

Heatshield design particularly illustrates the systems approach. The materials development is embedded in a broader design problem, but the overall design is strongly influenced, in fact almost completely determined, by materials capabilities. The development of an adequate heatshield for manned re-entry of space vehicles required the contributions from several organizations and many locations. In our language, this program is science-intensive. The program had a clearly defined overall objective and is an example of responsive materials R & D.

The transistor story emphasizes the changing nature of a materials R & D program with time. In its early phases, only fundamental understanding of the nature of electrical conduction in semiconductors was involved. The motivation or "application" was stated only in a most general way, but there was a perceived need to replace vacuum tubes in communications circuitry. Although this program substantially increased understanding of the solid state, it necessarily built on much basic work in physics and chemistry which had been completed in earlier decades. As the program succeeded in providing device capabilities, the emphasis naturally shifted from research on phenomena to the engineering aspects of design and manufacture. Movement of personnel from research to development played an important role. This program provides a particularly strong example of close coupling between basic research and engineering. The solid-state industry which has grown out of the original transistor work is the archetype of a science-intensive industry and creative materials R & D. The transistor story also illustrates the cardinal importance of a proper intellectual and working environment for innovative materials R & D. A sense of direction was provided by the management in a sufficiently general way so that individual creativity and insight were encouraged, and yet was sufficiently definite to arouse the enthusiasm and dedication of the experts involved. Leadership in the research and development program fell naturally on those able to span intellectually and motivationally the full scope of such programs.

The field of synthetic fibers, spanning several decades in time, is very large in terms of the number of investigators and organizations involved in R & D as well as in terms of market volume. As in the case of the transistor, the early effort was on basic understanding, but there was also a perceived need to improve on natural fibers. In time, engineering emphasis was added but not at the expense of further scientific investigation so that we now find the general problem of synthetic fibers being attacked across the entire spectrum from basic science to engineering. The major contributions to this important development have been made by chemistry, but inputs were required from other disciplines such as the metallurgical development of appropriate containers for the hot-liquid corrosive melt. To reach the ultimate customer, this materials advance also required innovations in spinning and weaving machinery for the new fibers.

Textured materials is a description used in this report to refer to polycrystalline microstructures in which a degree of control is exercised on the alignment of neighboring crystals. Examples are permanent magnet alloys, and high-strength phosphor bronze alloys for use as springs in relays and connectors.

The central theme of materials science in the relation among composition, structure, and properties is beautifully illustrated by this program. Here the emphasis is on structure, more particularly control of structure, and its influence on properties. Basic work by a physicist, followed many years later by metallurgists in the laboratory and supported by extensive computation techniques from the mathematicians, has led to a capability for predicting the str-
has led to a capability for predicting the structure and related physical properties of materi-its preparation. The program has set a high standard for the direct contributions which science can make to practical programs.

Although integrated circuits provide a logical follow-on to the transistor story, they are included as a separate piece because different aspects of materials R & D are illustrated. In the rapid development of integrated circuits, effective coupling has been achieved principally through cross-licensing of patents among industrial or-

*(please turn to page 31)*

# The $11,940 Check: A Comedy of Errors

*"It seems to me that a system for computer-produced checks could be made error-free in the following way: ... "*

*Edmund C. Berkeley*
*Berkeley Enterprises, Inc.*
*815 Washington St.*
*Newtonville, Mass. 02160*

On December 17, 1979, Tuesday, we received in our morning mail a check for $11,940.00. The date was Dec. 7. The payee was Berkeley Enterprises. The invoice number was 30903. The check was prepared by computer, and signed with two signatures of two persons. Presumably they were both satisfied with the payment. It was from Electronic Systems Div., Geosource Inc., in Houston, Texas, a company I had never heard of.

The only trouble was that it was not our money. We had never billed anybody ever for that amount of payment!

What does one do with that kind of "hot money" — send it back at once and run the risk of giving it the wrong person? Well, obviously, we needed to escape (1) the possibility of theft, (2) the possibility of loss, (3) whatever liabilities we might be incurring, etc., and probably the best thing to do was to deposit it in our bank, and wait to see what would happen next.

On Dec. 18 in the afternoon, as I was about to leave my office to catch a train, a clerk telephoned me from Geosource in Texas. Her voice sounded frantic. Had I received the check? Would I please return it, since it was sent by mistake? I said "I couldn't. It has been deposited." I said I needed a written letter from Geosource asking for the check back. She flatly said such a letter was not possible nor needed. I hung up.

A few minutes later, her supervisor telephoned and asked for the check back. I said the check was deposited. So she wanted our check at once. Again, I said we had to have a request from Geosource in writing. She said she could not send me that. I said why not — but added that my time had run out, I had to leave to catch a train and I said I could talk to Geosource again on Friday.

On Dec. 20 Friday one of the persons who had signed the check, Mr. John Synnott, telephoned. I asked him "Why don't you stop payment on the check?" He said it was too late: the check had already cleared. I said in view of our liabilities, I needed a request in writing, such as a bill from Geosource for refund of $11,940 sent Berkeley Enterprises in error.

As a partial fulfilment of my request, he arranged for me to receive a telegram from their bank in Houston (a branch of the First National Bank of Chicago), saying that the check had cleared. See Figure 2. The telegram came on Monday (Christmas Eve). I telephoned him to acknowledge it — but Geosource was closed for a four day holiday. On Wednesday Dec. 26 John Synnott telephoned me again, and gave me an invoice number of Geosource for billing us "Refund of $11,940 sent Berkeley Enterprises in error". All that evidence persuaded me to send him our check at once without waiting for the 10 working days that our bank required before crediting a deposit to our account. We sent off our check for $11,940 to Geosource on Wed. Dec. 26.

On Dec. 28 Friday the head office of the First National Bank of Chicago telephoned me from Chicago. They said they had received a "stop payment" instruction from their Houston office, and had stopped payment; and they apologized for saying the check had cleared when it had not cleared! Shortly afterwards, John Synnott called and also apologized. I asked him to return our check. It came back on Jan. 2, with an additional apology. Figure 3 shows a portion of the invoice previously received from Geosource.

---

What points are to be deduced from this comedy of errors?

1. Codes for payees should include characters in payee codes that correlate at least partially the payee name.
2. An outgoing check should be compared with the original invoice to make sure the payee is the same and the invoice number is the same.
3. It is unwise for each of two persons to sign an incorrect check.
4. In setting up a file of payees, it is good to enter for each payee what is the maximum amount that that payee is likely to bill. (In our case almost the most we can bill for any subscription is about $60).
5. A check received in error places liabilities on the recipient, and the recipient needs to be cautious.

ELECTRONIC SYSTEMS DIVISION, GEOSOURCE INC. - P O BOX 36827 - HOUSTON, TEXAS 77036

| DATE | REFERENCE | INVOICE NO. | DISCOUNT | INVOICE AMT | DATE | REFERENCE | INVOICE NO. | DISCOUNT | INVOICE AMT |
|---|---|---|---|---|---|---|---|---|---|
| 102679 | 034688 | 30903 | 00 | 1194000 | | | | | |

REC'D DEC 17 1979

| VENDOR NO. | VENDOR NAME | CHECK DATE | CHECK NUMBER | TOTAL DISCOUNT | CHECK AMOUNT |
|---|---|---|---|---|---|
| 07585 | BERKELEY ENTERPRISES INC | 12/07/79 | 54004 | 00 | 1194000 |

**ELECTRONIC SYSTEMS DIVISION GEOSOURCE INC.**
POST OFFICE BOX 36827
HOUSTON, TEXAS 77036

THE FIRST NATIONAL BANK OF CHICAGO
ONE FIRST NATIONAL PLAZA
CHICAGO, ILLINOIS 60670

GEOSOURCE

NO. 54004 2-1/710

| CHECK NO. | DATE | | AMOUNT |
|---|---|---|---|
| 54004 | 12/07/79 | PAY $11,940 DOLLARS AND 00 CENTS | ***11,940.00 |

TO THE ORDER OF
BERKELEY ENTERPRISES INC
815 WASHINGTON ST.
NEWTONVILLE, MASS.
02160

DISBURSEMENT ACCOUNT.

