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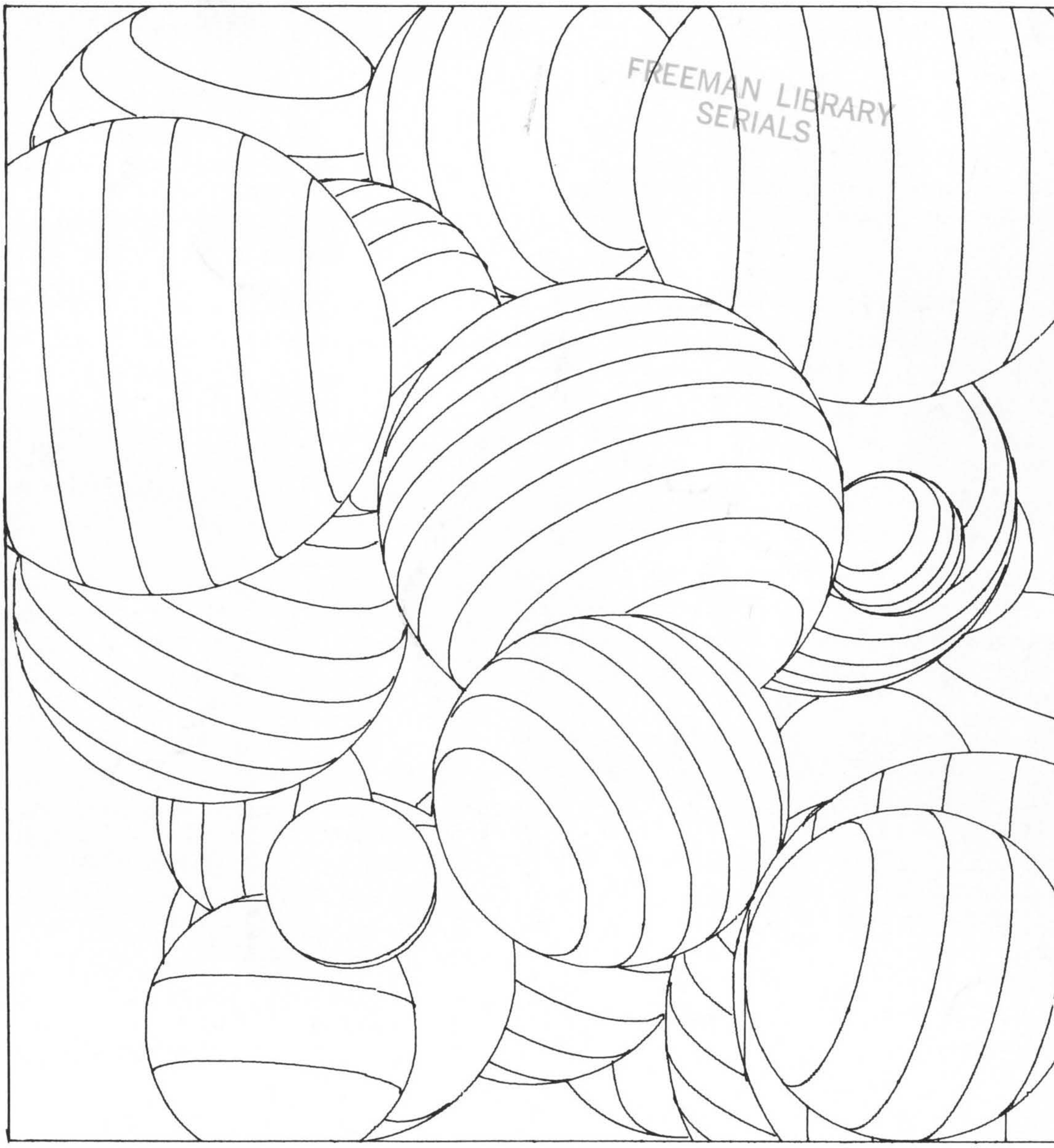

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The Computer Almanac and Computer Book of Lists — Instalment 53

Neil Macdonald, Assistant Editor

24 PROPOSITIONS RE: NATURAL AND ARTIFICIAL LANGUAGES AND COMPUTER SYSTEMS (List 870501)

- Computer languages were created to precisely specify low-level tasks.

- Natural language instructions for computers make them much more accessible to users.

- The tasks seen by artificial intelligence are high-level, not requiring specifications of fine details.

- Computers, unlike people, do not "magically" learn natural language as they "grow".

- Almost all people learn at least one natural language before reaching age 6 or 7.

- How they manage to do this is mysterious and puzzling to students, experts, and scientists.

- Teaching computers to understand English is a very difficult problem, of great scientific interest, and of great commercial value.

- The level of specification useful for human understanding of a problem is almost never useful for computer understanding of the problem.

- "Full directions written for humans to translate one natural language to another are almost always incomplete and inconsistent.

- Linguistics, the study of language, has three divisions: semantics, which deals with meanings; syntax, which deals with structure; pragmatics, which deals with the speaker's intent.

- Most ordinary dictionaries for human use are filled with circular definitions; there is no selection of "primitive" words upon which all other definitions are based.

- A dictionary for computer use regularly requires all definitions to make use of simpler, more basic words (selected as "primitive" words) than the word being defined.

- The syntactic analysis of a sentence is "parsing", recognizing and specifying the structural parts of the sentence, such as subject, predicate, nouns, adjectives, modification, etc.

- The semantic analysis of a sentence is recognizing and specifying the meaning, as in "that bell" (a designated bell) "is ringing" (making a designated sound); the pattern is often the actor and the action.

- Syntactic analysis may be ambiguous, as in "Time flies like an arrow," "Fruit flies like a banana," "Notice flies like a dragonfly;" the pattern is (1) noun, verb, preposition, (2) adjective, noun, verb, (3) verb, noun, preposition.

- Semantic analysis may be ambiguous, as in "A hot cup of tea" in which the logical meaning is a "a cup of hot water containing tea."

- A commercial natural language system depends critically on the level of semantic primitives chosen by the system designer.

- Too low a level of semantic detail is confusing and very difficult to implement; too high a level leads to inability to make required and important decisions.

- A natural language system should not assume that the user knows all the rules or can talk unambiguously.

- Very reasonable problems referring to files can translate into very complicated problems in designing data bases.

- In the future humans will interact with computers using spoken words, from machine to human, from human to machine.

- Much communication takes place not by what the words say, but by what the speaker wants to find out.

- Pragmatic analysis requires supplying what the speaker wants to know, not what the words of the speaker say, as in "Who is Mr. Jones?"

- Practical expert systems number more than 50 as of the end of 1986.

(Source: Neil Macdonald's notes and other readings.)

PERSONALITIES OF 39 NUMBERS (List 870502)

100 $2 \times 2 \times 5 \times 5$, $6^2 + 8^2$

101 prime, $1^2 + 10^2$

102 $2 \times 3 \times 17$

103 prime

104 $2 \times 2 \times 2 \times 13$, $2^2 + 10^2$

105 $3 \times 5 \times 7$

106 2×53, $5^2 + 9^2$

107 prime

108 $2 \times 2 \times 3 \times 3 \times 3$

109 prime, $3^2 + 10^2$

110 $2 \times 5 \times 11$

111 3×37

112 $2 \times 2 \times 2 \times 2 \times 7$

113 prime, $7^2 + 8^2$

114 $2 \times 3 \times 19$

115 5×23

116 $2 \times 2 \times 29$, $4^2 + 10^2$

117 $3 \times 3 \times 13$, $6^2 + 9^2$

118 2×59

119 7×17

120 $2 \times 2 \times 2 \times 3 \times 5$

121 11×11

122 2×61, $1^2 + 11^2$

123 3×41

124 $2 \times 2 \times 31$

125 $5 \times 5 \times 5$, $2^2 + 11^2$, $5^2 + 10^2$

126 $2 \times 3 \times 3 \times 7$

127 prime

128 $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$, $8^2 + 8^2$

129 3×43

130 $2 \times 5 \times 13$, $3^2 + 11^2$, $7^2 + 9^2$

131 prime

132 $2 \times 2 \times 3 \times 11$

133 7×19

134 2×67

135 $3 \times 3 \times 3 \times 5$

136 $2 \times 2 \times 2 \times 17$, $6^2 + 10^2$

137 prime, $4^2 + 11^2$

138 $2 \times 3 \times 23$

12 ETHICAL QUESTIONS FOR COMPUTER PERSONS (List 870503)

- Should I work on a project which I am sure will never meet the goals of the sponsor?

- Should I work on a military project which will turn countless civilians into piles of ashes?

- Should I work for the government department which sells weapons to anybody who can pay for them?

- Should I work on research and development for the military?

- Should I do programming in languages (such as ADA) specialized for military applications?

- Should I work on nuclear weapons?

- If I know that other people will work on X, does that belief justify me to work on X?

- If I believe that another body of people will attack the body of people to whom I belong, does that belief justify me to work on any project whatever?

- Are there some projects (such as inserting broken glass into women's legs -- done by Nazi doctors to imprisoned Polish women in 1943) which no person should ever work on?

- Should I work on any project which if successful will shorten average human life by a substantial number of years?

- Should I work on an ethically disgraceful project?

- In order to avoid working on an ethically disgraceful project, should I change my job?

(Source: Neil Macdonald's notes and reading)

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Artificial Intelligence

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by Martin A. Fischler and Oscar Firschein, Stanford Research Institute, Menlo Park, CA
Whether or not machines are "intelligent" can be better answered if we understand the strategies human beings use to solve problems, the differences between mechanical and intelligent behavior, and how the learning ability of digital computers compares to that of humans.

16 **Artificial Intelligence and Natural Language Systems – Part 2** [A]
by Susan J. Scown, Digital Equipment Corp., Concord, MA
Natural language systems allow us to communicate with computers without learning a particular programming language or even without hardware mechanisms like keyboards or printers. Some practical commercial systems are already available in the areas of machine translation, document understanding, and speech understanding.

