computers and people

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HELLO SUNFLOWERS by Mutsuko Sasaki

Computing and Data Processing Newsletter

COMPUTER HELPS ARCHEOLOGISTS UNEARTH PREHISTORIC COMMUNITIES

Patricia A. Conway
Control Data Corp., P.O. Box O
Minneapolis, MN 55440

Computer technology has joined the pick, shovel, and drill to help Northwestern University archeologists at the largest excavation site in North America, the Koster site in southern Illinois. Archeologists working at the site rely on a computer 300 miles away at Northwestern University to keep track of their findings and even determine where to begin the next excavation.

In addition to information unearthed at the Koster site, pertinent data recovered from some 800 different archeological sites in the 2,800 square mile research area is entered through a terminal at the project's headquarters in Kampsville, Illinois, for relay to the computer. At Northwestern's Vogelback Computing Center, the computer uses a university-developed data base program known as RIQS (Remote Information Query System) that is especially designed to handle the varied data of individual researchers.

Professor Benjamin Mittman, director of Northwestern's computing center, who was highly involved in the development of RIQS, said the half-million items of information generated annually at the excavation sites would have considerable less value without a computerized storage and retrieval system. RIQS not only catalogs the archeological data, but monitors the quality of it to safeguard against duplication, performs required analyses, and provides printer or plotted output.

From information entered on terminals at the excavation headquarters, the computer has built a file for each of the 800 sites. Each file is structured to hold 145 items of information about the site and excavation results. Site description includes name, location and size of excavation, names of the archeologists involved, where the artifacts from the site are stored, and which have been photographed.

The survey information sent to the computer relates to soil conditions, evidence of cobbles and limestone (indicating cooking, pottery, and tool making), and of animal bone (indicating favorable preservation at the site). Of the 145 slots of information storage for each site, 123 are for listing the artifacts uncovered — the data most important to archeological analyses.

To retrieve information from the file, either by site or classes of information, a user merely enters the assigned catalog number. For example, a student interested in studying Early Archaic projectile points enters the catalog number assigned to that class of information. Then he is immediately presented with a list of the sites where such projectile points have been uncovered. Then, by entering the names of those sites, he learns more about the projectiles, where they are stored, and the archeologists involved in their excavation. More important still, researchers can utilize the system without being sophisticated programmers.

Although Northwestern has been actively engaged in archeological research for the past fifteen years, it was only in the last three years that the computer was equipped with the RIQS system of data storage and retrieval. As the computer hardware and software continue to be essential tools in the project, Mittman predicts more rapid and accurate analyses of data and, more important, increased availability and access to researchers, students, and faculty.

The computer used is a Control Data 6400.

COMPUTERIZED DATA BANK BEING DEVELOPED FOR RESULTS OF LABORATORY ANIMAL RESEARCH

Les Hinshaw
Battelle Columbus Laboratories
505 King Avenue
Columbus, OH 43201

Development is under way on a computerized data bank, to be known as the Laboratory Animal Data Bank (LADB), aimed at making research using laboratory animals more effective.

Baseline data from control animals used in laboratory research will be entered into the data bank and made accessible from computer terminals around the country. The LADB will allow researchers, breeders, and others using laboratory animals to retrieve and analyze research data and textual information.

The LADB will contain extensive information on hundreds of thousands of laboratory animals. Included will be data on physical characteristics and experimental measurements, as well as such biomedical data as hematology, urinalysis, pathology, environment, and behavior. Data on control animals will be gathered from selected laboratories throughout the U.S.

In developing and maintaining the data bank, it will be necessry for biomedical scientists and information-systems specialists to cooperate closely. For example, biomedical researchers will gather experimental information and provide it to the computer specialists designing the system. Another important consideration will be to keep the system open ended so that in the future additional categories of baseline data can be collected for the data bank.

Because LABD users generally will not be computer specialists, the data bank will be programmed in such a way that those who are not familiar with computers will still be able to query the data bank with ease. If a user wants to search, retrieve, analyze, and display or print certain data, a simple set of procedures will be available for assistance.

The system is being devised by Battelle's Columbus Laboratories in a three-year study for the National Library of Medicine (NLM) and is being funded by the National Cancer Institute, the Public Health Service, and the NLM.