GEO 148

⑈00054004⑈ ⑆071000013⑆ 57 85871⑈

**Figure 1 – Check for $11,940 in error**

---

Telegram western union

REC'D DEC 22 1979

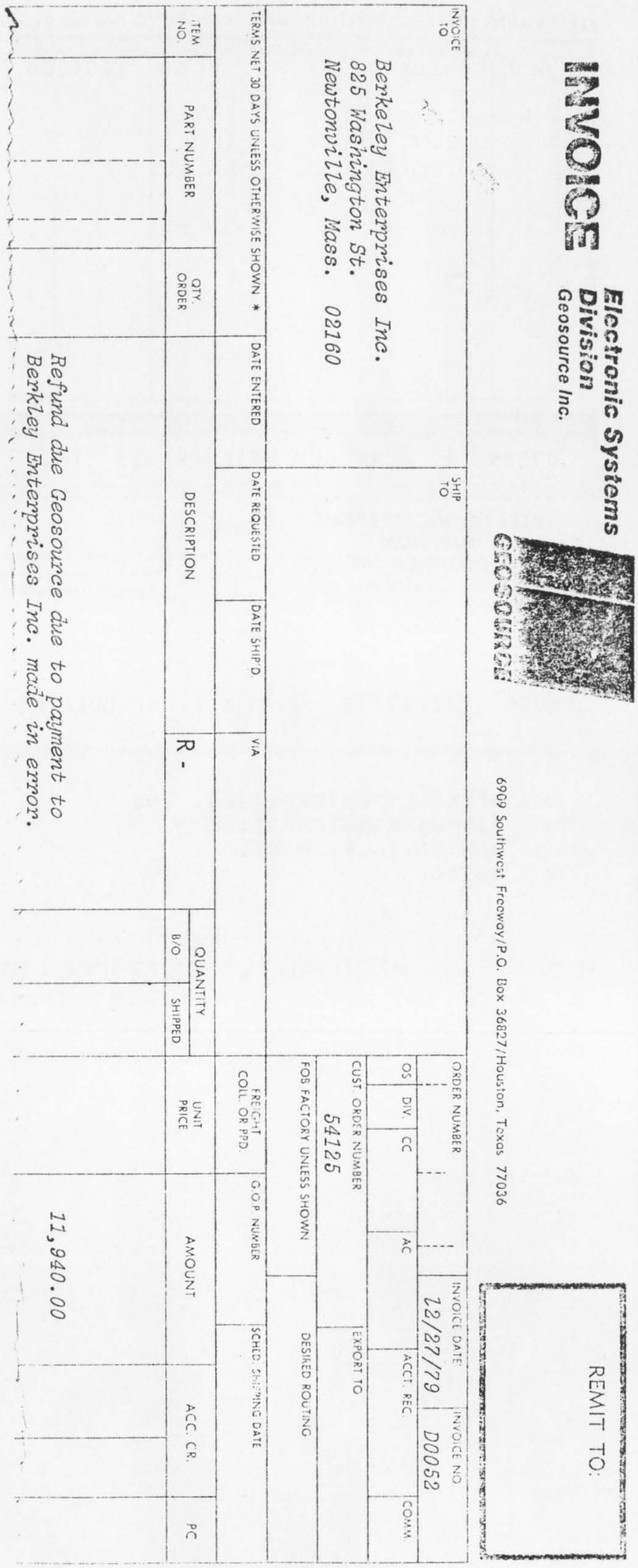
```
VWUY181
  BBB333(1644)(4-062808S355)PD 12/21/79 1643
ICS IPMBNGZ CSP
 7136581000 TDBN HOUSTON TX 28 12-21 0443P EST
PMS MR EDWIN BERKLEY BERKLEY ENTERPRISES INC RPT DLY MGM, DLR
815 WASHINGTON ST
NEWTONVILLE MA 02160
BY REQUEST OF OUR CUSTOMER GEOSOURCE INCORPORATED PLEASE BE ADVISED
THAT THEIR CHECK NUMBER 54004 TO BERKLEY ENTERPRISES INC FOR
$11,940.00 CLEARED OUR BANK ON DECEMBER 19 1979
  HOUSTON REGIONAL OFFICE THE FIRST NATIONAL BANK OF CHICAGO
  1100 MILAM SUITE 3280
  HOUSTON TX 77002
NNNN
```

**Figure 2 – Telegram from First National Bank of Chicago saying check had cleared when it had not cleared**

6. Even if a branch bank says it has cleared, the head office can still stop payment!
7. To make sure of all of the grounds for repayment, more than 7 working days is highly desirable, if not necessary.

Upon reflection, it seems to me that a system of computer-produced checks to pay invoices could be made error-free in the following way:

1. When the invoice is received, the supplier name and invoice number are entered as a part of the procedure of accounts payable.
2. When the check is prepared, the supplier name and invoice number are entered on the check.
3. Compare the supplier name and the invoice number by computer. If the same, fine. If not the same, ERROR: to be located and removed before the check is mailed.


INVOICE

Electronic Systems Division
Geosource Inc.

GEOSOURCE

6909 Southwest Freeway/P.O. Box 36827/Houston, Texas 77036

REMIT TO:

INVOICE TO: Berkeley Enterprises Inc.
825 Washington St.
Newtonville, Mass. 02160

SHIP TO

ORDER NUMBER: OS | DIV. | CC | AC
INVOICE DATE: 12/27/79
INVOICE NO: D0052
ACCT. REC. | COMM.
CUST. ORDER NUMBER: 54125
EXPORT TO
FOB FACTORY UNLESS SHOWN
DESIRED ROUTING
TERMS NET 30 DAYS UNLESS OTHERWISE SHOWN *
DATE ENTERED | DATE REQUESTED | DATE SHIP'D. | VIA | FREIGHT COLL. OR PPD. | G.O.P. NUMBER | SCHED. SHIPPING DATE

| ITEM NO. | PART NUMBER | QTY. ORDER | DESCRIPTION | QUANTITY B/O | QUANTITY SHIPPED | UNIT PRICE | AMOUNT | ACC. CR. | PC |
|---|---|---|---|---|---|---|---|---|---|
| | | | R - Refund due Geosource due to payment to Berkley Enterprises Inc. made in error. | | | | 11,940.00 | | |

**Figure 3 – Portion of Geosource invoice billing for refund of $11,940 payment sent in error**

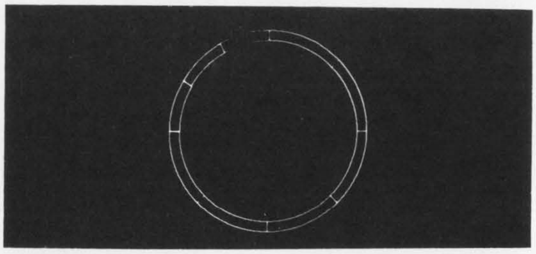
## COMPUTER ART – A MINI-EXPOSITION

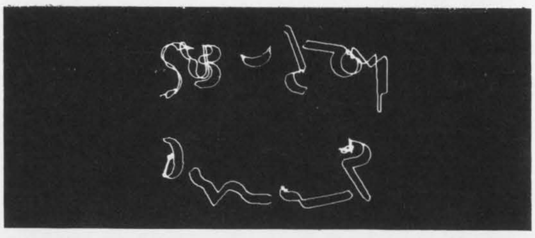
*Art Editor – Grace C. Hertlein*

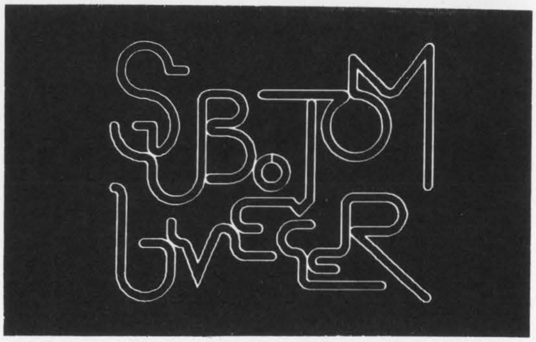
### Computer Art for Television

*by Tomislav Mikulic, Zagreb, Yugoslavia*

The black and white frames show the computer animation for the show opening of "Subotom uvecer", which means "Saturday Night". The logotype was designed using another computer program. In addition to black and white graphics, I also work in color, and my computer art is combined with music and ballet numbers, shown on RTZ, Zagreb television.







# The Turnkey Minicomputer Installation

*"Anytime we can expand our total package capabilities, we also expand our capacity to attract and service new business."*

*Robert G. Timberlake*
*Exec. Vice President*
*Reynolds and Reynolds Co.*
*Dayton, OH 45401*

The subject of this article is the turnkey minicomputer installation: — how it deals with the trend towards providing the customers of service firms with small in-house computer systems that can cover virtually all their data processing needs: How this development of a turnkey mini strategy has provided our industry with the opportunity to add new dimensions of service. — What the mini has meant to our customers. In other words by the addition of software and service to the mini we have really developed an HVA (high value added) strategy.

Obviously, a discussion of a turnkey minicomputer installation begins with the minicomputer, a word that used to strike fear in the hearts of most of us.

### The Technological Advances of the Minicomputer

As exciting as it has been these past few years watching the technological advances of the mini, it has been almost as much fun getting into arguments about whether the mini means boom or doom for service firms.

A lot of us looked (some of us are still looking) at the mini as a threat — as some kind of miniature electronic monster sent here for no other reason than to take our ongoing service business away from us. But it is not a monster, or even necessarily an enemy: the mini is just a tool, a tool we can use for our own benefit. It's as simple as "if you can't beat 'em, join 'em," but one of the questions we have to be asking ourselves is "since the mini is here to stay, what are we going to do about it?"

### Providing a New Level of Business

One of the things we're beginning to do about it is to incorporate the mini into a new level of service to our customers. As you know, many of us at ADAPSO (Association of Data Processing Service Organizations) got our start as a service bureau, either providing standard batch computer services to a market segment, or providing customized systems to very large businesses or specific end-users.

Based on a talk before the Association for Data Processing Service Organizations, New York, June 1979

Whatever type of orientation we had, the key word in the service bureau was service. We were providing our customers a needed service — the capability to collect and process their work by computer. Generally speaking, our customers did not have to have programmers or machine operators, as we provided those functions as part of our service as well as the processing. With the advent of the turnkey mini, that key word remains service.

### The Trend toward Service

The trend toward the turnkey is again the trend toward service and toward providing customers with a package for their total computer systems needs. The turnkey mini has allowed us to integrate, in various combinations, a range of service capabilities from software and support to computer time, customer training, and hardware. Anytime we can expand our total package capabilities, we also expand our capabilities to attract and service new business. Specifically, this means a continuation of the historical patterns already established by data processing service company operations.