Computers and Arms Control

13 **The Strategic Defense Initiative and the Global Policy of the United States** [O]
by Paul M. Sweezy and Harry Magdoff, Monthly Review Foundation, New York, NY
What is the U.S. position on military supremacy and the balance of world power? and the function of SDI in preventing improved U.S.-Soviet relations and definitive arms control negotiations?

Computers and Languages

6 **Languages – Official, Multiple, Universal** [E]
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Computers and Privacy

23 **New, Increasing Surveillance Technology** [A]
by Dr. Gary Marx, Massachusetts Institute of Technology, Cambridge, MA
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The magazine of the design, applications, and implications of information processing systems — and the pursuit of truth in input, output, and processing, for the benefit of people.

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Program documentation (user manuals, etc.) is intended to help people use computers, but it often doesn't. Non-technical explanation by non-technical authors in common situations will help solve the puzzle of good explanation.

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Opportunities for Information Processing

28 Opportunities for Information Systems (Instalment 9): The Promotion of Scientific Behavior [C]
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Why is scientific behavior something that should be promoted? and how can information systems provide an opportunity for such promotion?

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NUMBLE – Deciphering unknown digits from arithmetical relations among them.

Front Cover Picture

The front cover shows a sample of art by David Dameron of Palo Alto, CA. This illustration is executed on a Z-80 computer system with 48K RAM and one 5¼ inch disk drive, using a modified Sylvanhills DFT-2 plotter. Each sphere has circles at constant Z drawn on it, and is then rotated about the X and Y axes before it is drawn. Each sphere is also checked before it is drawn with all previous spheres to determine any segments which are hidden and thus should be eliminated.

Computer Field → Zero

There will be zero computer field and zero people if the nuclear holocaust and nuclear winter occur. Every city in the United States and the Soviet Union is a multiply computerized target. Radiation, firestorms, soot, darkness, freezing, starvation, megadeaths, lie ahead.

Thought, discussion, and action to prevent this earth-transforming disaster is imperative. Learning to live together is the biggest variable for a computer field future.

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Editorial

Languages — Official, Multiple, Universal

Edmund C. Berkeley, Editor

"An amazing consequence of the general vocabulary developed by human minds is that we can grasp, understand, and discuss a vast amount of the real world."

Outline

An Official Language

International Communication

An International Vocabulary

Special Vocabularies

The General Vocabulary

Numbers

A Remarkably Successful Tool

An Official Language

Recently California has voted that the official language of California is English. This has occurred as a response to former U.S. Senator Hayakawa's campaign for this purpose, and to offset efforts by various ethnic groups, particularly Hispanic, to require as a matter of entitlement public school instruction in any language that a local ethnic group may choose.

The vote is also an encouragement and a confirmation of the achievements of more than a hundred million people who, speaking another native language, have emigrated to the United States over 150 years and have determined that they and their families should acquire English thoroughly. They have realized that they should adapt to the customs and culture of the United States, including the immensely important one of language.

A common language among the people of a nation is, of course, a tremendous asset in all that a nation seeks. It is possible for a nation to have more than one language and function well: examples include Switzerland, Canada, Belgium. But multiple language is unusual, and it requires energy, study, and will. Splits of nations according to linguistic groupings, especially when increased by ethnic and religious differences, is an unfortunate and regularly avoidable consequence.

International Communication

In regard to languages for international communication, the usual practice at international conferences is to have simultaneous translation by competent human translators. Each of the several languages spoken at the conference can be heard through an earphone at a delegate's desk as the human translator converts what a speaker says in the real time in which he says it. This capacity is not yet possible in a computer system.

In the case of technical manuals written in a natural language about equipment, often the manual can be translated by a computer system into a translation which is about 95% correct, and then final correction of the translation by editing and amending can be accomplished by a human editor. The more extensive and powerful the computerized translation, the costlier is the computer system.

In most countries of the world, it is normal and expected that a student will learn not only his own language but also a second one. The degree of the learning of the second language is usually 6 years of instruction, and the attainment of pronouncing, reading, and speaking the second language. Usually the second language is one of the much used languages such as English, Spanish, French, Russian, or German. The advantages of knowing two languages well are great, and it is likely that in days to come it will be normal and expected that most Americans by the time they are age 18 will know two languages.

But these arrangements for humans are still far from what we can plan for the future, especially with the power and speed of computer systems. They are likely to give us a far greater control over words and ideas than we have ever had previously. And that may give us something that has been forecast in fairy tales, a universal language. A universal language has in fact begun, and is detectible in three areas: an international vocabulary; special vocabularies; a general vocabulary.

An International Vocabulary

First, there exists already in our own days an area of universal language, a language which conveys commonly needed ideas to almost anybody. This is the portion of language which is used internationally. As more and more people travel over the globe, for business, pleasure, or necessity, more and more the words and concepts of frequent global cultural ideas will become recognized and standardized. They will be signaled or communicated (spoken and understood) internationally.

This is a modern necessity. It shows in airport terminals, railroad stations, traffic signals, highway signs, information bureaus, signs of entrance and exit, and similar situations. Accompanying these signs there are a number of internationally common words such as "OK, hotel, telefone, exit, 2, 3, book, taxi" and so on. A reasonable estimate for these internationally very common words would be perhaps a hundred or 150 words.

Special Vocabularies

Next, there are special vocabularies, words assigned for scientific and technical ideas and concepts. These are produced in quantity by specialists in research, development, manufacture, production, and many other fields of practical and theoretical activity. New concepts in physics include "quark, muon, barn". New concepts in biology include "penicillin, DNA (deoxyribonucleic acid), AIDS (acquired immune deficiency syndrome)".

International collaboration leads many investigators and developers in a field to use jointly the same special term for the same special idea. They adopt standards internationally. Europe leads the way.

The number of special fields is now more than 3000, and is likely to become much bigger still, as progress in knowledge continues all over the world. The forces that push for a common name internationally for the same special idea are strong. As a result, special vocabularies internationally understood are likely to contribute thousands of words to a universal language. At 10 words (estimate) per special field, and 3000 specials fields, the result is 30,000 words of international language. Of course, no one person will ever know all those words, but the pressure for universal language for special fields is forceful.

The General Vocabulary

The third area of great importance in any language may be called the vocabulary of general knowledge. The general vocabulary consists of words and ideas dealing with fundamental properties and relations. These ideas penetrate all areas of discussion.

These words and ideas are those which we need and must use to talk about any subject, any area of discussion no matter what it may be. A partial inventory of them is:

- logic / "if, then, and, or, not, yes, no, only, if not, ..."

- mathematics / "4, 12, plus, times, percent, equals, more than, ..."

- statistics / "perhaps, probably, often, never, average, maybe, ..."

- time / "soon, year, future, past, before, after, today, ..."

- place / "below, above, nearby, in, on, around, away, ..."

- discussion / "believe, think, forget, question, wonder, reply, ..."

- person / "I, we, you, they, him, her, ..."

- courtesy / "please, thank you, sincerely, sir, ..."

- size / "big, great, small, little, huge, tiny, ..."

There are of course many more subdivisions, perhaps 50 altogether. If we estimate some 25 words and ideas for each subdivision then we come out with some 1200 to 1500 words.

Of course these words are all in English, which may not turn out to be a "universal language" for this area or territory of language, the common ordinary statements that we need to make from day to day. But it seems that in any language the total number of words and ideas needed for this department of talking is only about 1200 or 1500.

It would make sense for a person learning another language to learn the general vocabulary of that language and thereby become able rather quickly to talk fairly well in that new language.

Numbers

Numbers are a clear and interesting example of the general vocabulary.

The words and ideas that are general grow out of the use of language long before the start of written history. Contributions come from many diverse people, times, and places. The first numbers are "1, 2, many," found by missionaries among many primitive small native communities. Later come numbers organized according to scale "ten, hundred, thousand, ten thousand, ..." A recent number is "zero," probably first recognized by Hindu mathematicians about 500 B.C. Previously it was often confused with "none, nothing, nobody, ..." Some of the recently named and used numbers are "trillion" (1 with 12 zeros after it, a million times a million), "googol" (1 with 100 zeros following it), and "e" which begins with 2.71828 ... and has been calculated to more that 100,000 digits as a computer test.

As we grow older, we realize that all of the ideas in the general vocabulary have two layers. The first layer occurs when we begin using them in childhood. We don't think about them when we start to say "boy" for one boy, and "boys" for two or more boys. The second layer occurs when we cound the number of boys in a classroom, or estimate the number of boys in a city. In fact, the general idea when studied or examined becomes a special idea.

A Remarkably Successful Tool

The most important asset of the general vocabulary is that it is a remarkably successful tool for dealing with and organizing propositions and relations in almost every aspect of the real world. The general vocabulary consists of the nontechnical, familiar words and ideas that are found in almost every subject we human beings want to discuss. To organize a branch of knowledge, our standard approach is to name the pieces and assert the simple relations between them.

If the subject is persons in a family, they are given proper names like Robert, Mary and Susan, and we can say "Mary is the daughter of Robert" and "Susan is another daughter of Robert." And we can know that "Robert is the father of Mary and Susan."

If the subject is vegetables in a garden, we can say "The first two rows are cabbages, and the next row is carrots." And from that we know that "The row of carrots is not between the two rows of cabbages."

If the subject is chemistry, we can say "The gas carbon dioxide has molecules which each contain one atom of carbon and two atoms of oxygen." And from that we know that carbon dioxide does not have atoms of any other material.

An amazing consequence of the general vocabulary developed by human minds is that we can:

- consider,
- grasp,
- understand, and
- discuss

a vast amount of the real world. We can organize our words and ideas so that problems, solutions, and methods of solving them can be applied.

Of course, not all the problems that humans can imagine and express, can we solve. But for a tremendous collection of those problems, we can see:

- how it may be possible to solve them, and
- how to maneuver to solve them.

And immensely greater power to solve them will come from computer systems.

Reference

Chapter VII, "Analysis of Conversational Language," in "Elements of Symbolic Logic," by Hans Reichenbach, copyright 1947 by and published by Macmillan Co., New York, NY, 444 pp.