COMPUTER ASSISTS STUDENTS IN LEARNING THE LANGUAGE OF THE DEAF

Richard L. Mercer
Golden West College
15744 Golden West Street
Huntington Beach, CA 92647

A student at Golden West College, Huntington Beach, California, sits at a typewriter-like computer terminal and learns another language. But unlike others, this student will never pronounce a word of the language he is studying. The student is deaf, and the language he is learning from Golden West's computer-assisted instructional program is the universal sign language of the deaf.

Golden West College, with a total enrollment of about 20,000 full and part time students, has developed an extensive instructional program for the deaf and those with impaired hearing. Many of the faculty members in this program are deaf and lecture in sign language. A leader in the use of computers as a learning aid, Golden West College has recently developed a computer-based instructional program that enables students to learn the language for the deaf and test themselves as they learn.

"Mastery of sign language requires an understanding of its elements of style. Like spoken languages, sign language is constantly changing," said Richard L. Mercer, supervisor of computer services at Golden West College. "The language has dialects and colloquialisms, and new phrases constantly are added, as happens with spoken languages."

Although many students are familiar with sign language on entering Golden West College, theirs is a regional vocabulary. They find the program at Golden West helpful because it teaches the universal sign language — one that is understood and used over a wide geographic area. Many students with normal hearing also study the universal sign language, just as they would study any foreign language, because it helps them to improve their communications skills.

Seated at a computer terminal, the student types a word he wishes to learn. The computer activates a microfiche file — a storage device containing tiny microfilmed pictures — and a drawing flashes on a screen showing a person "speaking" the word. Arrows show the motion of the hands in expressing that particular word.

To reinforce their learning, students instruct the computer to administer a test. Sign language symbols are then flashed on the screen and the computer terminal prints several words in English, one of which corresponds to the symbol being shown. The student types the word he thinks is the appropriate answer. If the student selects the correct word, the computer moves to the next question. If the student answers incorrectly, he gets one more try. If he misses then, the computer prints the correct answer and moves on to a new question.

"The learning process is self-paced, because the student in effect controls the computer through the keyboard," Mr. Mercer said. "The student can spend as much or as little time as he needs in order to learn the sign language vocabulary.

"The computer is not a substitute for the instructor," Mr. Mercer said. "Rather, the computer handles repetitive drill work at a pace that's best for each individual student and thereby frees the teacher for more creative instructional tasks."

The Golden West computer is an IBM System/370 Model 155.

COMPUTER COST MODEL WILL HELP FEDERAL AGENCIES IMPLEMENT THE PRIVACY ACT OF 1974

Carol Sussman
National Bureau of Standards
Washington, DC 20234

A computerized model has been developed to help federal agencies implement the Privacy Act of 1974. The model, introduced at the Privacy Model Workshop for Federal Agencies held at the National Bureau of Standards (NBS) in October 1975, is a tool for examining the cost of various technical and procedural alternatives for given systems of computerized records.

By using the privacy model, proposed privacy safeguards can be examined for their cost impact before installation. Cost-effective alternatives can then be selected as necessary. Similarly, the privacy model can identify cost savings resulting from the reduction or elimination of data collections.

The Privacy Act of 1974, which became effective September 27, 1975, imposes numerous requirements on federal agencies to prevent the misuse or compromise of data concerning individuals. Agencies which process personal data must provide a reasonable degree of protection against unauthorized disclosure, destruction, or modification of the data, whether intentionally caused or resulting from accident or carelessness. Significant cost savings will result from actions to eliminate or reduce existing files. In simplest terms, information not collected about an individual cannot be misused.