The custom suppliers of market-specific products (those tailoring their services to the large applications) will still have to place as much emphasis on marketing their products as they place on the products themselves. Custom end-users, the Federal government, for example, are generally so large and powerful that they can just about dictate their own terms to the vendor.

### Industry-Specific Applications

Distinctly separated from that kind of market and that kind of marketing approach, suppliers of standard systems (servicing small and medium sized businesses) will continue to gear their services to entire markets, to "industry specific" applications. Here are the systems that meet most of the computer needs of a typical user in a given industry. That means the system (particularly the software) must be standard, well documented, and easy to use.

The last published survey for ADAPSO reported its studies showed this standard (i.e., industry specific) segment to be the most profitable and, not surprisingly, the fastest growing of any form of processing services.

There are several ways to approach this area: Develop or obtain products that are themselves highly industry specialized. Or, take generalized products and services and develop industry specialized marketing plans. But a critical first step for any service firm in developing a turnkey mini capability is to look in its own backyard, at the industries each is already servicing. The groundwork of service and much of the software has already been laid there. Building on that foundation, moving vertically into new service capabilities, should follow naturally.

Because of the equity in expertise most service firms have built up over the years with their specific customers, we are probably the best suited of all computer-oriented companies to install, operate and support turnkey mini systems. This may seem optimistic, but all the optimism in the world is meaningless unless we can show customers some real economic advantages, some hard dollar advantages, of working through a service firm rather than taking the do-it-yourself road.

### Single Source Supplier

To begin with, the turnkey system permits a customer to deal with a single source supplier. He has no need to spend time, therefore money, searching for other firms to provide hardware, software or maintenance support. The customer also knows that the system was developed for his specific industry. So he knows it will meet his company's needs as well. Because it has already been developed, he knows that he alone is not footing the bill to cover high front-end software and start-up costs. It's going to be a lot more economical for him.

### Avoidance of Custom Programming

For the service center itself, moving toward the turnkey mini has some real economic benefits, too. This is especially true when the vendor's turnkey mini product becomes a high-value-added strategy because it includes the incorporation of standard software instead of some of the traditional custom programming, OEM sales, time sales, and other low-value-added products.

### Total System

Providing the high-value turnkey really means you're providing a total system, a total solution to the customer's problems. So he's going to be looking at the total economic savings, not merely at the competitive prices on each component of the system. You can talk economic value. And, generally, achieve higher profits on a high-value TURNKEY installation than on time sales or equipment alone.

### Charges Spread Out Over Time

A common criticism I hear about the turnkey mini is that it normally involves solely a one-time sale of hardware. But that doesn't mean the elimination of on-going revenues from our customers.

Many of us, for example, have taken the front-end costs of the system's software and spread them over a several year period. Coupled to that we have applied on-going fees to cover the costs of periodic updating of the software. The results have been continuing (and relatively level) revenues from our customers, just as we in the service bureau business have been used to.

### Charges Spread Out Over Many Customers

Another major economic advantage of the high-value-added TURNKEY mini is its higher return on investment. This is possible because we have taken the initial investment necessary to create a standard system and spread it over large numbers of users rather than place it on a single customer.

Returning to the fear that a turnkey strategy reduces on-going revenues, customers who make use of the system are actually contracted for much longer periods, as much as five or ten years. Compare that to the month-to-month arrangements service bureaus had worked under previously. A new advantage found in this strategy is the lesson we have all been taught well by the master salesman, IBM: that is, the constant upgrading and add-on sales of additional hardware and new applications. We believe now that this can become a much more significant factor than ever imagined.

### Pitfalls

Developing the turnkey mini system, like any other new product, has its potential pitfalls. For one thing, though they can be spread out, there are higher front-end development costs. And higher marketing costs. But the most dangerous pitfall, and the one that has caused the most disasters within service firms up to now, is simply a failure to ascertain an industry's need for a standard turnkey mini system before developing one. No matter how many economic advantages you can point to, if nobody needs it, nobody's going to buy it.

Again, this is as simple as really knowing your customer's needs. If I specialize in credit unions, I know (or better know) credit unions. I have to take what I know and apply that knowledge to the turnkey mini. It's just another step up.

### Upgrading Sales for Computer Applications in the Automotive Industry

One company, the one I'm of course most familiar with, Reynolds and Reynolds, provides a pretty good example of how this vertical upgrading can work in a specific industry. Like other service bureaus, for years we had been providing batch and distributed processing services to an industry, in this case, the automotive industry. The services we provided covered a range of automotive dealership needs, accounting, inventory management, lease, payroll, accounts receivable.

Then, several years ago, we began to complement that capability with the development of an on-line or time sharing system for several dealers in a given metropolitan area. It was a first step in providing hardware along with our processing services. As dealers demanded more utility, we added new systems and software: invoicing, vehicle merchandising, service merchandising.

At the same time we were also providing dealerships with input terminals that could be located

*(please turn to page 21)*

# Annual Index for Vol. 28, 1979 of computers and people

This index is organized by title, author, and subject. The following designations for issues apply: J–F, Jan. – Feb.; M – A, March – April; M – J, May – June; J – A, July – Aug.; S – O, Sept. – Oct.; N – D, Nov. – Dec.

# The Computer Almanac and the Computer Book of Lists

**Annual Index, 1979, by Title and Main Subject**

Timberlake – *Continued from page 16*
in each department and tied directly with the on-line system. Other terminals were also developed to allow the dealer to communicate directly with his own manufacturer as well as our computer.

The next logical (and vertical) step, of course, was the development of an in-house turnkey mini system. We found that with only three separate applications, a customer could justify the cost of the in-house unit. Typically he may have had four or five applications.

### Programming for the On-Line System Transferred to the Turnkey Mini System

Quite simply, we were able to take most of the programming from our on-line system and apply it to the turnkey mini. So now our larger customers have a system, right in their own location, that meets virtually all their data processing needs. I believe this scenario applies to almost every firm in our industry.

In addition to the economic justifications, the turnkey mini has also produced some important side benefits to customers. To begin with, they get exclusive use of a computer. That gives them a better ability to accommodate business growth. And, of course, instant access to any required data for more accurate decision-making information. More than a few customers like the turnkey mini simply for its "pride of ownership" advantages: "Be the first on your block to own your own computer network."

Customer acceptance of the turnkey mini concept, and of the product itself, has been phenomenal. As late as 1975, we were not even offering an in-house system. By 1978, TURNKEY mini sales had jumped 200 per cent over the previous year. And sales were growing at a 400 per cent rate entering 1979.

### Additional Support People

Vertically expanding the services to our customers has brought with it a necessary expansion of our support personnel. And that's an important expansion for any HVA turnkey capability.

For example, right now we have over 300 technical support people in the field to take care of the day-to-day application support of the systems. We have over 80 people in programming, 32 in marketing and product development, 28 in communications alone. Then there are 43 people who provide software diagnostic analysis support for both on-line and turnkey systems. And that doesn't include the several hundred salesmen and operations people. Or those in batch customer service, or customer training, or equipment control for terminals.

The addition of hardware to the service bureau's capabilities is a trend expected to accelerate at even faster rates during the upcoming years. Though it is not necessarily a mirror of what will happen to the turnkey mini system in the future, projections of increases in sales of the mini computer itself would seem to have a significant impact on that future. Even though the price of the hardware will continue to drop, the cost of software will not. And we in the computer services industry are better able to provide the total package to customers than anyone else.

### Minicomputer Installations Approaching One Million

By 1982, the number of minicomputer installations will approach one million. And still, that will represent only one-fifth of the total potential market. Of those one million installations, about sixty per cent will be geared toward "small business" commercial applications. That means there are a lot of doors waiting to be opened.

Once the capability to install and support a turnkey system exists for a vendor serving any industry, the next step is to look for new horizons: for "alternate markets." Here is the direction that the trend toward the turnkey mini will head in the near future. New vertical markets are just now opening up. But, unfortunately, some suppliers do not yet grasp the significance of being able to provide these markets with their own turnkey systems. They're thinking: "I don't want to look over there; that's a one-time sale. I'm going to keep my on-going revenue coming in every month."

### The Strategy of "High Value Added"

Well, the problem with that is such people are going to lose the business completely one day soon. Maybe the on-going revenue won't be as much from an individual user as it is today. But, with the turnkey mini, they've got that user tied up for five or ten years. They can take that "one-time" sale and combine it with recurring revenues for maintenance, updating and support. That's the real high-value-added strategy behind service bureaus with turnkey mini capabilities.

The computer service companies who understand that strategy, and who capitalize on it, will grow rapidly and profitably in the upcoming years. Those that look at the mini as a threat won't. It's that simple. Not only is a challenge there: more importantly there is an opportunity there. □

# The Automatic Prevention of Computer Errors: An Important Area of Computer Science

*Lawrence M. Clark*
*Mathematician*
*863 Edmands St.*
*Framingham, MA 01701*

*"The time is coming when a computer will not allow a wrong answer to be output. And if such an answer is produced (as for example by a deliberate human overriding command), the computer will also output, to a system supervisor for example, a right answer with an appropriate message."*

**Outline**



### 1. Solving Problems

The basic mission of a computer is to solve problems. With more than 2600 applications of computers, according to a list published as long ago as 1974, /1/, it is evident that computers (programmed computers) solve a very large number of significant problems, or else the persons who have started to use them would not continue to use them. See for example Table 1, "108 Applications of Computers in Office Operations", which is the same as List 800301 in the instalment of "The Computer Almanac and the Computer Book of Lists" in this issue.