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Questions, Intelligence and Intelligent Behavior —Part 2

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"The digital computer is the only device that has been used to achieve any significant degree of artificial intelligence."

(Part 1 appeared in the May-June, 1987 issue of "Computers and People.")

The Machinery of Intelligence: Reliance on Strategies

It would appear that we deal with the world by relying on paradigms, overall strategies or frameworks that we use as the high-level plan for solving various problems. The use of paradigms allows us to reduce the complexity of our environment by discarding most sensory data and selecting only that which is relevant. Thus, we are usually unconscious of breathing, body support pressures, background hums and noises, but any of these could become important in special situations; e.g., consciousness of breathing could be important to an astronaut in a space suit. If the paradigm for dealing with a situation is not adequate, then performance will be poor: If the only tool you have is a hammer, you tend to treat everything as if it were a nail. For example, the city dweller may not have the proper paradigms for dealing with a jungle environment. His "city paradigms" would not help him to focus on the necessary sensory data; he would not be able to properly interpret the jungle environment data being received, and he would not be able to invoke the appropriate actions for survival.

Sequential and Global

There is evidence to show that the two hemispheres of the human brain are specialized to deal with problems in different ways by the use of two distinct types of paradigms. The sequential (or logical) paradigm is based on a problem solving approach that considers only a small portion of the available data at any given time, while the parallel (or gestalt) paradigm processes data on a global basis, or all at once. That these are fundamentally different capabilities can be seen from an experiment. A human subject is given an opaque card with a small window in it and asked to explore an English word (printed in a rather unusual type font) by moving the card over it. The subject will not be able to perceive the word because all of the pattern data must be viewed at once to reveal the structure.

The important point here is that problems that can be successively decomposed into simple and relatively independent parts can be effectively solved using the sequential/logical paradigm. On the other hand, many problems, especially those of a perceptual nature as in the example, do not permit decomposition, and can be effectively solved only by employing the gestalt paradigm that can deal with global information.

Left and Right Hemispheres of the Brain

In most normal people, the left hemisphere of the brain is specialized to deal with tasks amenable to a sequential paradigm. These include language understanding and production, logical reasoning, planning, and time sense. The right hemisphere of the brain is more competent to deal with spatial tasks requiring a global (gestalt) synthesis. These include comparing and identifying visual imagery, visual and analogic reasoning (including, perhaps, dreaming), and body sense and coordination.

Some of the evidence supporting the concept of specialization of the two brain hemispheres with respect to the gestalt and sequential paradigms has come from split brain experiments with subjects who have had brain surgery to control epilepsy. The connection between the right and left hemispheres is severed so that signals no longer flow between the hemispheres. By examining the subjects of such experiments, it has been found that the human brain can support two separate and distinct "personalities," one in each hemisphere. The philosophical implications of this finding are rather staggering and are still being investigated.

The Mechanization of Thought

The idea of man converting an inanimate object into a "human-like" thinking entity is an old one. In Greek myth we have the story of Pygmalion, a king of Cyprus who fashions a female figure of ivory that was brought to life by Aphrodite. In the Golem legend of the late sixteenth century, Rabbi Low of Prague breathes life into a figure of clay. In the nineteenth century there is the story of the scientist Frankenstein, who creates a living creature.

During the seventeenth century, the idea arose of converting thought into a formal notation and using a calculating device to carry out the reasoning operations. In 1650, the English philosopher Thomas Hobbes proposed the idea that thinking is a rule-based computational process analogous to arithmetic. Gottfried Wilhelm Leibnitz (1646-1716) describes his book "De Arte Combinatorica" (1661) as containing "a general method in which all truths would be reduced to a kind of calculation." Much later, in 1854, George Boole published "An Investigation of the Laws of Thought, on which are Founded the Mathematical Theories of Logic and Probabilities." In the first chapter he states, "The design of the following treatise is to investigate the fundamental operations of the mind by which reasoning is performed."

The Framework of a Logical Language

The dream of devising a formal system that could be a basis for all reasoning seemed to be almost at hand with the publication of Russell and Whitehead's "Principia Mathematica" (1910-1913). The codification of logic and the reduction of significant portions of mathematics to the language of logic appeared to provide the means by which people (or machines) could do mathematics without having to understand what was actually happening; it would be sufficient to manipulate the symbols according to permissible logical transformations. Even the sequencing of the transformations could be done "blindly" (mechanically).

It even seemed possible that all questions of philosophy could be phrased and answered in such a logical language. The logical positivists, extending the empiricism of David Hume, believed that only within the framework of a logical language could philosophical problems be raised with any degree of precision: All problems are either questions of fact or questions of logic; the former are properly relegated to the sciences and philosophy simply becomes a form of logical analysis. W. Barrett in "The Illusion of Technique" notes, "...when Philosophy, which was supposed to question everything, turns to questioning itself, it finds that it has vanished," i.e., it is reduced to physics and logic. However, at least in part for reasons touched on below, the dream of a formal system for reasoning began to fade in the 1930s.

Formal investigation of the limits of mechanical reasoning did not occur until the twentieth century. Alan Turing, a British mathematician, carried out investigations using a conceptual model that he called an automaton (now known as a Turing machine). In the 1950s, Turing was able to prove formally that there is a "universal automaton" that can simulate the performance of any other automaton if it is given an appropriate description of that automaton. In addition, Turing proved that certain types of automata could never be built, e.g., one that could tell whether an arbitrary program run on an arbitrary automaton would ever halt.

The Construction of Automata

Also in this era, John von Neumann dealt with the questions of how complex a device or construct need be in order to be self-reproductive, i.e., to make a copy of itself. He also investigated the problem of how to design reliable devices that must be made from parts that can malfunction. He surmised that automata whose "complexity" is below a certain level can only produce less complicated offspring, whereas those above a certain level can reproduce themselves or even construct higher entities.

In recent years, the information processing paradigm has become a popular model for explaining the reasoning ability of the human mind. As stated by H.A. Simon in "Cognitive Science: The Newest Science," "At the root of intelligence are symbols, with their denotative power and their susceptibility to manipulation...and symbols can be manufactured of almost anything that can be arranged and patterned and combined." This view, that intelligence is independent of the mechanisms by which the symbol processing is accomplished, is held by most researchers in the field of artificial intelligence.

The Computer and the Two Strategies

The digital computer is the only device that has been used to achieve any significant degree of artificial (machine) intelligence. However, the conventional digital computer is a sequential symbol manipulator, and is primarily suitable for tasks that can be broken down into a series of simple steps. Thus, it is only effective for realizing one of the two basic paradigms employed in human intelligence: the sequential paradigm. Attempts to duplicate human abilities involving the global (gestalt) paradigm, such as visual perception, have been strikingly inferior, even for visual tasks that people consider extremely simple.

At the present time there is a vast difference in favor of the human brain, as compared to the computer, with respect to logical complexity, memory characteristics, and learning ability. Computer-based AI must be specialized to very restricted domains to be at all comparable to human performance. For example, games with a limited number of positions and possible moves are well matched to the computer's great search speed and infallible memory.

Distinguishing Mechanical and Intelligent Behavior

Two basic attributes of intelligence are learning and understanding. One might think that an artificial device possessing these capabilities is indeed intelligent.

We can illustrate the presence of both of these attributes in the very limited context of a coin-matching game. In this example, the computer learns the playing pattern of its opponent, and in practice will beat almost all human opponents who are not familiar with the details of the program. The computer demonstrates its understanding of the game situation by its outstanding ability to predict the opponent's moves. However, the computer starts with the key elements of its later understanding, since the programmer has provided the model of choosing heads or tails based on the statistics of the opponent's previous four-move patterns. The only active role played by the program is to collect the statistics of play, and to make choices based on these statistical data. To the outside observer the program seems intelligent, but once we examine its actual details we see that it is quite simple and mechanical.

Some might point out that this same argument can also be applied to human performance; it is conceivable that most of the basic models necessary for intelligent performance are inborn, and all we do is select the proper model and adjust the parameters.

The Role of Representation in Intelligent Behavior

A paradigm is an overall approach for dealing with a class of problems. One of the most critical elements in the specific realization of a paradigm is the form in which the relevant knowledge is encoded. To illustrate the role played by the selected representation in solving a problem, consider Figure 1 which shows a configuration of 17 sticks of equal length arranged into a rectangle of two times three small squares. The problem is to remove five sticks so as to leave three squares with no extra sticks remaining. You are required to find all such solutions! You might try to find one such solution before you read further.

If the primitive element you manipulate in searching for a solution is the individual stick, and you remove five sticks at a time and check the result, then even if you are careful not to repeat a particular trial twice, you must make over 6000 trials to be sure that you have found all possible solutions. (There are about 6000 combinations of 17 sticks taken 5 at a time.)

If the primitive element you manipulate is a square, you can select three squares at a time and retain the configuration if there are exactly five sticks left to be removed.

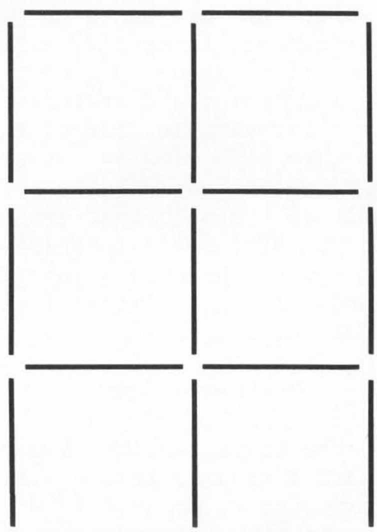

Figure 1: The problem is to remove five sticks so as to leave three of the original squares with no extra sticks, and to do this in all possible ways.

Then there are only 20 unique configurations that must be examined to find all solutions, and there is a 300:1 reduction in the number of trials over the approach based on representing the given configuration as a collection of individual sticks. (There are 20 combinations of 6 squares taken 3 at a time.)

Finally, we note that there are 17 sticks, and after removing five, the remaining 12 can form three squares only if these squares are noncontiguous (i.e., have no sides in common). It is easily seen that there are only two configurations of three noncontiguous squares, and both of these are valid solutions. Here, by using a representation that allowed us to employ deductive reasoning, the required effort is reduced by a factor of 3000:1.