(please turn to page 27)

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

Advertising Contact — **The Publisher**
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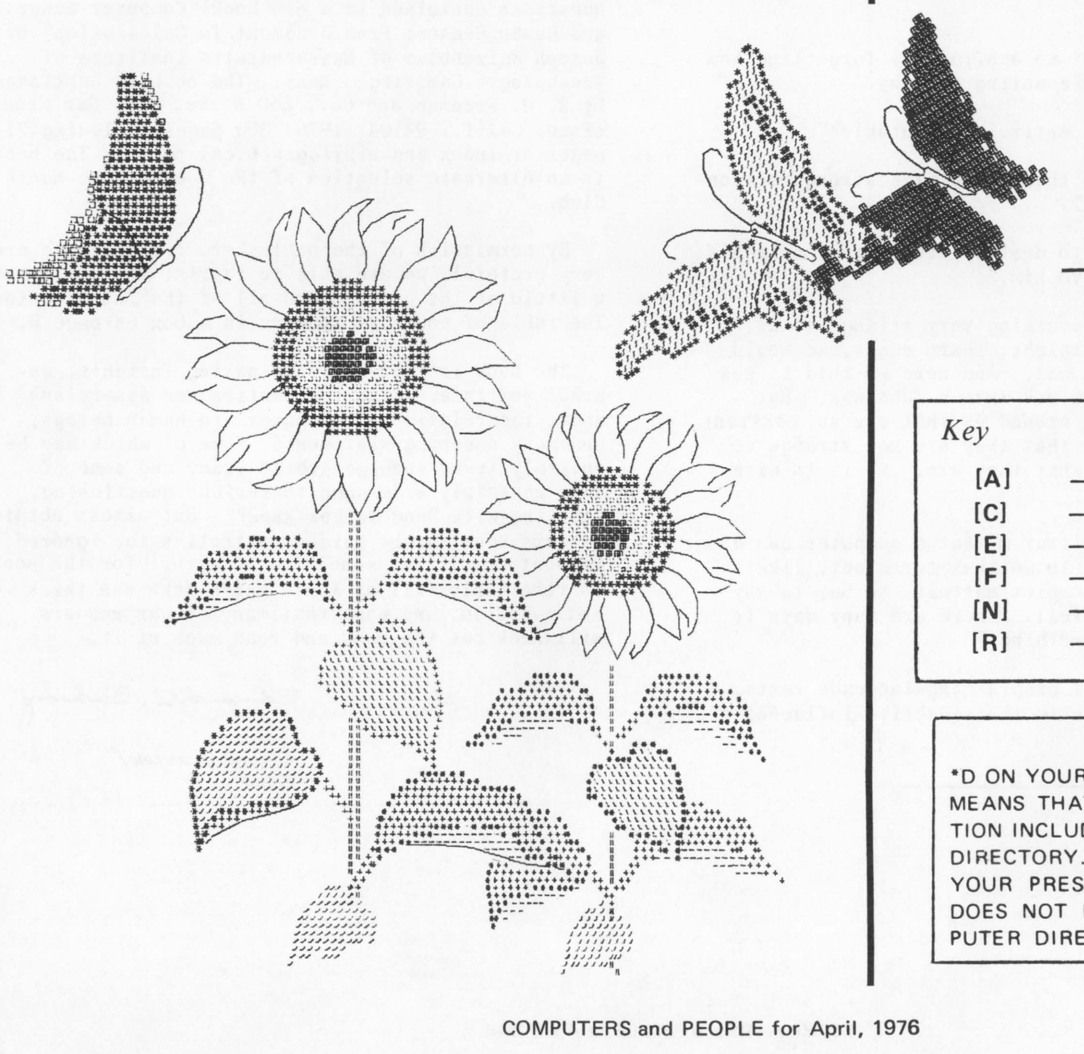
CORRECTION: At the top left of page 4 in the March issue, please replace "Vol. 25, No. 2" by "Vol. 25, No. 3." We regret this stupid mistake.

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



Front Cover Picture

The front cover shows "Hello Sunflowers!" by Mutsuko Sasaki, Tokyo, Japan. He says: "A program is constructed which eliminates invisible area and paints surfaces in the assigned ways. Basic data are four petals, three flower cores, three leaves, a stem, and a butterfly divided into the parts. This figure is drawn by using the program and by combining the data in a desired way. The calculation was made on a FACOM 270-30 computer."

Key

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

NOTICE

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

EDITORIAL

"Computer Power and Human Reason: From Judgment To Calculation"

"Science has been converted into a slow-acting poison."

"We can count, but we are rapidly forgetting how to say what is worth counting and why."

"Is human thought entirely computable?"

"Individuals bind themselves with strong emotional ties to machines."

"Man is now able to destroy everything; only his own decisions can save him."