The great mathematician, Dr. George Polya, author of "How to Solve It" and a number of other books, concentrated on solving problems. He wrote in a published letter /2/ to the unnamed chairman of a mathematics department:

> As you may know, I am especially concerned with problem solving. ... That the role of problem solving is not understood by non-mathematicians 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 that there is a serious matter of principle involved. ...
>
> Problems play an essential role in the progress and the teaching of science. ... Problems play an imortant role on all levels of mathematical instruction. ... Problem-solving is a perfectly acceptable and respectable 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.

In fact, the solving of problems plays not only an essential role in the progress and teaching of science, as Polya says, but also in the progress and teaching of all human knowledge, and in the day-to-day activities of countless human beings.

Computers certainly do solve problems. They solve them on a much more prodigious scale than has ever before been possible for human beings.

Because of computers the power of humans has been substantially increased over the real world and almost all of its amazing facets. For a computer is like a motorized book - a motor stored with knowledge, and enabled to reason, to make choices, and to activate other machines.

Instead of guessing or assuming an answer to a problem, a computer can figure out the answer. The navigation of a spaceship on a small budget of energy, changes from impossible to possible. The simultaneous transmission of millions of long distance phone calls changes from impossible to possible. And all those people who, before computers, would be hired to do simple clerical work in an insurance company or a bank or an office are no longer hired — but become available to do other work.

### 2. Wrong Answers

But, unfortunately, computers (programmed computers) provide at present not only a great quantity of right answers but also many wrong answers. These wrong answers, though far fewer than right answers, produce dismay, distrust, and disbelief in the power of computers. They also lead to a bad reputation. This is reenforced by the delight of human beings when they "catch a computer" in making an error.

More specifically, the wrong answers are regularly produced not by computers as such but by (1) wrong computer data supplied by human beings and (2) wrong computer programs produced by human beings. However, humans do not readily accept the blame for errors; instead, they charge the computer with the blame — in the time-honored style of a human to place the blame on somebody else's shoulders. As someone has said, "To err is human, but to forgive is contrary to company policy."

Some of the wrong answers are so ridiculous no clerk with even a grain of common sense would ever propose them for an answer. They are essentially due to human errors in the interface between computers and the real world.

For example, a campaign for promotion of sales mails 2 or 3 or 4 identical letters all addressed to the same addressee. This is a flagrant waste, plus a considerable annoyance to the addressee, plus an inducement to react unfavorably to the promotion. In my case, I have received mail addressed to "L M CLARKE, LAURENCE CLARK, L CLERK, LAWRENCE CLERKE" etc., all of them wrong in one way or another.

Another example is the retail store computer which threatens a customer with the loss of his privilege to charge merchandise because for 3 months he has not paid his balance due of $0.00.

Still another example is the error made in copying a payee number incorrectly so that the sum of $11,940 is paid to the wrong payee. See the report on this error in this issue.

### 3. Errors

Let us now take a look at the entire class of computer errors; a relatively small class of errors from hardware malfunctions; and a large class of errors due to human malfunctioning, in the interface between computers and the real world.

Let us direct our attention to some of the important questions:

1. What are the causes of errors? for if we understand a cause, we may more easily counteract or prevent a happening. (Causes)
2. What is automatic error prevention? (Definition)
3. How can errors be automatically detected? (Detection)
4. Is it possible to program a computer so that all (or almost all) errors can be prevented? (Error-Free Programming)
5. Is it possible to supply data to a computer so that all (or almost all) data entry errors can be prevented? (Error-Free Data Entry)
6. How will error prevention operate automatically? (Technique)
7. Will the benefits of automatic error prevention outweigh the costs? (Cost vs. Benefits)

### 4. Causes of Errors

A list of 101 causes of errors is shown in Table 2, which is the same as List 800302 in the instalment of the "Computer Almanac and Computer Book of Lists" that is published in this issue.

This list of course is not unique, because different people will make many different lists. But here at any rate is a list of many common causes of errors. And there is an advantage to making a careful list of them because that brings to the front of one's mind many possibilities (and probabilities) of error to be thought about and weighed.

### 5. Automatic Error Prevention

"Automatic error prevention" is of course, the prevention of errors by automatic means; and the automatic means implies some machine or device composed of hardware or software, and not composed of people.

For example, suppose that every character that flows through a computer is represented by a series of 9 bits such as:

| Series of Bits | Letter |
|---|---|
| 111 000 001 | A |
| 111 000 010 | B |
| 011 000 011 | C |
| 111 000 100 | D |
| 011 000 101 | E |
| ... | ... |

Suppose the computer automatically checks at the time of every transfer to make sure that the number of bits in that character is even (if even parity is stipulated) or odd (if odd parity is stipulated). Then if some bit suffers a circuit malfunction, it will be 0 when it should be 1, or 1 when it should be 0. Then parity has failed, and the machine gives an alarm. In this case the eight right-most bits carry information; the ninth bit at the left is the check digit, and confirms that no single circuit malfunction from 1 to 0 or from 0 to 1 has occurred.

This is actually a simple and long-used trick to guarantee that the invisible microscopic pattern of magnetic or electronic signals to express a character is almost certainly correct. Also, this is an excellent example of automatic error detection and automatic error prevention. This example stands like a shining beacon for the future of automatic error prevention on a much broader scale.

### 6. The Territory of Office Applications

Now, in our examination of automatic prevention of errors, it is reasonable at this stage in our survey to narrow the field of all applications of computers to the field of applications of computers in the office.

The reasons are these:

1. Probably a great majority of all errors are represented in errors in office work.
2. Probably more than 80 percent in volume of of all computer applications are applications to office work.
3. Probably here is the largest mass of human gathering of information from the real world and inputting it into computers.
4. A great many human errors in computerized office work are conspicuously reported in the press.

See again, in Table 1 (List 800301) the quantity and variety of office applications.

### 7. Error Detection: Examination of Variables

In the field of computers, already some investigators are considering and working on automatic error prevention. One of the most interesting observations was expressed by D. L. Waltz of the University of Illinois at Urbana /3/:

> We feel that the time is ripe for computers to be equipped with natural language systems which can be used by persons who are not trained in any special computer language. In order for such systems to be of value to a casual user, the system must tolerate simple errors, must embody a degree of "common sense", must have a relatively large and complete vocabulary for the subject matter to be treated, must accept a wide range of grammatical constructions, and of course must be capable of providing the information and the computations requested by the user. ...
>
> We would like to trap certain types of unreasonable requests without actually performing a data base search for answers. For example, the request "Did any Skyhawk crash more than 3 times last month?" is suspicious. Whenever a question includes a comparison with a number, a check can be added to the request form, using simple tables for items like various types of maintenance, actual frequency of failure rates, and information about the fact that certain events, e.g., crashes, typically happen only once to a particular airplane.

For our present purpose, however, we do not need to extend our examination of automatic error prevention to all of the many avenues just mentioned: natural language systems; the phrasing of questions addressed to data bases; a "large and complete vocabulary" of the subject matter; etc.

But it is important to examine:

1. The variables that are or should be taken into account.
2. The ranges of values of the variables.
3. The "habit" of values of each variable, as for example in the study of minerals one speaks of the habit of the forms of crystals of a mineral, for example, quartz has the habit of horizontal striations on the sides of the hexagonal prisms of its crystals.
4. The nature and number of characters or digits that may be required to express the values of the variables.
5. The correlations of values of variables with other values of other variables.

For example, the normal value of the temperature of a day is highly correlated with the time of day, the season of the year, and the latitude of the place. The temperature of the day is likely to rise as the sun rises in the sky, to fall as the sun sets, to be highest between two and three in the afternoon, and to be lowest shortly before dawn. If the behavior of reported temperature is widely different from this pattern, there is some ground for suspicion of error, some degree of reason for distrust of the report. And the same is true for other variables and other patterns of behavior of variables.

In such cases, it is desirable to report a cause or to show a special tag to indicate special verification. For example, in ordinary language we may find "sic" in a sentence to mark a wrong spelling copied from the original, or the use of "not repeat not" in a telegram or a military order.

### 8. Variables in Office Operations

Many aspects of variables are routinely considered and possible errors in them are routinely counteracted in the production of a computer program. But it is hard for a systems analyst or a computer programmer to deal with a contingency when he has never thought of it, or when he has very little understanding of the details of a company's business. See Table 3, "Variables in Office Operations", which is the same as List 800303 in the current instalment of "The Computer Almanac and the Computer Book of Lists" published in this issue.

Suppose we are designing a computer system that is to fill stock items ordered from a wholesaler, whom we shall call John Jones and Co., by a customer, whom we shall call Samuel Smith.

One of the conditions that may occur is the simple one, that the item is in stock and that the quantity ordered is less than the quantity in stock; then the order is quickly and easily filled. Another condition is that the item is not in stock; in that case a message to Smith is needed, to tell him so, and also to tell him how quickly he can obtain it from Jones and Co., for they don't want to lose the sale. That message depends on a quantity of variables: the possible suppliers; how much Smith wants; the demands of various Jones' customers for the item; the economic reorder quantity; the times needed for delivery to Jones; etc. A third condition is that Jones has found out that the stock item is going out of production because of a newer model, say; but he happens to know (or the computerized system is to tell him) that Smith likes the old model and is a good customer, and Jones could perhaps offer to sell Smith more of that item to close out the stock, perhaps at an unusually favorable price. For all of these actions are in the interest of Jones and Co. to keep Smith as a customer satisfied — and pleased — and even delighted.