Learning

Intelligence is more an open collection of attributes than it is a single well-defined entity. Some of the attributes most closely identified with intelligence are learning, reasoning, understanding, linguistic competence, purposeful behavior, and effective interaction with the environment (including perception). Since intelligence has no clear definition, differing theories of intelligence are not necessarily in conflict, but often differ mainly in the assumed definition of intelligence as either (1) a natural phenomenon appearing in living organisms, especially man, or (2) an arbitrarily specified set of abilities.

Performance

Most psychological theories of intelligence are what might be called "performance theories" since they are based on measurements of performance in specified skills, and make assertions about the relationships and correlations between different tests of performance. For example, correlations between tests have been used by investigators attempting to determine if human intelligence is the result of a single coherent mechanism or a collection of loosely integrated independent processes. Such theories are largely empirical and offer very little insight into the nature of intelligence.

Intelligence Tests

Intelligence tests, whether for people or machines, have some practical utility, but cannot be expected to accurately measure an undefinable quantity. Another complicating factor in our understanding of intelligence is the role played by consciousness, and the relation between mind and brain.

It is possible to assume that most intelligent behavior arises from one of two distinct paradigms (strategies): In the sequential (or logical) paradigm, a single path is found which links available knowledge and evidence to some desired conclusion; in the parallel (gestalt) paradigm, all connections between evidence and possible conclusions are appraised simultaneously. There is some evidence that the human brain has separate specialized machinery for each of these two paradigms.

A key insight provided by work in artificial intelligence is that intelligent behavior not only requires stored knowledge and methods for manipulating this knowledge, but is critically dependent on the relationship between the specific encoding of the knowledge and the purpose for which this knowledge is used. This concept, the central role of representation in intelligent behavior, is one of our major themes.

The Ultimate Limits of Artificial Intelligence

We have briefly sketched the nature of human and machine intelligence. We will repeatedly return to the questions, "What can a machine know about the world in which it exists?" and "What are the mechanisms needed to acquire, understand, and employ such knowledge?" We will also address a number of basic questions concerning the limits and ultimate role of machine intelligence:

- Can man create a machine more intelligent than himself?

- Are there components of man's intelligence that cannot be found in any animal or duplicated in a machine?

- Can all intelligent behavior be duplicated by the current approach to AI (artificial intelligence), namely by decomposing a given problem into a sequence of simple tasks or subproblems that can be precisely stated and solved?

- Can a machine ever exhibit fully human behavior without having been human and thus properly socialized? In a more limited sense, is human intelligence in some way bound up in the human experience or even human heredity?

- Is intelligent behavior realizable, or even conceivable, with the type of computing instruments currently available?

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Opinion

The Strategic Defense Initiative and the Global Policy of the United States

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"It is extremely important to understand that SDI becomes the centerpiece and pivot of all future arms-control negotiations."

The Global Policy of the United States

The global policy of the United States is caught in an insoluble contradiction.

On the one hand it proclaims what may be called the Reagan Doctrine, which was given a clear and militant formulation only a few months ago. It basically repeats the message of President Truman of the late 1940s and the major "doctrines" and policy pronouncements of all U.S. presidents since World War II. The essence of the doctrine is a declaration of war on any fundamental change in power (that is, class) relations anywhere in the world of production for profit, and a complete commitment to the proposition that any and all attempts to effect such change are ultimately the responsibility of the Soviet Union.

On the other hand, the U.S. seeks to convince world public opinion that the U.S. wants an end to the arms race and a peaceful settlement of outstanding differences with the Soviet Union.

Two Irreconcilable U.S. Positions

On the face of it, these two positions are irreconcilable. The one requires unconditional U.S. military supremacy, which the Soviet Union obviously cannot agree to. The other implies abandonment of the Reagan Doctrine and acceptance of its opposite, a global doctrine of live-and-let-live.

The Real U.S. Position

Which is the real U.S. position? Evidently, the first. This is evident from the continued expansion of the U.S. military budget and the continued rejection by the U.S. of all concrete proposals emanating from the Soviet Union for the control and/or reduction of specific arms programs. These include most notably nuclear testing and the Strategic Defense Initiative (SDI). The chief strategic purpose of the SDI would be to make more plausible the threat of a nuclear first strike.

Any doubts that this is indeed the real U.S. position should be effectively dispelled by the results of the meeting between Reagan and Gorbachev in Iceland in October, 1986. There was nothing essentially new about the Soviet proposals put forward at that meeting -- even more radical disarmament measures had already been proposed on numerous occasions.

But Gorbachev did lean over backwards to meet objections the Reagan administration had raised in the past relating to such matters as verification, the treatment of British and French nuclear weapons, and the cessation of further testing. He even went a long way toward acceding to Reagan's position on SDI, asking only that work on this kind of extension of military preparations into space be confined to the laboratory for ten years.

If Reagan had really had the slightest desire for an agreement, he could have accepted this proposal in principle, leaving the particulars to future negotiations, without committing himself to give up or even significantly slow down work on SDI. The opinion of scientists, even those favorable to SDI, seems to be overwhelmingly that at least ten years of lab work will be needed before meaningful testing, let alone deployment, can be undertaken. But instead of proceeding along this road, Reagan chose to interpret Gorbachev's mild proposal as a demand to "kill" SDI, and this he categorically rejected. The upshot was that the meeting was abruptly terminated and Reagan was able to return to Washington claiming to have been on the verge of concluding a sweeping arms-reduction agreement, only to have it torpedoed by Gorbachev's intransigence.

The Seeds of a Future Failure

As usual with Reagan, the Reykjavik performance was skillfully executed and, to judge from press reports and opinion polls, has to be considered a short-term tactical success. But there is every indication that from a longer-term point of view it planted the seeds of a future defeat. What Reagan accomplished, i.e., blocking any kind of arms agreement, could have been achieved more easily by refusing to go to Reykjavik in the first place -- something which, it seems, his advisers advocated. But this would have been to give away the show in advance: as we already remarked above, Reagan (and this would apply to any U.S. head of government) needs to appear to be anxious for peace, for negotiations, for arms control, etc. Failure in this respect would lead to certain and rapid loss of political support both at home and among allies abroad. Reagan therefore had to accept Gorbachev's proposal to meet, and to maneuver to throw the blame for failure to reach agreement on the Russians. It was here that he scored his short-term tactical success. But for that success he had to pay a price the full amount of which will only become clear over a period of time measured in years rather than weeks or months.

The Real Consequences of Nuclear War

With the continuing arms race, the growing worldwide awareness of the real consequences of nuclear war, and the emergence of powerful peace movements, however, the U.S. policy of military supremacy became increasingly untenable. In the early days it was easy to dismiss Soviet disarmament proposals as mere propaganda, not to be taken seriously. But as the two superpowers reached a situation of rough parity in military power, and the rest of the world came to understand that no one could escape the dire consequences of a nuclear war, a subtle change set in. With the Soviet economy urgently needing relief from the enormous cost of the arms buildup and with worldwide pressure on both superpowers growing, the United States, even under its most right-wing postwar administration, could no longer afford to continue in its old ways. And added to this was the fact that the Soviet Union, after undergoing a lengthy and unsettling political transition, emerged with a younger and more vigorous leadership determined to play a more active -- which also means less reactive -- role in the international arena.

The Soviet Approval of On-Site Inspection

Previously, almost any Soviet arms proposal could be rejected on the ground that without on-site inspection there could be no guarantee of compliance. This was a conclusive argument for the U.S. public and Congress -- until the Soviet leaders began to show flexibility on the point and finally in the last year or so have dropped the whole idea of no inspection and now seem as ready as the United States to negotiate appropriate arrangements. This is a tremendous change.

For all practical purposes, it means that neither side can any longer reject an arms-limitation proposal for purely technical or procedural reasons. In this situation the United States is finding it more and more difficult to turn down proposals, especially those having to do with testing and with the quantitative limitation of the numbers of various weapons systems. So much so indeed that Reagan at Reykjavik felt obliged to accept, at least in principle, a number of limitation agreements of a kind that in the past had been routinely dismissed as out of the question. It was this that gave rise to all the talk of the great historic breakthrough that was almost but not quite achieved at Reykjavik.

The Strategic Defense Initiative Becomes the Pivot

What saved the day for Reagan of course was SDI which he continues to portray as a purely defensive system to which no reasonable person could object. He had, he said, promised the American people not to abandon this ultimate protective shield (which of course he was not asked to do). Gorbachev on the other hand, according to Reagan, insisted that "killing" SDI was an indispensable part of the whole package. Hence no historic breakthrough.

It is extremely important to understand what this means, i.e., that SDI becomes the centerpiece and pivot of all future arms-control negotiations. Reagan in effect gave up all other pretexts for saying "no" at Reykjavik and is now left with this one final and all-inclusive negation: no agreements that conflict with U.S. freedom to pursue SDI in whatever way Washington chooses. SDI has thus become, in the words of a letter to the editor of the "New York Times" (October 26) "a leakproof defense against improved U.S.-Soviet relations and against arms control." It worked well enough on this particular occasion, but how will it stand up over time? Will U.S. public opinion, will public opinion in the countries allied to the United States, continue to be satisfied that hanging onto SDI is more important than realization of the "historic breakthrough" toward arms limitation and, further down the road, genuine disarmament that Reykjavik showed to be a real possibility?

If so, Reagan and company will have achieved much more than a short-term tactical success; they will in fact have thrown up a permanent barrier to meaningful negotiations with the Soviet Union. And this in turn means that they will have acquired what they have long sought as their fondest goal, a free hand to intensify the arms race to the point (they hope) of forcing the Soviet Union to "cry uncle" and adapt not only its policies but its whole system to the imperatives of U.S. global hegemony.

If on the other hand U.S. and allied public opinion decides, after due consideration, that SDI is not worth a permanent arms race and the concomitant end of any hope of better relations between the superpowers, then the foreign policy of the Reagan administration -- and indeed that pursued with minor variations by all its post-Second World War predecessors -- will lose its essential political support and enter a period of profound crisis.