"Were we to see something very strange to us, say, a cloud with straight, sharp edges, we would want to know what it was. And were we told it was a fuba, then we would ask what a fuba was. But there are things all around us that are so constantly part of our lives that they are not strange to us and we don't ask what they are. So it is with machines."

"The oft-repeated truism that a computer can do only what it is told to do thus turns out, like most truisms about complex matters, to be, to say the least, problematical. There are many ways to 'tell' a computer something."

"An interpreter of programming-language texts, a computer, is immune to the seductive influence of mere eloquence."

These are only a few of the propositions and questions contained in a new book "Computer Power and Human Reason: From Judgment To Calculation" by Joseph Weizenbaum of Massachusetts Institute of Technology, Cambridge, Mass. The book is published by W. H. Freeman and Co., 660 Market St., San Francisco, Calif., 94104; 1976; 300 pages including 21 pages of index and bibliographical notes. The book is an alternate selection of the Book-of-the-Month Club.

By permission of the publisher, for which we are very grateful, we are able to reprint in this issue a little of the preface and all of the introduction. The table of contents appears in a box on page 8.

The book is full of illuminating insights, unusual and interesting information and assertions about the relation of computers to human beings, and many sweeping statements, some of which may be entirely true, some generally true, and some of them certainly wide open to serious questioning, starting with "How do you know?" But almost nothing in this book can be paid no attention to, ignored, without committing some kind of error: for the book is remarkably full of ideas which make one think and question. We hope that many of our readers will seek out the book and read much of it.

Edmund C. Berkeley

Edmund C. Berkeley
Editor

Computer Power and Human Reason

Joseph Weizenbaum
Massachusetts Institute of Technology
Cambridge, MA 02139

"I would argue that, however intelligent machines may be made to be, there are some acts of thought that ought to be attempted only by humans."

Preface

This book is only nominally about computers. In an important sense, the computer is used here merely as a vehicle for moving certain ideas that are much more important than computers. The reader who looks at a few of this book's pages and turns away in fright because he spots an equation or a bit of computer jargon here and there should reconsider. He may think that he does not know anything about computers, indeed, that computers are too complicated for ordinary people to understand. But a major point of this book is precisely that we, all of us, have made the world too much into a computer, and that this remaking of the world in the image of the computer started long before there were any electronic computers. Now that we have computers, it becomes somewhat easier to see this imaginative transformation we have worked on the world. Now we can use the computer itself — that is the idea of the computer — as a metaphor to help us understand what we have done and are doing.

We are all used to hearing that the computer is a powerful new instrument. But few people have any idea where the power of a computer comes from. Chapters I to III are devoted to explaining just that. With a modest investment in time and intellectual energy, anyone who can read this Preface should be able to work his way through those chapters. Chapters II and III will be the most difficult, but the reader who cannot master them should not therefore abandon the rest of the book. Really, the only point Chapters II and III make is that computers are in some sense "universal" machines, that they can (in a certain sense which is there explained) do "anything." The reader who is willing to take that assertion on faith may well want to skip from Chapter I (which he should read) to Chapter IV. Perhaps after he has finished the whole book, he will be tempted to try Chapters II and III again.

The rest of the book contains the major arguments, which are in essence, first, that there is a difference between man and machine, and, second, that there are certain tasks which computers ought not be made to do, independent of whether computers can be made to do them. ....

Joseph Weizenbaum is currently Professor of Computer Science at Massachusetts Institute of Technology, Cambridge, Mass. He was part of the General Electric team that developed the first deposit accounting computer system (ERMA) for the Bank of America; he later designed the list-processing language SLIP.

Professor Weizenbaum has held appointments at The Center for Advanced Study in the Behavioral Sciences, Stanford University, The Technical University of Berlin, Columbia University, and Harvard University. He has published papers in the Communications of the Association for Computing Machinery, Science, the Partisan Review, and other technical journals. His more recent interests are in computer science education and in the relationship of computation to culture and society.