In Table 3 is a list of 160 variables in office operations, and these are not all. The dimensions of a good system design are staggering, and it is little wonder that different systems designers produce different systems, each with many merits and some defects.

The general territory of the variables that affect office operations becomes very clear as we survey the list.

The number of variables in office operations far exceeds the ordinary number of variables in ordinary mathematical problems. This tends to make the situation much more interesting and much more elaborate than ordinary mathematical problems.

The types of variables in office operations are also more than the types of variables in ordinary mathematical problems, and this also tends to make the situation more interesting, more elaborate, and more demanding than in ordinary mathematical problems. Important types of variables in office operations include: integer, numeric; real, numeric — also called floating point; real, decimal — such as 13.94 with two decimals; Boolean — or 0 and 1, or truth values; string — or alphanumeric, such as BUTTERFIELD 8 2357; string variable — or strings that have strings for values — such as State with values like Maine, Maryland, Mass., Michigan, Mississippi, Missouri; etc.

The complexity implies for the usual mathematician nonelegance, and the inability to prove general theorems, and so he usually likes to go in the direction of Riemann surfaces and Banach spaces. But the systems analysts are in far greater demand.

This situation also points up the importance for human beings of the careful and suggestive naming of the variables, and the downright silliness (in view of human minds) of trying to designate them with just two characters (plus $ for string variables) as in Dartmouth BASIC, where standard variables are like B2 and H7. But of course Dartmouth BASIC was not designed nor intended for office operations.

## 9. Sources of Information for Preventing Errors

Where do we obtain the knowledge of all the conditions and factors that may affect or modify the delivery of an order by Jones and Co. to Samuel Smith? and all the conditions and factors that may govern other office operations where a computer is or may be applied?

The knowledge comes basically from four sources:

1. Office Procedures: Existing company procedures that apply to the collection of problems to be solved in the department where the computer system has been or is to be installed.
2. General Knowledge, including generalized experience, and caution, such as that gained by a clerk with ten years experience in the work. Often, that knowledge is rather deeply buried in consciousness because it comes out of the mind when the mind is stimulated with a question or an instance; otherwise it is not open to deliberate systematic recall. It is like the knowledge of how to tie one's shoe laces, learned at age five and then completely forgotten except in the habit of doing it. Clerks take these procedures for granted "Oh, that is the way we do things" but they hardly have words to describe it — and so the computer does not know it either, without considerable effort in programming.
3. Company Policy: Decisions that a company makes or uses about its modes of doing business, such as: company attitudes towards customers; or stockholders; or top management; whether cents or dollars will be used in the annual statement; etc.
4. Principles for Solving Problems: Choices that the company makes regarding principles for solving problems, such as feedback control (try something, learn, correct, and try again); or consult the boss (or an expert) and do what he says; etc.

These are the same broad sources of information by which the computer program is first designed and constructed. But careful provision for preventing errors over a much wider range of contingencies is like a second and better approximation to an ideal computer program.

### 9.1 Office Procedures

This is the regular first source of computer programming and "error-free" operation, of ways to do things that are free of error: the practices and procedures of the company in a given department of the work up to the current time.

Information comes from: the persons who are doing clerical work; the persons who are supervising the work; actual examples and illustrations of the work; section rule books; the file of precedents or decisions that the section maintains; and perhaps some other sources. We need to determine the usual variables and the occasional variables, and the rules that produce actions taken.

For example, in the filling of orders, many companies do not need the variable "time of calendar year" in their order filling. But there are goods that can only be shipped in cool but nonfreezing weather, usually April, May, September, October; and this variable must be taken into account by florists, growers, seedsmen, etc.

### 9.2 General Knowledge, Experience, and Caution

A main second source of information for automatic error prevention is general knowledge — knowledge of the external, multitudinous, kaleidoscopic, real world. This knowledge comes under the headings:

- General knowledge and common sense (including the category of the "obvious" — so difficult to see before an error, so easy to see after an error has occurred);
- Logic, mathematics, statistics, probability, and other codified and systematic branches of knowledge which are applicable everywhere or almost everywhere;
- Careful observation and perception which interprets sense impressions into standard objects, events, and processes and assigns names to them (a behavior which

for example changes the Evening Star and the Morning Star into the planet Venus as the understanding of a culture develops over the centuries);
- Caution: carefulness, deliberateness, and judgment, a tempered mixture of considering and weighing with deciding and doing.

It is not difficult to program a computer with general knowledge, provided that the programmer has a fund of general knowledge and knows how it is to function in the situation which he is dealing with.

For example, in arithmetic, a programmer knows that division by zero is a special case. The ordinary operations of arithmetic will not suffice, and a special rule has to be invoked to take care of zero. In a time-shared computer system, it is likely that once in a while a user will try to divide by zero, or to divide a billion by a number close to one. The time-shared system must detect that kind of case, and then dump that program out of the central processing unit into some file, and report to the user that an almost infinite loop of instructions has caused his program to abort.

In the general problem, to program a computer that is to make use of and act upon general knowledge, it is important to:

- Notice and determine all the cases that occur within a variable or parameter or operation that need to be taken into account for dealing with that variable;
- Determine all the conditions or variables that need to be taken into account in that problem.
- Apply information from general knowledge and experience to deal with those cases or conditions.
- Consider the correlations of variables and values arising from the context of the problem, so that rather strange and perhaps even unbelievable situations receive extra attention.

### 9.3 Company Policies

Company policy affects automatic error prevention. These policies consist of decisions a company makes about its modes of doing business. Among these are decisions about ways of treating customers, for example, people waiting for a bus in a station. Will there be separate areas for smokers and nonsmokers? Will every person waiting for a bus ordinarily have a seat? Or decisions in a biscuit-making company: Will the company slack-fill its boxes of biscuits, when the wrapping is opaque? but if translucent fill them full? Or decisions in a monopoly: Will the price to customers be much higher when there are almost no competitors? and much lower than any competitive price when there is competition?

Automatic error prevention is bent, distorted and basically dishonest when a company is deliberately hiding errors that are 90 percent in its favor, and 10 percent in favor of its customers.

### 9.4 Principles for Solving Problems

The choice by a company of principles for solving problems is another significant factor in determining the nature of computer programs and their degree of automatic error prevention. See Table 4, which is the same as List 800304 in the current instalment of The Computer Almanac and the Computer Book of Lists which is published in this issue. This table is entitled "27 Principles for Solving Problems in Office Operations". To fit in with the editorial angle of the Computer Book of Lists, some of these principles are serious, some are mock-serious. But all of these principles are frequently used, some in some companies, some in others. And they have considerable effects on errors.

### 10. Looking Ahead to the Future

Of course, it takes work to include various important branches of knowledge in the artillery of a computer program to prevent errors automatically.

General knowledge is a large field, one of the largest for incorporation in a computer program. In the case of office operations, it consists of all the common everyday knowledge about: names of persons; names of companies; addresses; sizes of organizations; the common designations of time, seconds, minutes, hours, days, weeks, months, years; denominations of money; classes of equipment; and far more. I would estimate that some two thirds of the vocabulary of a high school graduate (i.e., some 20,000 words) refers to or reports some aspect of general knowledge.

But there are several mitigating factors. First, for a department in an office, a computer program has a limited context to which it must apply. Second, many necessary variables in the computer program will inevitably require aspects of general knowledge to deal with them properly.

Furthermore, the territory of general knowledge needs to be studied and systematized only once. For example, if temperature is a variable, then no temperature on earth can be as cold as 80 degrees below (Fahrenheit) nor as hot as 170 degrees above zero. Or, no airplane can crash more than once. Or, a good customer who over and over pays what he owes on time should not be given the same set of messages as a bad customer who over and over pays late. Etc.,etc.

After (1) office procedures, (2) general knowledge, experience, and caution, (3) company policies, and (4) appropriate principles for solving problems are incorporated in a computer program for preventing errors, then automatic error prevention becomes feasible, reasonable, and practical. Currently, this may sound fanciful and idealistic; in a dozen years, it should be realistic. It is most certainly not impossible.

The time is coming when a computer will not allow a wrong answer to be output — any more than it will be baffled by trying to divide by zero. And if a wrong answer is produced, as for example by a deliberate human overriding com-