The Central Question

As we see it, we, the movement for peace, progress and survival of the human species, have a very important task of public education and persuasion to perform. This task can be divided into two quite distinct parts.

Negotiations

Most people favor, at least in principle, negotiations and agreements. But a great many, for complex historical reasons, are dubious about the value of such dealings with the Soviet Union. We have to convince them, not that the Soviet Union is trustworthy -- in fact all history teaches that there is no such thing as a trustworthy nation when it comes to matters it regards as being in its own interest -- but that it is in the interest of the Soviet Union, as it is of the United States, to reach and abide by agreements limiting and eventually reducing armaments both nuclear and conventional. We have to demonstrate that, at least as far as major powers are concerned, the days of profitable conquest by military means are over, and that the best -- and maybe the only -- way for any leadership in the Soviet Union to strengthen its position and enhance its legitimacy is to begin by reducing the heavy burden of the arms race.

Expense

No one knows what SDI would look like if it ever became a reality. But we already know some things it is bound to be, and some it cannot be. It is bound to be enormously expensive, with estimates, including almost impossible computer systems, running into the trillions of dollars in the next ten years or so. This is in addition to the already huge and growing cost of the existing military establishment, and it comes at a time when the federal budget deficit is out of control and threatening to throw the economy into a tailspin. Reagan understandably does not like to dwell on this aspect of SDI, but it is not going to go away and indeed seems certain to loom larger and larger as time passes.

This is something everyone can understand: if the country cannot handle its present military program, how can it take on an open-ended, multi-trillion-dollar, multi-year addition? The truth is, and we must hammer away at it, that it can't be done -- at least not within the framework of our existing democratic political institutions. In its simplest form the message is: the United States, just like the Soviet Union, cannot afford SDI. As to what SDI cannot be, the most important point is that it cannot be what Ronald Reagan says it is intended to be, an impenetrable shield against nuclear missiles.

Reliability of a Country's Adherence to an Agreement

Of the two parts of the educational task facing the peace movement, that dealing with the reliability of the Soviet Union as a partner in negotiating and adhering to arms-limitation agreements is probably the more difficult. With negligible exceptions, all the institutions of U.S. society have been working overtime for more than half a century now to convince the American public that the Soviet Union is an embodiment of evil fully comparable to Nazi Germany -- with which it was indeed impossible to reach agreements that could be relied on because

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Artificial Intelligence and Natural Language Systems —Part 2

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"As with all natural language systems, the more limited is the domain of discourse, the better is the translation from human words to computer concepts."

(Part 1 appeared in the March-April, 1987 issue of "Computers and People".)

Machine Translation

Work in machine translation from one natural language to another has revealed that the subtleties of human language do not easily yield to computerization. The word-for-word translation systems of twenty years ago just didn't work. Research in machine translation has made it increasingly clear that human language cognition is a very complex ability that requires many kinds of knowledge, including knowledge of the structure of sentences; the meaning of words; the patterns of conversation; the expectations, goals, and beliefs of the partner with whom you're conversing; and a great deal of knowledge about the particular topic of conversation.

Current implementations that most closely approach automatic translation may use syntactic and semantic information in order to translate words in context. Different systems require varying degrees of human assistance to edit machine-translated drafts or to assist in translating elements outside the bounds of the systems' abilities. In addition, systems described as "fully automatic" are, at this time, restricted to small domains. The speed of translation may be as slow as 600 words per hour for output that requires little editing or as fast as 60,000 words per hour for output that is likely to need considerable editing. Faster speeds are achieved in some systems by constraining the input to shorter sentences or by setting lower standards for the quality of the output. As with all natural-language systems, the more highly constrained the domain of discourse, the better the translation.

Some Actual Systems

The LOGOS system, from Logos Corporation, Waltham, Massachusetts, is designed for business use. LOGOS works in partnership with a human translator. Before LOGOS begins a translation, the system examines the document for words it doesn't know. The translator then provides the system with information about those words, expanding the general dictionary. After the dictionary is complete for the purposes of the particular translation, LOGOS generates a draft of the document, which the translator then edits. Customizing the dictionary with multiple definitions of words for various contexts does not make the system unable to accept new releases of the vendor's dictionary.

Weidner Communications Corporation, Northbrook, Illinois, sells semiautomatic systems. The vendor supplies a core dictionary of 15,000 words and idioms to which users add their own terms. The Weidner system is much like LOGOS except that the machine prompts the translator interactively for words it doesn't know and incrementally builds a dictionary.

The ALPS system from Automated Language Processing Systems, Inc., Provo, Utah, takes a slightly different tack in that the translation process operates in an interactive, rather than in a batch, mode. This system goes a bit further in that the interactive mode not only finds unknown words but also words with ambiguous meanings in context. In general, the ALPS dictionary is somewhat more sophisticated, accommodating word strings or phrases, such as idioms, as well as single words. Instead of one large dictionary, ALPS utilizes several reference dictionaries and, moreover, builds a separate dictionary for each document. The document dictionary can be fine-tuned for the document's specific context without affecting dictionary definitions that will be applied to documents written in other contexts.

Experimental systems are beginning to incorporate more semantic information in knowledge structures such as conceptual dependencies and scripts that provide the system with knowledge that helps to resolve ambiguities in interpretation. For instance, semantic elements are being included in EUROTRA, a system being developed under the support of the European Economic Community. This system, intended to perform machine translation among eight languages, is scheduled to be operational by the end of the decade.

Document Understanding

Researchers at Yale University, working under the direction of Professor Schank, have developed a number of document understanding systems. FRUMP, developed by Gerald DeJong (now associate professor of electrical and computer engineering, University of Illinois, Urbana), was an attempt to model how people skim newspaper stories. This system scans wire service stories and produces brief summaries of them in several languages. FRUMP utilizes "sketchy scripts," scripts that note only the most important aspects of a situation that conforms to a stereotype. A system called CYRUS, developed by Janet Kolodner (now associate professor of computer science, Georgia Institute of Technology) was designed to store information from FRUMP relating to the activities of former Secretary of State Cyrus Vance. The purpose of CYRUS was to model how people's memories are organized. The system cross-referenced information and was able to reorganize its memory structure to accommodate new information. CYRUS was aided in its task by the inclusion of a knowledge base about what secretaries of state do, about protocol, and other matters pertaining to Vance's activities

Retrieving Information Based on Concepts

CYRUS and FRUMP skim text, but BORIS is a story-understanding and question-answering system that involves many knowledge sources in an attempt to understand stories in as great a depth as possible. BORIS was developed by a team of researchers under the direction of Wendy G. Lehnert (now associate professor of computer science at the University of Massachusetts, Amherst) at Yale University. BORIS was an advance over modular systems. In BORIS, the various elements that process the input and aid understanding are integrated, not used one at a time. BORIS has four basic processing units that interact in order to understand a story in depth. A parser, called the conceptual analyzer, reads the English text and stores the information in conceptual dependency form. As the story is read in, the event assimilator examines the concepts stored up to that point in relationship to each other and to a previously stored fund of knowledge about the world. A question-and-answer module uses the conceptual analyzer to parse questions submitted to the system. The module then makes inferences based on memory contents, which the system expresses in conceptual dependency form. And finally, the English generator translates the conceptual dependency representation into English language output.

Document understanding systems such as those described above make it possible for computers to summarize text and generate responses based on content. They also make it possible for computers to store and retrieve information based on concepts, rather than just keywords.

Text Critiquing

One aspect of document generation, text critiquing, has been implemented in EPISTLE. EPISTLE was developed by researchers at the IBM Thomas J. Watson Research Center. The current implementation of the system provides business letter writing support (spelling, grammar, and style checking) for office workers. A natural language processing unit analyzes typed text by means of an online dictionary and a system that parses sentences according to rules that encode English grammar. The system flags errors by highlighting the problem text and indicating the type of error (spelling, grammar, or style) in a mode window. The user selects an error to work on by pointing to it with the cursor. The system proposes corrections in a fix window. The user may implement a suggested correction, ignore it, request additional information, or substitute a correction of his or her own.

Speech Understanding

Because we do not yet understand how human beings are able to make sense of the stream of sound that is spoken language, it is not surprising to find that this area of natural language communication is not yet in its maturity. Early techniques involved storing the sound patterns of a selection of words relevant to a problem domain and comparing the input signal with these patterns, attempting to make matches.

The Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense sponsored the Speech Understanding Research (SUR) project in the early 1970s in an effort to promote advances in this field. HEARSAY-II, a document retrieval application developed by Carnegie-Mellon University in response to the ARPA challenge, was able to understand a 1,011-word vocabulary of connected speech from one male speaker after the system was supplied with about 60 training sentences pronounced by the speaker. HEARSAY-II understood the speaker's utterances with from 9 to 26 percent error. HEARSAY-II is perhaps the best known of the SUR systems because of an innovative control structure that is not limited in applicability to speech-understanding: independent knowledge sources communicated with each other via a "blackboard" where results were shared and subproblems posed. This control structure had been used previously in HEARSAY-I, a speech-understanding system that played chess in response to voice commands.

Systems in use at the moment vary in several respects. Some are speaker-independent, while some recognize only a particular individual's speech. Some can recognize only isolated words, while others can pick a particular word out of a stream of connected speech, and some even understand connected speech within certain narrow limits. Systems also vary in the size of their vocabularies. Right now, there are speaker-dependent, isolated-word systems that can recognize about 1,000 words. For reliable recognition, that number falls to about 50 well-chosen words. A large vocabulary for a reliable connected-speech system would be 200 words, fewer still for a speaker-independent, connected-speech system.

Samples of a Person's Speech

To train a system to recognize words in a speaker-dependent format, you must provide it with samples of a person's speech. While there is some variation in the way one or more individuals pronounce consonants, there is huge variation in the pronunciation and diction speed for vowels. These factors require the training to include many varying samples.

Attempting to enable a system to understand connected, or continuous, speech adds difficulty to the problem. Syllables of adjacent words may blend or cause some sounds to be dropped. Since connected speech bears little resemblance to the stream of sound made if each word in the string is pronounced individually, it does not suffice to simply match patterns, word-for-word.