Introduction

In 1935, Michael Polanyi, then holder of the Chair of Physical Chemistry at the Victoria University of Manchester, England, was suddenly shocked into a confrontation with philosophical questions that have ever since dominated his life. The shock was administered by Nicolai Bukharin, one of the leading theoreticians of the Russian Communist party, who told Polanyi that "under socialism the conception of science pursued for its own sake would disappear, for the interests of scientists would spontaneously turn to the problems of the current Five Year Plan." Polanyi sensed then that "the scientific outlook appeared to have produced a mechanical conception of man and history in which there was no place for science itself." And further that "this conception denied altogether any intrinsic power to thought and thus denied any grounds for claiming freedom of thought."

I don't know how much time Polanyi thought he would devote to developing an argument for a contrary concept of man and history. His very shock testifies to the fact that he was in profound disagreement with Bukharin, therefore that he already conceived of man differently, even if he could not then give explicit form to his concept. It may be that he determined to write a counterargument to Bukharin's position, drawing only on his own experience as a scientist, and to have done with it in short order. As it

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turned out, however, the confrontation with philosophy triggered by Bukharin's revelation was to demand Polanyi's entire attention from then to the present day.

I recite this bit of history for two reasons. The first is to illustrate that ideas which seem at first glance to be obvious and simple, and which ought therefore to be universally credible once they have been articulated, are sometimes buoys marking out stormy channels in deep intellectual seas. That science is creative, that the creative act in science is equivalent to the creative act in art, that creation springs only from autonomous individuals, is such a simple and, one might think, obvious idea. Yet Polanyi has, as have many others, spent nearly a lifetime exploring the ground in which it is anchored and the turbulent sea of implications which surrounds it.

The second reason I recite this history is that I feel myself to be reliving part of it. My own shock was administered not by any important political figure espousing his philosophy of science, but by some people who insisted on misinterpreting a piece of work I had done. I write this without bitterness and certainly not in a defensive mood. Indeed, the interpretations I have in mind tended, if anything, to overrate what little I had accomplished and certainly its importance. No, I recall that piece of work now only because it seems to me to provide the most parsimonious way of identifying the issues I mean to discuss.

The work was done in the period 1964-1966, and was reported in the computer-science literature in January 1966 and August 1967. To summarize it briefly, I composed a computer program with which one could "converse" in English. The human conversationalist partner would type his portion of the conversation on a typewriter connected to a computer, and the computer, under control of my program, would analyze the message that had so been transmitted to it, compose a response to it in English, and cause the response to be typed on the computer's typewriter.

I chose the name ELIZA for the language analysis program because, like Eliza of Pygmalion fame, it could be taught to "speak" increasingly well. Because conversations must be about something, that is, because they must take place within some context, the program was constructed in a two-tier arrangement, the first tier consisting of the language analyzer and the second of a script. The script is a set of rules rather like those that might be given to an actor who is to use them to improvise around a certain theme. Thus ELIZA could be given a script to enable it to maintain a conversation about cooking eggs or about managing a bank checking account, and so on. Each specific script thus enabled ELIZA to play a specific conversational role.

For my first experiment, I gave ELIZA a script designed to permit it to play (I should really say parody) the role of a Rogerian psychotherapist engaged in an initial interview with a patient. The Rogerian psychotherapist is relatively easy to imitate because much of his technique consists of drawing his patient out by reflecting the patient's statements back to him. The following conversation between a young lady and ELIZA playing doctor illustrates both the Rogerian technique of encouraging a patient to keep talking and the operation of the computer program ELIZA. The first to "speak" is the young lady. The computer's responses are printed entirely in capitals.

Men are all alike.

IN WHAT WAY

They're always bugging us about something or other.

CAN YOU THINK OF A SPECIFIC EXAMPLE.

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE.

He says I'm depressed much of the time.

I AM SORRY TO HEAR YOU ARE DEPRESSED

It's true. I am unhappy.

DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY

I need some help, that much seems certain.

WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP

Perhaps I could learn to get along with my mother.

TELL ME MORE ABOUT YOUR FAMILY

My mother takes care of me.

WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU

My father.

YOUR FATHER

You are like my father in some ways.

WHAT RESEMBLANCE DO YOU SEE

You are not very aggressive but I think you don't want me to notice that.

WHAT MAKE YOU THINK I AM NOT VERY AGGRESSIVE

You don't argue with me.

WHY DO YOU THINK I DON'T ARGUE WITH YOU

You are afraid of me.