*(please turn to page 31)*

# The Computer Almanac and Computer Book of Lists — Instalment 12

*Lawrence M. Clark*
*Mathematician*

**108 APPLICATIONS OF COMPUTERS IN OPERATIONS OF AN OFFICE (List 800301)**

Absenteeism reports
Accounts receivable: posting, rebilling
Advertising effectiveness: analysis, data handling, etc.
Air tube message handling
Attendance records, analysis, evaluation
Billing and invoicing
Budgeting
Capital investments: analysis, evaluation
Catalog indexing
Charitable contributions; recording, analysis
Consumer credit: recording, verification
Contracts: lists, categories, analysis
Correspondence: personalized letters for solicitation, for delinquent accounts, etc.
Cost accounting: analysis, evaluation
Data gathering from multiple locations
Depreciation calculations, records
Dispatching
Equipment: registers, transactions
Expenses: analysis, reports
File maintenance
Filing operations: single, multiple
Financial statements
Fixed assets accounting
Forecasting
General ledger: operations
Hiring: analysis
Information retrieval
Insurance: records, schedules
Inventory control
Job placement: matching people with jobs
Labor cost determinations
Lease and rental accounting
Libraries: classification, records, holdings
Linear programming
Mailing list operations
   addressing mail
   bundling by address groupings
   personalized computer letters
   updating and maintaining
   zip coding
Management:
   management games
   management information systems
   reports using the exception principle
   simulations
   statistical analysis
   strategy analysis
Manhour records and analysis
Market research: studies
Message switching
Operations research applications
Optical character recognition applications
Orders, incoming:
   acknowledgment
   analysis
   filling
   processing
   shipping
Overhead cost allocation
Overtime reports
Parcel mailing (high volume):
   packing, computerized
   postage meter, computer operated
   weighing, computer operated
Payroll:
   computation
   general increases
   payment
   overtime reports
Pensions: reporting, updating, valuing
Personnel: planning, placement, records
PERT charts: automatic drawing, updating
Performance evaluation
Plastic plates: embossing, code-punching
Point-of-sale transactions: orders, invoices
Price analysis
Production forecasting
Property accounting
Purchase orders: issuing, followup
Questionnaire responses: analysis, summaries
Record retention and destruction: studies, schedules
Repair and maintenance
   control
   records
   scheduling
Rent analysis
Retirement funds: records, valuation, payments
Salary advances: control
Sales:
   analysis
   area distribution
   forecasting
   quota calculations
Sales order processing:
   customer credit checking
   inventory checking
   invoicing
   picking-document preparation
   shipping instructions
Savings bonds: deductions, deliveries
Security systems: reports, analysis, alarms
Seniority records
Social Security records
Systems: analysis, evaluation, synthesis
Taxes, calculations
Telephone calls: reporting, analysis
Transportation optimization
Traveling salesmen: scheduling
Turnover analysis
Vacations: scheduling, verifying
Wages and salaries:
   analysis
   records
   tax computations

Warehousing and stocking: records, analysis
Work-in-process records

(Source: "2600 Applications of Computers" in the "Computer Directory and Buyers' Guide" for 1974 published by Berkeley Enterprises Inc., 815 Washington St., Newtonville, Mass. 02160; supplemented by Lawrence M. Clark's notes)

## 101 CAUSES OF ERRORS IN COMPUTER APPLICATIONS (List 800302)

### I. EXTERNAL CAUSES

Building damage: from earthquake, lightning, tornadoes, hurricanes, etc.
Fire damage
Flood damage
Hardware failure: main frame, peripheral devices, communication lines, etc.
Messages: garbled during electrical transmission, lost or destroyed physically in transit, misunderstood during verbal communication or written communication, etc.
Input data incorrect: "garbage in, garbage out"
Operating system failure
Power failure
Rodent damage: rats, squirrels, etc.
Software failure: program bugs, etc.

### II. CAUSES RELATED TO PEOPLE: HONEST AND INTELLIGENT

Absence of choice among a wider set of alternatives
Analysis failure:
- incomplete analysis
- not seeing all relevant factors
- not asking all relevant questions
- not defining appropriate objectives etc.

Concentration failure:
- momentary inattention
- spell of inattention
- slip of the mind
- selection of the wrong formula
- adoption of the wrong assumptions

Feedback failure:
- not searching for all the lessons
- not applying all the lessons
- not learning from experience
- not applying iteration

Ignorance:
- in general
- of a special field by a generalist
- of a general field by a specialist

Interpretation failure:
- of observations
- of facts
- jumping to conclusions

Illogic: ("I reasoned wrong", "I added wrong")
Overestimating
- of one's own knowledge
- of one's own capacity
- of the knowledge or capacity of one's own experts

Perception failure: ("I didn't notice, " "I did not watch,")
Precedents: ("There was no precedent")
Rules: ("I didn't apply the rule")
Testing failure:
- not testing even once
- not testing at least several cases
- not testing in a systematic yet random way
- not testing according to guidelines

Understanding failure (misunderstanding)
Vagueness: failure to verify the precise application of vague legislative or managerial specifications

### III. CAUSES RELATED TO PEOPLE: OTHER KINDS

Criminality:
- dishonest and disloyal (wants wealth by fair means or foul)
- borderline dishonest and disloyal ("they will never miss that,", "It's just a little sin", "it's like taking a wooden pencil home")

Deception: (covering up, afraid to tell the truth, concealing important information)
Disaffection: disgruntled, prejudiced, harboring grievances, resentful of authority
Dishonesty: person dishonest but not criminal:
- practical joker
- cracking passwords for "fun"
- stealing long distance calls for "fun"

Disloyalty:
- reading on company time
- idling by the coffee machine
- gossiping and chatting to excess

Language disability:
- person unwilling to explain
- person unable to express simple ideas in plain ordinary language

Laxity:
- content with sloppy work
- tolerant of little mistakes
- inspects and initials without inspecting

Sickness (temporary disability):
- at work but without enough sleep
- at work but too full of lunch
- had two cocktails at lunch
- worried about family problems
- ill, feverish, and should not be at work

Sickness (rather permanent disability)
- alcoholic
- on drugs
- lazy because of medical troubles

Unfriendliness:
- chip on shoulder
- unwilling to explain
- contemptuous of users or customers
- priesthood attitude re computer programming
- eager to use jargon to confuse the manager

(Source: Lawrence M. Clark's notes)

## 160 VARIABLES IN OFFICE OPERATIONS (List 800303)

Accounts:
  Expenses
    materials
    labor
    services
    taxes
    shipping
    repairs
    rent
    travel

postage
equipment
furniture
fixtures
buildings
transportation

Income
- sales
- services
- rentals
- interest
- dividends

Other Items
- overhead
- gross profit
- net profit
- fixed assets
- other assets
- good will
- liabilities
- surplus
- proprietorship
- capital

Transactions
- debit
- credit
- transfer
- journal entry
- ledger entry
- cost of goods sold
- cost of services sold

Cost Accounting
- price
- cost
- margin
- budget amount
- depreciation

Customer Purchase Order:
- customer identification
- list of items on order
- list of quantities on order
- customer bill-to address
- customer ship-to address
- customer credit category
- customer's authorization of order
- customer's delivery requirements
- warehouse picking instructions

Employee Attendance:
- employee identification
- day identification
- on time and present
- tardy but present
- absent
- present but left early
- out on medical appointment
- out on business
- out for illness

Employee Classification:
- employee identfication
- part time
- full time
- hourly
- salaried
- officer
- non-officer
- office
- factory
- temporary
- permanent
- on trial
- not on trial
- summer
- all year
- student
- not student

Employee Status:
- employee identification
- active
- retired
- withdrawn
- laid-off
- on vacation
- on military leave
- on leave for personal reasons
- on temporary disability
- on permanent disability

Hours Worked Classification:
- employee identification
- time period identification
- regular
- overtime
- double overtime
- eligible for overtime pay
- not eligible for overtime pay

Leave Days Accounting:
- employee identification
- time period identification
- vacation days credited
- vacation days taken
- sick leave credited
- sick leave taken

Number or Symbol Identification:
- descriptive identification
- numeric, whole number
- numeric, dollars and cents
- numeric, whole number and decimal
- percent
- positive
- negative
- zero
- alphanumeric
- alphabetical
- literal
- abbreviation
- abbreviated
- rounded
- truncated
- typewriter symbol
- punctuation
- symbolic
- binary
- decimal

Payables Accounting:
- supplier identification
- delivery verification
- invoice preparation
- invoice verification
- invoice approval
- schedule date of payment

Person or Organization Identification:
- identification code
- name
- street address
- city address
- state address
- zip code
- post office box number

bill-to address
ship-to address
credit rating
delinquent or not
employee
customer
supplier
consultant
stockholder
director

Personnel Records:
- employee identification
- date of birth
- date of employment
- date of retirement
- date of death
- date of withdrawal
- dates of starting on leaves
- dates of returning from leaves

Receivables Accounting:
- customer identification
- transaction identification
- invoice preparation
- receipt of payment
- disputed invoices
- delinquent receivables
- standard messages for customers

Salesman Supervision:
- salesman identification
- salesman territory
- sales for month
- quota for month
- sales for year to date
- commission formula
- commissions for month
- commissions for year to date
- salesman training

Stock Classification:
- stock identification
- stock description
- unit quantity
- unit price
- unit cost
- unit margin
- in stock
- out of stock
- on order
- expected delivery date
- out of production at the supplier
- reorder point
- reorder quantity
- supplier(s)
- standard messages to customer

(Source: Lawrence M. Clark's notes)

## 27 PRINCIPLES FOR SOLVING PROBLEMS IN OFFICE OPERATIONS (List 800304)

The Principle of Precedent
"if there is a precedent, use it"

The Principle of Higher Authority
"ask the boss, and do what he says"

The Principle of Consulting
"consult an expert, and apply his advice"

The Principle of Noninvolvement
"that problem is none of our business -- let's not get involved"

The Principle of the Committee
"since the problem affects several areas of the company, let's appoint a committee to reach a consensus"

The Principle of the Commission
"since the problem calls for more understanding, let's appoint a commission to investigate for several months and make recommendations"

The Principle of No Innovation
"since the solution to the problem smacks of something new and unproved, let's have nothing to do with it"

The Principle of Not Invented Here
"since the solution to the problem was not invented here, let's have nothing to do with it"

The Principle of No Solution
"since the problem, after much effort spent, has no apparent solution, we must accept that"

The Principle of Denial
"if the problem is looked at in the right way, there is no problem at all"

The Principle of Delay
"let's delay for a while, because something might turn up"

The Principle of Indefinite Procrastination
"if we delay long enough, the problem should evaporate and disappear"

The Principle of Experience
"see what experience we have had on the problem, and do what experience indicates"