Difficulties for speech-understanding systems also arise with homonyms, words that sound the same and may or may not have the same spelling but have different meanings, such as "I heard the song," and "I saw a herd of buffalo." A closely related difficulty is presented by similar sounding phrases like "I scream" and "ice cream."

Connected speech is easier for a system to interpret when rules of conversation are provided to help predict which words can legally follow each other. Limiting the vocabulary to certain words within a domain also helps, reducing the processing time for pattern matching.

Research is now being done on providing systems with knowledge about the world that will help them predict what expressions might mean, based on context.

Speech Generation

Speech generation is the term for a machine reading text aloud. The speech is the audible production of the output of a system, whose text has already been determined, in correctly pronounced speech. This part of the natural language problem has been solved with the arrival of commercially available speech-generation devices.

Digital Equipment Corporation has developed DECtalk, a product that converts alphanumeric text into human-quality speech. DECtalk uses logical rules to evaluate the context and punctuation of the phrase to be spoken and converts it to conversational English. It works by reviewing the whole input phrase to examine sentence structure, grammar, and context. DECtalk compares the incoming words to a dictionary of more than 5,000 exceptions, contractions, and abbreviations. If a match is found, the pronunciation is simply pulled from the list. If the word is not found in the main dictionary, DECtalk then searches through a second, smaller, user-defined dictionary that contains industry-specific words and abbreviations used in the particular subject area. Pronunciation for words not included in DECtalk's dictionaries is achieved by applying a set of 500 letter-to-sound rules.

A truly sophisticated speech generating system must pronounce phrases the way a human reader would. As an example, a simple device would read $125.75 as "dollars one two five point seven five." But state-of-the-art systems read it as it should be read: "one hundred twenty-five dollars and seventy-

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Computer-Human Interaction and the Documentation Puzzle

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"The software package sells for $600, and then I have to pay $10,000 for a consultant to show me how to run it. But, for $600, I ought to be able to understand it." — *an unhappy user*

Complexity

Because of the complexity of computer hardware, the greater complexity of computer programs, and the overwhelming complexity of human computer users, the interface of these three is an area fraught with problems. The supposed purpose of program documentation (user manuals and the like) is to reduce these problems to a manageable level.

Sometimes it works.

When it does not, the effect on the end users, the effect on the attitudes with which they approach the program, is disastrous. Their attitude changes from one of hopeful anticipation to one of disillusionment, discouragement, and demoralization. A barrier of complexity now stands between them and their goal, the efficient use of a new computer program. They are now frustrated and angry.

And quite predictably it is the documentation which receives the blame for the program's not working, not the computer users themselves. Social attribution theory is quite clear about this. When something goes wrong, human beings are not prone to attribute much responsibility to themselves for its going wrong. Rather, they scan the situation in which they find themselves and try to discover something upon which to fix the blame. The program and its documentation comprise the situation in which the angry user finds himself, and it is these which become the targets.

The Documentation of a Program

This is certainly not to imply that the documentation is, in fact, blameless, the innocent victim of human defense mechanisms. Rather, as V. Douglas Hines of the U.S. House of Representatives House Information Systems, speaking at the National Bureau of Standards Software Documentation Workshop, stated, "all software [documentation] should be clearly written, easy to use, accurate and complete. As most of us are painfully aware, much of it isn't."

Perhaps the most devastating of all documentation deficiencies upon end-user attitudes is not so much when the information is unclear, difficult to use, or incomplete, as when it is inaccurate -- wrong. When the documentation is actually wrong the effect is disastrous. It destroys any confidence the users might have had in it. Their attitude becomes one of cynicism: "Why should I spend my time wading through this? What else is wrong? How am I supposed to know what is right and what is wrong?"

Their first impulse is to return the package and demand their money back.

The Service of Support

One solution to the documentation dilemma is the support service supplied by the vendor. If this were always friendly, efficient, knowledgeable, and readily available, support services would be a pleasant solution indeed. Unfortunately, many users have had the experience of one financial vice president who complained, "My office manager called the support service. 'There is no one available right now,' she was told. An hour later I called back myself, and I got the same message.

"I got angry at them. 'Look,' I said, 'we have a payroll to get out by 5:30 tonight! I'm thinking about sending this package back to you.' I was put on hold, and only then, after I threatened them, did the guy come on."

This was not a pleasant solution.

A second possible solution to the documentation dilemma is the use of a computer consultant to assist novice users in implementing their program. A warm, sympathetic human being sitting at one's elbow who not only will lead one through the difficulties of traversing unknown territories but who will also calm and comfort one as he traverses them is certainly an attractive solution.

The drawback of computer consultants is their cost. This was the major objection of a user who stated, "The software package sells for $600, and then I have to pay $10,000 for a consultant to show me how to run it! But for $600 I ought to be able to understand it."

"Help" Messages

Help screens are not a great deal better than the printed documentation in reducing end-user difficulties, especially help screens which offer cryptic messages such as "pointer fault," "wild interrupt" and "fatal error." By definition, a help screen ought to help, and only by communicating messages in the language of the end-user, not the programmer, can they do that. Occasionally, to exacerbate the situation, these cryptic error messages are nowhere to be found in the printed documentation, or, if they are in the documentation, they are in places that the end users would not think of looking for them. They certainly do not appear in the index in any understandable form, for example. What this does is to add to the user's attitude of angry frustration.

Programmer Language vs. User Language

Why is it that the documentation for software programs does not do what it is supposed to do -- inform, lead, direct and instruct? The problem lies in the historical foundations of documentation. Historically, documentation was written by programmers for other programmers telling what their software did, how it did it, and why it did it that way.

The problem with current end-user documentation is that the programmers are still either the people writing out the documentation for their programs or they are largely in charge of the written documentation. They develop the programs, they develop the end-user instructions, and they see that their instructions are put into written form. They wear too many hats.

Note, incidentally, that the term "documentation" as used in the present context refers to the application information found in user manuals as well as the keyboard templates, troubleshooting guides, quick-reference cards, tutorials and help screens directed to the program user. Documentation is that entire class of information by which programmers attempt to communicate with non-technical software users. On the other hand, the process by which programmers communicate with other programmers about their software is perhaps more correctly termed "leaving tracks," and the individual who follows these tracks is said to be "tracking."

Programmers Know Too Much, Users Too Little

But returning to the concept of programmers wearing too many hats, why should the fact that they write the documentation cause any problem? The main reason is that programmers simply know too much about computers and about programs. When they write the documentation for their package, they fall into the trap that awaits everyone who tries to communicate information about his field to lay people who are naive to his field: he assumes his audience knows more than it does. He skips steps which to him are minor common-sense items but to his audience make his message almost useless. Subtle errors creep in, errors which he himself would correct almost automatically but which leave the naive user in a quandary. He operates at too high a level.

But then, programmers should not be the ones to write the documentation for consumption by the end user. It is somehow unreasonable to expect one single individual to educate and train himself in more than one field in only one lifetime. Perhaps it is because of this that, as Jan Yetsingmeir writing in the "Sigchi Bulletin" states, "Documentation is considered a necessary evil among interactive software designers. Although they recognize the necessity of good documentation, they prefer not to do it. They prefer to focus on the more technical aspects of the program." In the light of their training and background, this is entirely understandable.

The Documentation Puzzle

The documentation dilemma is, therefore, a two-part problem. First, computer programmers who are writing the documentation are simply too sophisticated in their field to communicate effectively with relatively naive end users. Secondly, little of their training and background has prepared them for the extensive written communications which are required for the preparation of end-user instructions.

If one part of the documentation problem is that programmers are overly sophisticated in the area of computers, then one part of the solution is to enlist the help of individuals who are not sophisticated in the area of computers. An ideal group of such naive individuals is those people who will eventually be using the program which is being developed. A sample of such potential users would be a valuable asset in writing the documentation not only because of their naivete relative to the programmers but also because of their interest in the end product. Two-way communications should be established between the programmers and this sample before the documentation is started, and this communication should continue throughout all stages of the design.

Larry Tesler also writing in the "Sigchi Bulletin" talks about getting a "reality check" during the formative stages of his developmental effort by interviewing potential users at their workplace. He seeks out novices who are prospective end users of his system. For example, if he is testing out an accounting package, he tries to find accounting clerks who have very little experience with this kind of program. Such potential users should be provided with prototype software as well as the preliminary drafts of the supporting documentation, and they should use these to perform actual work on their jobs.

Prototype Testing

When this form of prototype testing uncovers unanticipated problems, the documentation can be rewritten to correct the problem, and this revised version can then be retested. This sequence should be iterated as many times as is necessary until the documentation becomes, in fact rather than just in name, user friendly.

This is close to what Marilyn Mehlmann terms "consensus democracy" in her book "When People Use Computers." Interestingly, Ms. Mehlmann states that an objection to consensus democracy is "our users aren't clever enough -- they lack the necessary level of education." This limitation is obviously an advantage when writing documentation. It does not mean that these end users are somehow educationally deprived, but rather that they lack computer sophistication, a distinct plus when writing documentation.

For, as the programmers' expertise puts them at a disadvantage when communicating with the lay public, it is the potential end-users' naivete which works to their advantage when communicating with other naive users. Because of their lack of sophistication, they require that the most mundane of operations be presented in redundant language. As they ask for this information, they should carefully note the information they have required. It is these notes that will eventually become the documentation on which they are working. This product will allow the most naive future program user to run the program with no other assistance than the printed pages in the ring binder. Once the documentation has achieved this level of clarification, it is communicating at the level it should be at when communicating with naive end users.

Question and Answer Format

The ideal solution would mimic a method utilized by some social psychologists when they are performing laboratory experiments in communications. No oral interactions are allowed; instead all verbal interchanges are by written notes. In this way, a complete and accurate record of all queries from the potential end users and the replies from the software designers would be produced. It would be these written communications that would form the backbone of the future documentation. What better way to ensure that what is written is both understandable and applicable?

And what better presentation than a question-and-answer format?