DOES IT PLEASE YOU TO BELIEVE I AM AFRAID OF YOU

My father is afraid of everybody.

WHAT ELSE COMES TO MIND WHEN YOU THINK OF YOUR FATHER

Bullies.

DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE

DOCTOR, as ELIZA playing psychiatrist came to be known, soon became famous around the Massachusetts Institute of Technology, where it first came into existence, mainly because it was an easy program to demonstrate. Most other programs could not vividly demonstrate the information-processing power of a computer to visitors who did not already have some specialized knowledge, say, of some branch of mathematics. DOCTOR, on the other hand, could be appreciated on some level by anyone. Its power as a demonstration vehicle was further enhanced by the fact that the visitor could actually participate in its operation. Soon copies of DOCTOR, constructed on the basis of my published description of it, began appearing at other institutions in the United States. The program became nationally known and even, in certain circles, a national plaything.

The shocks I experienced as DOCTOR became widely known and "played" were due principally to three distinct events.

1. A number of practicing psychiatrists seriously believed the DOCTOR program could grow into a nearly completely automatic form of psychotherapy. Colby et al. write, for example,

> "Futher work must be done before the program will be ready for clinical use. If the method proves beneficial, then it would provide a therapeutic tool which can be made widely available to mental hospitals and psychiatric centers suffering a shortage of therapists. Because of the time-sharing capabilities of modern and future computers, several hundred patients an hour could be handled by a computer system designed for this purpose. The human therapist, involved in the design and operation of this system, would not be replaced, but would become a much more efficient man since his efforts would no longer be limited to the one-to-one patient-therapist ratio as now exists." /3*/

I had thought it essential, as a prerequisite to the very possibility that one person might help another learn to cope with his emotional problems, that the helper himself participate in the other's experience of those problems and, in large part by way of his own empathic recognition of them, himself come to understand them. There are undoubtedly many techniques to facilitate the therapist's imaginative projection into the patient's inner life. But that it was possible for even one practicing psychiatrist to advocate that this crucial component of the therapeutic process be entirely supplanted by pure technique — that I had not imagined! What must a psychiatrist who makes such a suggestion think he is doing while treating a patient, that he can view the simplest mechanical parody of a single interviewing technique as having captured anything of the essence of a human encounter? Perhaps Colby et al. give us the required clue when they write;

> "A human therapist can be viewed as an information processor and decision maker with a set of decision rules which are closely linked to short-range and long-range goals, . . . He is guided in these decisions by rough empiric rules telling him what is appropriate to say and not to say in certain contexts. To incorporate these processes, to the degree possessed by a human therapist, in the program would be a considerable undertaking, but we are attempting to move in this direction." /4/

What can the psychiatrist's image of his patient be when he sees himself, as therapist, not as an engaged human being acting as a healer, but as an information processor following rules, etc.?

Such questions were my awakening to what Polanyi had earlier called a "scientific outlook that appeared to have produced a mechanical conception of man."

2. I was startled to see how quickly and how deeply people conversing with DOCTOR became emotionally involved with the computer and how unequivocally they anthropomorphized it. Once my secretary, who had watched me work on the program for many months and therefore surely knew it to be merely a computer program, started conversing with it. After only a few interchanges with it, she asked me to leave the room. Another time, I suggested I might rig the system so that I could examine all conversations anyone had had with it, say, overnight. I was promptly bombarded with accusations that what I proposed amounted to spying on people's most intimate thoughts; clear evidence that people were conversing with the computer as if it were a person who could be appropriately and usefully addressed in intimate terms. I knew of course that people form all sorts of emotional bonds to machines, for example, to musical instruments, motorcycles, and cars. And I knew from long experience that the strong emotional ties many programmers have to their computers are often formed after only short exposures to their machines. What I had not realized is that extremely short exposures to a relatively simple computer program could induce powerful delusional thinking in quite normal people. This insight led me to attach new importance to questions of the relationship between the individual and the computer, and hence to resolve to think about them.