The Principle of Minimum Expense
"see what solution will cost the least, and choose that one"

The Principle of Maximum Profit
"see what solution will yield the most profit, and choose that one"

The Principle of Least Trouble
"see what solution will produce the least trouble, and choose that one"

The Principle of "the Customer is Always Right"
"see what solution will make the customer the most satisfied, and choose that one"

The Principle of "the Squeaking Wheel"
"see what solution will stop the biggest squeak, and choose that"

The Principle of "Reinventing the Wheel"
"since it is too much bother to search out the best prior solution, let's reinvent a new best solution"

**CACBOL** – *Continued from page 30*

The Principle of Trial and Error
"if at first we don't succeed, let's try and try again"

The Principle of Successive Approximation
"if at first we don't succeed, let's try and try again, but learn what not to do from each trial"

The Principle of Systematic Analysis and System Synthesis
"take all factors and variables into account; then build and test the system until it works well"

The Principle of Successive Cases from Simple to Complex
"solve the problem first for a simple case; then solve it for successively more complicated cases"

The Principle of Feedback Control
"every time the process strays off a little, correct it, bring it back to the desired condition"

The Principle of Calculation
"figure it out, compute it"

The Principle of the Scientific Method
"experiment, draw conclusions, test them — repeat until satisfactory"

The Principle of Continuing Verification
"continually check all statements and conditions — everything always gets out of date"

(Source: Lawrence M. Clark's notes) □

**Clark** – *Continued from page 26*

mand, then the computer will also output a right answer with an appropriate message to a system supervisor.

All the needed computer capacities exist. If any one of half a dozen independent verification tests of an answer fails, then a second computer program could be called, to independently recompute an answer and verify it.

### References

1. "Over 2600 Applications of Computers and Data Processing" by Linda Ladd Lovett in the "1974 Computer Directory and Buyers' Guide", pubished by Berkeley Enterprises Inc., 815 Washington St., Newtonville, Mass. 02160

2. Letter to the editor by Dr. George Polya, Professor Emeritus, Stanford Univ., Palo Alto, Calif., published in the "American Mathematical Monthly," January, 1973.

3. "Natural Language Access to a Large Data Base", by D. L. Waltz, Univ. of Illinois, Urbana, Ill., published in "Computers and People", April 1976. □

**Cohen** – *Continued from page 11*

ganizations which are highly competitive. Whereas the transistor required important new scientific understanding, the creation of the sophisticated integrated circuits resulted principally from inventiveness and engineering ingenuity, particularly in processing technology. At the same time, the small dimensions and extreme material purity needed for integrated circuits could not be achieved without a wide array of diagnostic tools and instrumentation provided by earlier unrelated scientific programs.

Copper conductors for electricity come from an experience-based industry, but recent problems in copper availability as reflected in price have injected new science and engineering into the industry. Although aluminum as it existed a few years ago was unsatisfactory for many copper-wire applications, materials R & D has demonstrated that it is possible to modify and control aluminum alloys to meet the necessary properties, such as electrical conductivity, ductility, and corrosion resistance. The objectives of the program were clear, the time scale was relatively short, and the contributions were more of an engineering nature than scientific. This is a clear example of the user in a science-intensive industry demanding new material capabilities and providing leadership to attain that end. It illustrates the ability to develop, through materials R & D, a substitute material to satisfy a specified function.

Although the above summaries cannot do proper justice to the full case studies, nonetheless these glimpses nicely convey the varied scope and modus operandi of MSE.

### A General Perspective

In the years ahead, as mankind finds itself under mounting pressure to accommodate to nature, there will be increasing regard for the materials cycle as one of the elemental strands of national and world systems, along with food, energy, information, and the environment. At the same time, society will inevitably structure its growing knowledge-base so that the human mind will be ever stimulated to understand nature more thoroughly, and likewise human purpose will be ever motivated to cooperate with nature more prudently. This is precisely what MSE strives to do in the realm of materials — the very substances by which mankind is inherently bound to nature. Surely, then, the spectrum of knowledge which we now call MSE has a central role to play in human destiny. □

**Newsletter** – *Continued from page 34*

payable operation as well. "The beauty of the system is that it has a special reporting capability that allows us to prepare various reports, listings, and breakdowns of particular interest to the nursing home or required by government regulators," Ms. Gross said. "In addition, H.I.S. technicians are constantly updating the basic programs. We get a new program disc about once a month," Ms. Gross said. "And the company welcomes suggestions from our facility and other users of the system for the basic software." □

# Computing and Data Processing Newsletter

## CANADA GEESE MIGRATION BEING STUDIED AT LOUISIANA STATE UNIVERSITY

*Dr. Vernon L. Wright*
*Assistant Professor of Experimental Statistics*
*Louisiana State University*
*Baton Rouge, LA*

The migration patterns of Canada geese are being studied thoroughly here using computer statistical programs. We hope the study will yield clues to help conservationists redistribute the flocks — more than a million birds — that now winter mostly in Missouri, Illinois and Tennessee. Until 50 years ago, as many as 15,000 birds wintered in Louisiana, with tens of thousands of others swooping out of late autumn skies to winter in Florida and the southern Gulf states. Now hardly any geese come that far south.

Redistribution could help the geese avoid a catastrophe, such as a drought or oil spill, that could jeopardize the two things they must have to survive: food and open fresh water. Also, if some of the birds returned to their former winter habitats, it would benefit the bird-watchers and hunters as well.

We are applying advanced statistical techniques to massive quantities of bird-banding data.

The Illinois Department of Conservation and the U.S. Fish and Wildlife Service's Region III office at Minneapolis are providing funding for the water-fowl management study. Magnetic computer tapes obtained from the Patuxent Wildlife Research Center in Maryland contain the records of more than 117,000 Canada geese banded in southern Illinois between 1939 and 1976. They also contain data on almost 18,000 bands recovered through 1977, between the Rocky Mountains and the Atlantic Coast and from Canada's Hudson Bay to the Texas Gulf Coast. People who band birds report when and where they were banded to the Federal Bird-Banding Laboratory at Patuxent. This information is stored in a government computer. People who find banded birds send the bands to the Patuxent laboratory and this information is also stored in the computer. The lab, in turn, sends cards to the finders and banders, telling where and when the birds were banded and where the bands were recovered. Thus, over the years, massive amounts of data accumulated.

Although it was available to all waterfowl biologists, few actually made use of it. The information only yielded gross migration patterns, because of a lack of computer power, programming capabilities, and advanced statistical techniques. These were needed to make precise analyses for waterfowl management decisions.

The two-year project was begun in 1978. It is aimed at answering many questions. It will summarize its findings in a report that will be especially useful to the Mississippi Flyway Council, an organization composed of state and provincial conservation officials from the United States and Canada.

There are three distinct populations of Canada geese, Many questions have arisen about how distinct these populations are, how long the birds live, what their average survival rate is, and what changes are going on. We can see that changes have occurred — for example, part of the Tennessee Valley flock may have split off from the Mississippi Valley flock that winters in Illinois — and we really don't know very much about them. We also want to identify other major changes in migration patterns that have taken place over the last 40 years. The distribution of geese in North America has changed drastically over that period of time. At one time, large numbers of birds wintered in Louisiana, on the Louisiana coast and along the Mississippi River. Very few birds winter there now; so one of the questions often asked is, are Illinois refuges and hunters stopping the birds short of the South?

We're finding that most of the Illinois birds never came to Louisiana in great numbers. A few wintered in the northeast part of the state, but most spent the winter along the Mississippi River as far north as St. Louis. Probably, the bulk of the Louisiana flock now spends the winter at Swan Lake in north-central Missouri.

Similarly, Canada geese that used to winter in other parts of the Deep South now winter along the Chesapeake Bay. Those from the Florida-Alabama-Mississippi area now comprise the Tennessee Valley flock.

Why are the birds wintering in the North? Probably because of manmade changes there: the development of wildlife refuges and open fields of grain. They always flew over Horicon, Wisconsin, which is only 50 miles west of the Lake Michigan shore. They didn't stop there in large numbers, however, until the refuges were built there. The geese have found what they want without having to go so far to get it. Being opportunists, they simply go there, alight, and enjoy themselves.

Yet this aspect of their behavior is a major reason why there is pressure to distribute the geese more widely according to their historical patterns. This is one of the goals of the Mississippi Flyway Council. With too many geese in a restricted area, biologists are concerned that a disease or some other natural catastrophe might decimate them: a drought, perhaps, or an oil spill. In that event, it would be better to have those birds that traditionally went somewhere else return to a migration more closely resembling their historical distribution patterns, rather than have them just sit where they are, waiting to be fed, and if not fed, starving to death. We don't know that that would happen, but we don't know that it won't.

The computer being used on this project at LSU is an IBM 3033.

## AN INEXPENSIVE MICROCOMPUTER (A NEW SCIENTIFIC TOOL FOR UNDERDEVELOPED COUNTRIES) INSTALLED IN HANOI

*Richard Rettig*
*onComputing, Inc.*
*70 Main Street*
*Peterborough, NH 03458*

Underdeveloped countries need leverage. They need much return for little investment. Inexpensive microcomputers promise exactly that. A heartening example of what a small investment in a microcomputer can accomplish for an underdeveloped country is described in the spring issue of the new McGraw-Hill quarterly "onComputing," a nontechnical magazine for beginners who want to learn about personal computers.