But computer end users -- accountants, managers, and the like -- usually have little more training in writing materials for publication than the programmers whom they are helping to construct the documentation. Because of this there should be a second step in constructing the end product before it is sent to the printer. This second step is to ensure that the package is, in fact, written in the language that it is supposed to be written: in this country, English.

English and Journalism Majors

And there is perhaps no one more proficient by way of training and education in the production of lucid English syntax than the

English and journalism majors graduating from the local college or university and who may consider a career as a technical writer. It is they who can most easily convert perhaps the most convoluted instructions into clear, logical, readable and understandable procedures.

More importantly, English and journalism majors are familiar with constructing the indexes without which any reference material, not only program documentation, loses much of its usefulness. The indexes which accompany much of the documentation published today are abysmally lacking, unfortunately. They are lacking in logical organization, they are lacking in cross references, and they are lacking in completeness. Fortunately English and journalism majors can correct this problem as well.

The solution to the documentation puzzle, therefore, is the use of several individuals each of whom, so to speak, is wearing a separate hat. First, a sample of people who will be similar to the final users of the program, and, secondly, another individual or individuals who are facile in the English language. In this manner, each person's education and training can be utilized to complement each other person's unique background.

A horrendous task? No, an enjoyable task, because the programmer, with the help of both some potential end users as well as the English or journalism graduate, is making his product more useful to other people. He is making other people a bit more comfortable in doing their job, and perhaps a bit happier. Is this not, in fact, what life is all about?

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Fischler – *Continued from page 12*

- Is intelligent behavior in some way a property of organic structure, and thus not achievable by nonorganic machinery?

Gathering Blackberries

To illustrate how far we still have to go to achieve a human level of performance, consider how much information would have to be stored in a machine to answer random questions of the following type:

If a young man of 20 can gather 10 pounds of blackberries in one day, and a young woman of 18 can gather 9, how many will they gather if they go out in the woods together?

Based on Chapter 1, *Intelligence*, of *Intelligence: The Eye, the Brain, and the Computer* by M.A. Fischler and O. Firschein, published by and copyright 1987 by Addison-Wesley Publishing Co., Reading, MA 01867. Reprinted with permission.

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Scown – *Continued from page 18*

five cents." Conventional speech systems have pronunciations that are preset at the factory. But the incorporation of AI technologies allows for a flexible user interface in which the end user can specify details. An important feature is a choice of many natural-quality speaking voices with variable speaking rates and intonations, a choice between male and female voices, and other special effects.

This article is based on an interesting and important excerpt from Chapter 2 of *The Artificial Intelligence Experience: An Introduction*, by Susan J. Scown, copyright 1985 by and published by Digital Equipment Corporation, Maynard, MA 01754. Reprinted with permission.

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New, Increasing Surveillance Technology

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"New surveillance technologies are increasingly breaking down the barriers between the private and public parts of your life."

Surveillance technologies are rapidly proliferating nowadays in the United States. French writer Alexis de Tocqueville once made some observations after visiting the United States:

> Everywhere the state acquires more and more direct control over the humblest members of the community and a more exclusive power of governing each of them in the smallest concerns. This gradual weakening of the individual in relation to society at large may be traced to a thousand things.

De Tocqueville wrote those words in 1835, so it's unlikely that computers, miniature tape recorders, polygraphs, and urine tests were among his "thousand things". But in 1987, these are only the most visible of the new surveillance technologies that are increasingly breaking down the barriers between the private and public parts of your life.

The Maximum Security Society

Modern society is increasingly absorbing the value system of the "Panopticon" or "Inspection House" -- the maximum security prison envisioned by 18th-century English philosopher Jeremy Bentham. In the Panopticon, no place is too remote or obscure to escape observation by authorities. There are five components of the "Maximum Security Society":

1. The Dossier Society, in which computerized records are more important than face-to-face encounters.

2. The Actuarial/Predictive Society, in which decisions are made based on the individual's membership in a group. This may be efficient but it harms the values of social justice and equity.

3. The Engineered Society, which limits choices. Consider the design of airports, which "channel you through," and the use of questionnaires where one must pick from a fixed set of choices.

4. The Self-Monitored Society, in which the individual must participate in his or her own surveillance. An example is the library book alarm system which goes off at the exit if you haven't checked out one of the books you are carrying.

5. The Transparent or Porous Society, which breaks down traditional privacy barriers.

The New Surveillance Technologies

A multitude of new technologies facilitate the creation of the Maximum Security Society. While some of the new surveillance technologies involve computers, many do not:

- Telephone lines, especially 800 numbers, allow persons to inform authorities, often anonymously, of illegal activities. There are phone lines for reporting drug pushers, poachers, and even cars that illegally use lanes reserved for carpoolers.

- Small video cameras need only pinhole lenses, and can be hidden inside mannequins, picture frames, ceiling globes, and other unobtrusive places.

- Mini-AWACS planes can spot a person or car from 30,000 feet up. These were used by the CIA in the 1960s to look at anti-war demonstrations.

- Satellites act as "telescopes aimed at earth."

- Light amplifiers allow one to take night pictures as if it were broad daylight. These devices use starlight, moonlight, and faraway street lights.

- Lasers and parabolic microphones can be aimed at a window to pick up sounds.

- Voice-activated tape recorders. A box the size of a refrigerator can tape 40 phone calls. It's no longer necessary to station somebody all day by a telephone tap, since the tape recorder only records when someone is actually talking on the line.

- Phone conversations transmitted by microwave relays, and cellular phone conversations, can be undetectably intercepted.

- Card-key entry systems allow an employer to track the locations of employees.

- Electronic "leashes," first used to study animals, can now be used to locate children lost in a shopping mall. More seriously, they are now used to monitor the movements of convicted criminals, by setting off an alarm whenever the criminal moves beyond a permitted area; these alarms enforce an electronic "house arrest." This could be a humane alternative to prison overcrowding -- but it could also be used to increase the number of citizens who are subjected to sanctions by the criminal justice system. And a professor at the University of Georgia has actually advocated a form of electronic leash that automatically administers electric shocks if the wearer leaves the permitted area!

- A device called the "Trip-Master," the size of a paperback book, can measure a truck driver's acceleration, shifting, and other actions involved in driving.

- A variety of "personal truth technologies" are becoming popular. These measure biological signs to detect drug use or lying. Some of these measure the contents of urine, saliva, and even hair. Others measure pulse rates, eye movements, and voice stress. There is now a passive form of the breathalyzer which works by suction: you don't have to actively breathe into it. This collection of techniques is a new form of "trial by ordeal." Many of these are worthless, but they're being sold.

- Employee monitoring systems can measure the number of keystrokes at a computer terminal, the pattern of use of a cash register, the length of an employee's break, and so on. A vice president in the credit department of Bank of America says, "I measure everything that moves."

Databases and Matching

The proliferation of databases is especially worrisome. There is a completely unregulated "data scavenging" industry that collects and sells public records such as drivers' licenses, property transfers, court records, and the like. Whenever a court serves an eviction notice, this goes into a database that landlords use to keep track of "problem tenants." Medical practitioners keep a database of patients that sue doctors. Lawyers, in turn, keep a database of doctors who have been sued.

A dazzling variety of mailing lists is available for purchase, covering such groups as bank-card holders, gay business owners, buyers of conch soup, contributors to anti-nuclear causes, and subscribers to a "Sex over 40" newsletter. In one notable case, the Selective Service purchased the list of children who had registered for an ice cream company's birthday club.

By combining such data as telephone calls and bank transactions, government and private organizations can map out a person's private behavior.

Distinguishing Features of the "New Surveillance"

Eleven features distinguish the new surveillance technologies from traditional techniques:

1. They transcend distance, darkness, and physical barriers. As an example, a heat sensor can determine which parked car on a street was recently driven. Such technologies eliminate "inefficiencies" that civil liberties may depend on.

2. They transcend time by "freeze-drying" information that eventually becomes outdated.

3. They make data increasingly interchangeable and combinable. Data can end up in places far away from its original source.

4. They are not easily seen, either because they have been miniaturized or because they operate from a long distance away. Not so long ago, a telephone tap created a noticeable drop in current across a telephone line. Now, however, one can listen to a phone conversation over a microwave link.

5. They are involuntary. You get put into many databases without your consent or knowledge.

6. They try to prevent an unwanted action -- and often can spend lots of money trying to prevent something that isn't likely to happen.

7. They are capital- rather than labor-intensive.

8. They place everyone in a category under suspicion. They do not discriminate, leading to an attitude that "everyone is a suspect" who is presumed guilty until proven innocent.

9. They are self-activated and automatic, often relying on people to report themselves either to obtain a benefit or to avoid a penalty.

10. They are more intensive, probing beneath the surface. They hear whispers, see through walls, and even attempt to see into the psyche.

11. They are more extensive, covering a larger area, and creating a sense of uncertainty about whether surveillance is present or not.

Not a Return to the Small Town

It is possible to fool ourselves by thinking that the proliferation of the new surveillance technologies is a return to the small town, where we all knew lots of private things about each other. But there is a big difference. When you live in a small town, you know as much about your neighbors, friends, and family as they know about you. In the modern surveillance society, you don't know who knows what about you.

Based on a report in the *CPSR/Boston Newsletter*, March, 1987, from CPSR/Boston, P.O. Box 962, Cambridge, MA 02142, (617)666-2777.

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Newsletter – *Continued from page 27*

Ford said more than 2,000 of its design engineers, manufacturing engineers and designers around the world have been trained in the use of the Design for Assembly program. The system has been in use in North America for two years and in Europe for about 18 months. It was introduced in Australia last year and is being translated into Spanish for Ford operations in South America and Mexico.

Ford is the biggest backer of the University of Rhode Island design program, according to Peter Dewhurst. Dewhurst and Geoffrey Boothroyd, both of the university's Industrial and Manufacturing Engineering Department, head the programs.

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Sweezy – *Continued from page 15*

they would be in the interest of both parties. Hitler still believed in the possibility of world conquest and never had more than a strictly temporary interest in mutually beneficial deals.

In reality the Soviet Union was never like that, and its ideology is totally opposed to any notion of conquest. There is ample evidence in the historical record -- the only kind of evidence that counts in such matters -- to support this view of the Soviet Union, but the American people for the most part are ignorant of it; and, given the nature of our mass media and educational system, it will certainly not be an easy task to convince them that the Russians are as interested in mutually beneficial agreements as they themselves are.

The Costs of the Strategic Defense Initiative

SDI, however, is another issue. Skepticism of its feasibility is widespread even among conservative Republican and Democratic politicians; the weight of scientific opinion is against it; those who strongly favor it are mostly motivated by greed or other opportunistic considerations. As the true costs and dubious prospects of the enterprise become more evident, support for it will probably weaken even without any special effort by the peace movement.

But with such a special effort, directed at the rank and file of politically concerned citizens, it should be quite possible to speed the process up. The discrediting of SDI in turn will tend to deprive the Reaganites (and their successors in years to come) of their power of veto over meaningful negotiations with the Soviet Union. And if and when these negotiations begin to yield concrete results, the people may at long last begin to conclude from actual experience that you can "do business with the Russians" and that both countries have the same interest in living together in a peaceful world.

Based on a report in the *Monthly Review* Dec., 1986, Slightly condensed.

Computing and Data Processing Newsletter

COMMON APPLICATIONS ENVIRONMENT WITH NO FRONTIERS

From "British Business"
Milbank Tower, Floor 11
Milbank, London, England SW1P 4QU

Eleven major computer manufacturers (including ICL) met in Luxembourg at the end of February, 1987, at the Jean Monnet building of the European Commission (X/Open), to view a show of transferring computer application programs to many other systems as a practical reality.

The group has worked for almost two years to produce a set of standards which enables users to 'mix and match' computer systems and applications from several suppliers. The commission was acting as host for the day.

The group's aim is to create a free and open market where software writers need to produce only one version of their programs, portable at the source code level onto many vendors' machines, and where users' software investment is protected.

At the heart of the group's agreement is the X/Open 'portability guide', which contains an evolving portfolio of practical standards for applications portability.

For the user this brings a growing portfolio of applications; freedom of choice of both the hardware and software and greater security of software investments.

For the software industry it means considerable savings in the development of a new product -- and access to a vastly increased market for software applications.

Using X/Open's common applications environment (CAE), software can be moved easily from one computer system to another at a much lower cost than usual.

This is feasible because the CAE standardizes a series of interfaces between the application software packages and the operating system. Once an application program has been developed on one system, it is usual to transfer it to as many other systems as possible.

If a new system is at all different from the first, transferring the application to that system requires the differences to be located and appropriate changes made. Such differences might typically occur in compiler input syntax, library functions and subroutine names, or in the behavior of system calls.

Adapting source code for such deviations can take many months of effort and lead to a number of different versions of the source which must be separately maintained and updated -- a costly operation.

Within the CAE, tape and floppy disc formats, command names, language syntax, system calls, library routines and all other interfaces specified behave in an identical fashion on any system.

Porting an application from one X/Open system to another requires three simple steps:

- Copying the source to the target system
- Compilation into the machine's machine code
- Testing the application software

X/Open has demonstrated that the entire process can now be completed in only a few hours.

As all systems conform to the same definition, no changes are required to the source code, and only one version of it has to be maintained.

This represents a major saving for those involved in porting application software, both in terms of the time taken to perform the port and in terms of the savings in maintenance.

At the Luxembourg demonstration, the same commands were given to 10 machines, with a different output, but with the same end result.

Having successfully proved that an application could be completely portable across 10 machines in the space of an hour-and-a-half, X/OPEN chairman Geoff Morris (business development manager at ICL) could fairly justifiably say: 'the commission is in the business of breaking down trade and political barriers -- we are in the business of breaking down computer barriers'.

The day's events might most appropriately be summed up in another quote from him: 'Computers without frontiers will help create a European Community without frontiers.'

AUTOMOBILE PRODUCTION, USING COMPUTERIZED ASSEMBLY, REDESIGN AND MANUFACTURE

Based on a report in "Automotive News"
1400 Woodbridge Ave.
Detroit, MI 48207

A computer program written by two University of Rhode Island professors is helping Ford Motor Co. cut assembly costs, shorten design time and improve quality and serviceability of its automotive components.

The Design for Assembly program has worked so well at Ford during the past two years that the company recently gave the University of Rhode Island Research Foundation $220,000. The money will be used to fund the first stage of a three-year project to expand its data base beyond assembly into manufacturing.

Ford will provide additional funding -- up to $660,000 -- if the research proceeds as planned.

The original Design for Assembly computer program helps engineers more easily create components that can be put together in the shortest period of time and for the lowest cost.

The program has allowed Ford to eliminate up to 30 percent of the parts in an assembly, according to Sandy Munro, Ford's corporate coordinator for the program.

Fewer parts mean easier assembly, which cuts labor costs and boosts quality, Munro said. It also reduces the material costs needed to produce a part.

"If you save five cents in assembly costs in using the program to redesign a part, you might save 10 cents in material costs," Munro said.

The program also is reducing design time, though Munro would not reveal the amount saved. Automakers see a reduction in design time -- from five to three years on a complete vehicle program -- as critical if they are to compete effectively in the future.

The Design for Manufacturing program now being developed at the University of Rhode Island will do the same for other manufacturing procedures as the original program did for assembly.

The new data will allow Ford to design a component so that it uses the most cost-effective material and machining and manufacturing methods, while greatly reducing the evaluation time.

With the Design for Assembly program, Ford is able to analyze in one day the cost in assembly of a component made up of 30 pieces. The process normally takes weeks.

The program aids the engineers in determining design changes needed to adapt a manually assembled component for fixed automation or robot assembly.

"We've used it to design everything from bits of clocks to airplane parts," said Munro. "So far we haven't found anything we can't thrift parts out of."

The automaker was able to cut 65 percent of the assembly cost and 36 percent of the overall parts costs in restyling a windshield wiper.

According to one published report, the windshield wiper redesign, expected to be adapted across Ford's entire model line, will save the automaker $2.4 million a year.

The simplified design had additional bonus effects. The effort cut the part's weight substantially and doubled its projected life.

"We didn't look at this program initially as a quality-related thing," Munro said. "But it certainly has worked out. Serviceability also has improved tremendously."

Originally, Ford used the program not as a cost-cutting procedure but in order to design parts that could be produced using assembly automation. But as designs became more simplified to accommodate automation, Ford began to realize the high-tech processes were not needed.

"As you reduce the variables (of assembly), you don't need as much automation," Munro said.

The reduction in parts required in a component assembly limits the amount of inventory Ford has to carry -- an additional cost savings.

(please turn to page 25)

Opportunities for Information Systems

– Instalment 9

THE PROMOTION OF SCIENTIFIC BEHAVIOR

Edmund C. Berkeley, Editor

Why is scientific behavior something that should be promoted? and how can information systems (computer systems) provide an opportunity for such promotion?

Scientific behavior (unlike many other kinds of human behavior) shows itself when people understand a trouble and take action that lessens or eliminates the trouble. For example, there is no sense in crying over spilt milk. But there is much sense in decreasing the hazard of spilling more milk.

In countless familiar situations, it is easy for anyone to see what is scientific behavior: a way of proceeding which is sensible and produces less trouble. But in many unfamiliar situations, it is not easy to see what is more sensible behavior. And in a still larger number of situations, what used to be sensible behavior is no longer sensible. Take for example a common human need, the gathering of firewood for cooking. In many arid regions, the supply of firewood used to be adequate. But with the increase of people in the world, from 5 billion (actual) in 1987 to 10 billion (predicted) 40 years from now, the supply of firewood will become almost zero. What will people do? Will they behave sensibly? or violently? or starve?

The exhaustion of firewood is a single one of many problems which face a human population that is doubling every 40 years. If the 10 billion people in 2027 again double to 20 billion people in 2067, do we reach "standing room only" for the planet Earth? Will people behave sensibly? or violently? or starve?

There is a big opportunity for information systems which are needed from these examples and conditions. The demand is for instructional systems which will explain, illustrate, teach, and promote wise action in a great many kinds of situations. These situations can be represented and studied in scenarios that imitate a portion of reality. We choose probabilities of population, distribution, conflict, death, survival, reproduction, etc. We run many sample scenarios for "a thousand years" (a few minutes on a fast computer). We see what happens. We vary the probabilities and proportions. We study, experiment, test, control, and manage scientific behavior. And thus we teach ourselves to become wiser, by calculating what some policies are likely to accomplish, and other policies will inevitably destroy.

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Games and Puzzles for Nimble Minds and Computers

Neil Macdonald
Assistant Editor

NUMBLE

A "numble" is an arithmetical problem in which: digits have been replaced by capital letters; and there are two messages, one which can be read right away, and a second one in the digit cipher. The problem is to solve for the digits. Each capital letter in the arithmetical problem stands for just one digit 0 to 9. A digit may be represented by more than one letter. The second message, expressed in numerical digits, is to be translated using the same key, and possibly puns or other simple tricks.

NUMBLE 8705

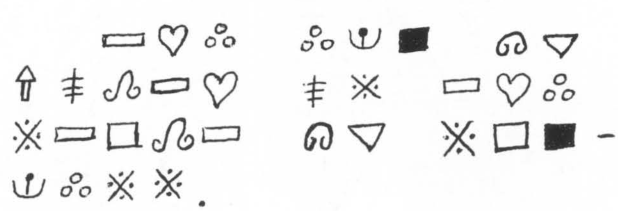
```
          E V E N
    *       T H E
    -------------
        H T T G K
      M S V G M
    I M N H E
    -------------
  = I V G E V M K
```

22570 91679 57

MAXIMDIDGE

In this kind of puzzle, a maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the 10 decimal digits or equivalent signs, plus a few more signs. The spaces between words are kept. Puns or other simple tricks (like KS for X) may be used.

MAXIMDIDGE 8705



SOLUTIONS

MAXIMDIDGE 8703: He who never begins never ends.
NUMBLE 8703: The hedge has no eyes but it has ears.

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