Thanks to Everett Hafner, Visiting Professor of Physics at Williams College, Williamstown, Massachusetts, the Center for Scientific Research in Vietnam both acquired and learned how to operate a scientifically useful computer system for $6,000. Moreover, of the $6,000 available for the project, only $4,000 was spent on an Apple-II microcomputer system and spare parts and the balance was used to transport Professor Hafner and the computer to Hanoi.

The microcomputer system was successfully installed at the Center for Scientific Research in Hanoi, in March 1979. This is the first useful microcomputer in a scientifically active country of fifty million. The Center and its affiliated Institute of Physics are using it for computation and control of laboratory processes in two projects, to speed up exploitation of the country's mineral resources, and to develop products for export.

On his return, Professor Hafner reflected both on the sophistication of microcomputers and on his experiences in Vietnam. About microcomputers, he commented: "I had become vividly aware of the sophistication that exists in modern microcomputer systems. Without having been forced by financial constraint to look carefully we might easily have chosen a larger, more powerful system, but one that would have been less feasible to maintain at an isolated and poorly equipped site."

As for Vietnam, Professor Hafner says, "I left with renewed faith in the ancient idea that scientific cooperation is one of the most effective ways of forging links between cultures, even in the presence of sharp political differences."

## U.S. AND CHINA AGREE ON LANDSAT GROUND STATION

*Debra J. Rahn*
*National Aeronautics and Space Administration*
*Washington, DC 20546*

NASA and the Chinese Academy of Sciences signed a Memorandum of Understanding in Beijing Jan. 24 covering China's participation in the experimental Landsat program. China will establish a ground station in the Beijing area to read out Earth resources data from Landsat D.

The ground station is to be purchased from U.S. industry under the Understanding on Cooperation in Space Technology of Jan. 31, 1979. The Landsat Memorandum of Understanding is the first formal agreement in the space area since the normalization of U.S.-China relations.

The signing came during a visit to China by a delegation, headed by Dr. Frank Press, Presidential Science Advisor, which included NASA Administrator Dr. Robert A. Frosch.

The agreement was reached with the Chinese Academy of Sciences which will acquire and operate the new ground station near Beijing. The station will receive, process, archive and disseminate Landsat Earth resources data. The agreement parallels those signed with a number of other foreign ground station operators and provides that the Chinese Academy of Sciences will make Landsat data it receives openly and uniformly available to others on a basis similar to the distribution policies followed by NASA and other U.S. agencies. The Academy will help share in the cost of operating the Landsat satellites by paying an annual access fee of $200,000, beginning six months after the Beijing station begins receiving data.

Six Landsat ground stations already are in operation outside the U.S.: two in Canada and one each in Brazil, Italy, Sweden and Japan. New ground stations in Australia and India now are receiving test data and soon will be operational. Another station is under construction in Argentina, while a number of others are in the planning stages elsewhere.

U.S. ground stations for Landsat are located at Fairbanks, Alaska; Goldstone, Calif.; and at the NASA Goddard Space Flight Center, Greenbelt, MD.

Landsat D is expected to be operational in 1982. Landsat 3, launched in March 1978, still is operating.

Landsat data are being used by scientists and local officials in the U.S. and more than 100 foreign countries for a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration. The Beijing ground station is expected to make significant contributions to Chinese modernization in such areas as agriculture, forestry and mining.

## COMPUTERIZED MAIL FORWARDING SYSTEM FOR THE U.S. POSTAL SERVICE HAS SAVED OVER $20 MILLION

*Jim Dunlap*
*Public Relations Dept.*
*Data General*
*Route 9*
*Westboro, Mass. 01581*

Since its installation 17 months ago, a computerized mail forwarding system (CFS) has saved the U.S. Postal Service more than 20 million dollars. The CFS system is being used in 61 cities as of December 6, 1979, and will be installed in 24 more by February 1980. It has already paid for itself more than three times over, according to department officials. Postal authorities estimate that the cost of the more than 1.5 billion pieces of undeliverable-as-addressed mail they handle annually has been reduced from 10.5 to 6.1 cents per piece.

At the same time, the system has speeded up the delivery of mail that is incorrectly addressed because people to whom the mail has been sent have moved to another location. The system also has reduced the amount of undeliverable mail (resulting from having no forwarding address) to less than 25 percent. The figure previously was up to 40 percent in many cities.

Each CFS system consists of a Nova minicomputer, a television-like display terminal with keyboard, and a label printer. In all, more than 630 CFS systems are now in operation.

To get the corrected address of someone who has moved, a postal clerk keys in a code based on the person's name, previous address, and class of mail being processed. Using the code, the computer searches its memory for the correct data and then produces a label with the correct information. The computer also provides the operator with a listing of publications notified of the address change, and indicates the customer's instructions regarding the disposition of various classes of mail.

## COGNITIVE SCIENCE SYMPOSIUM AT VASSAR COLLEGE

*David Bonis*
*Cognitive Science Symposium*
*Vassar College, Box 525*
*Poughkeepsie, NY 12601*
*(914) 452-7000*

The Vassar College Cognitive Science Group will hold a two-day symposium, from 1 p.m. Friday, April 25 to 3:30 p.m. Saturday, April 26, 1980, at the Vassar campus in Poughkeepsie, New York.

The symposium will be devoted to an exploration of the role which context plays in the perception and interpretation of language. Context will be considered from the points of view of social, perceptual, intentional, linguistic, and computational analysis, and the ways in which they are related.

Speakers will include:

Roger C. Schank, Artificial Intelligence, Yale University
Daniel C. Dennett, Philosophy, Tufts University
James D. McCawley, Linguistics, University of Chicago
Howard Gardner, Psychology, Harvard University
Jerre Levy, Biopsychology, University of Chicago

Participation in the conference will be limited to the first 150 people who register; pre-registration is necessary. To obtain further information and/or registration materials, contact me.

## 19-YEAR-OLD OFFICE MANAGER HANDLES COMPUTER AND ACCOUNTING FUNCTIONS AT NURSING HOME

*Richard G. Clancy*
*Creamer, Dickson, Basford, Inc.*
*1301 Ave. of the Americas*
*New York, NY*

*Burt Hochstein*
*Health Information Systems, Inc.*
*4522 Fort Hamilton Parkway*
*Brooklyn, NY 11219*

After completing her college training in elementary education, Brenda Gross of Brooklyn, New York, decided to exchange school books for office books, taking on a position as an assistant bookkeeper at a 280-bed nursing home.

Today, at age 19, and with a year-and-a-half on the job, Ms. Gross is the office manager of Resort Nursing Home in Arverne, New York. She is responsible for the institution's accounting functions. Her present duties include the operation of a minicomputer hardware and software system provided by Health Information Systems, Inc.

Prior to being exposed to the computer system at Resort, Ms. Gross had no formal computer or technical training whatsoever. "At first I got stuck with boring jobs like keypunching," she said. "Week by week, I became more familiar with and adept at using the system. Then I reached the point where I now handle the entire computer operation."

How does a former education student with no prior computer-related experience master a computer system so quickly? "It's been easy," the young office manager said. "All you need to know is simple English, how to follow simple directions, and then proceed step by step."

The nursing home uses its computer system for the entire range of accounts receivable and payroll functions, and for a portion of the accounts

*(please turn to page 31)*

# 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.*

## NAYMANDIJ

In this kind of puzzle an array of random or pseudorandom digits ("produced by Nature") has been subjected to a "definite systematic operation" ("chosen by Nature"). 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.)

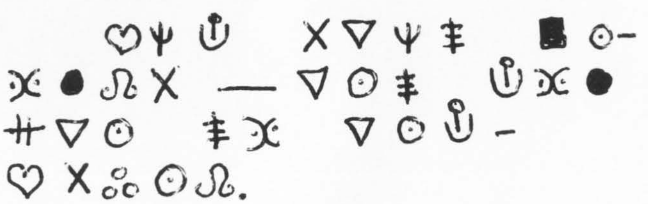
### NAYMANDIJ 8003

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

## MAXIMDIJ

In this kind of puzzle, a maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the 10 decimal digits or equivalent signs, 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.

### MAXIMDIJ 8003



## 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, exexpressed 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 8003

```
                D E B T
       *      M A K E S
              ---------
              E D A L D
            N L S D A
          T N B K N
        K A D A D
      A K M N L
      -----------------
    = A E K E A S D A D
```

9448 5766

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

### SOLUTIONS

**NAYMANDIJ 8001:** Sequence column 20.
**NUMBLE 8001:** Things take time.
**MAXIMDIJ 8001:** To live long, live slowly.

Our thanks to the following people for sending us solutions: Roland Anderson, Stockholm, Sweden – Maximdij 7911, Naymandij 7911, Numble 7911; Michael A. Ragusa, U.S.S. Barnstable City — Numble 7911; Steve Werdenschlag, Livingston, NJ — Maximdij 7911, Naymandij 7911, Numble 7911.

## The Frustrating World of Computers

*by Harry Nelson*
*1135 Jonesport Ct.*
*San Jose, CA 98131*


IT TAKES THREE TO FIVE WEEKS TO LOCATE ANY SPECIFIC ITEM, CAN YOU GET ALONG WITHOUT THE 5TH ARMY TILL THEN — ?


AS SOON AS I FIGURE OUT HOW TO OPERATE IT, I'M GOING TO FEED ALL THIS INFORMATION INTO IT AND LET IT RUN ITSELF.


I REALIZE IT WAS OUR ERROR BUT WE CHARGE FIFTY DOLLARS AN HOUR TO CORRECT OUR COMPUTER PROGRAM——


I READ THE BOOK, — BUT IT DIDN'T—