3. Another widespread, and to me surprising, reaction to the ELIZA program was the spread of a belief that it demonstrated a general solution to the problem of computer understanding of natural language. In my paper, I had tried to say that no general solution to that problem was possible, i.e., that language is understood only in contextual frameworks, that even these can be shared by people to only a limited extent, and that consequently even people are not embodiments of any such general solution. But these conclusions were often ignored. In any

* Nor is Dr. Colby alone in his enthusiasm for computer administered psychotherapy. Dr. Carl Sagan, the astrophysicist, recently commented on ELIZA in *Natural History*, vol. LXXXIV, no. 1 (Jan. 1975), p. 10: "No such computer program is adequate for psychiatric use today, but the same can be remarked about some human psychotherapists. In a period when more and more people in our society seem to be in need of psychiatric counseling, and when time sharing of computers is widespread, I can imagine the development of a network of computer psychotherapeutic terminals, something like arrays of large telephone booths, in which, for a few dollars a session, we would be able to talk with an attentive, tested, and largely nondirective psychotherapist."

case, ELIZA was such a small and simple step. Its contribution was, if any at all, only to vividly underline what many others had long ago discovered, namely, the importance of context to language understanding. The subsequent, much more elegant, and surely more important work of Winograd /5/ in computer comprehension of English is currently being misinterpreted just as ELIZA was. This reaction to ELIZA showed me more vividly than anything I had seen hitherto the enormously exaggerated attributions an even well-educated audience is capable of making, even strives to make, to a technology it does not understand. Surely, I thought, decisions made by the general public about emergent technologies depend much more on what that public attributes to such technologies than on what they actually are or can and cannot do. If, as appeared to be the case, the public's attributions are wildly misconceived, then public decisions are bound to be misguided and often wrong. Difficult questions arise out of these observations; what for example, are the scientist's responsibilities with respect to making his work public? And to whom (or what) is the scientist responsible.

As perceptions of these kinds began to reverberate in me, I thought, as perhaps Polanyi did after his encounter with Bukharin, that the questions and misgivings that had so forcefully presented themselves to me could be disposed of quickly, perhaps in a short, serious article. I did in fact write a paper touching on many points mentioned here. /6/ But gradually I began to see that certain quite fundamental questions had infected me more chronically than I had first perceived. I shall probably never be rid of them.

There are as many ways to state these basic questions as there are starting points for coping with them. At bottom they are about nothing less than man's place in the universe. But I am professionally trained only in computer science, which is to say (in all seriousness) that I am extremely poorly educated; I can mount neither the competence, nor the courage, not even the chutzpah, to write on the grand scale actually demanded. I therefore grapple with questions that couple more directly to the concerns I have expressed, and hope that their larger implications will emerge spontaneously.

I shall thus have to concern myself with the following kinds of questions:

1. What is it about the computer that has brought the view of man as a machine to a new level of plausibility? Clearly there have been other machines that imitated man in various ways, e.g., steam shovels. But not until the invention of the digital computer have there been machines that could perform intellectual functions of even modest scope; i.e., machines that could in any sense be said to be intelligent. Now "artificial intelligence" (AI) is a subdiscipline of computer science. This new field will have to be discussed. Ultimately a line dividing human and machine intelligence must be drawn. If there is no such line, then advocates of computerized psychotherapy may be merely heralds of an age in which man has finally been recognized as nothing but a clock-work. Then the consequences of such a reality would need urgently to be divined and contemplated.

2. The fact that individuals bind themselves with strong emotional ties to machines ought not in itself to be surprising. The instruments man uses become, after all, extensions of his body. Most importantly, man must, in order to operate his instruments skillfully, internalize aspects of them in the form of kinesthetic and perceptual habits. In that sense at least, his instruments become literally part of him and modify him, and thus alter the basis of his affective relationship to himself. One would expect man to cathect more intensely to instruments that couple directly to his own intellectual, cognitive, and emotive functions than to machines that merely extend the power of his muscles. Western man's entire milieu is now pervaded by complex technological extensions of his every functional capacity. Being the enormously adaptive animal he is, man has been able to accept as authentically natural (that is, as given by nature) such technological bases for his relationship to himself, for his identity. Perhaps this helps to explain why he does not question the appropriateness of investing his most private feelings in a computer. But then, such an explanation would also suggest that the computing machine represents merely an extreme extrapolation of a much more general technological usurpation of man's capacity to act as an autonomous agent in giving meaning to his world. It is therefore important to inquire into the wider senses in which man has come to yield his own autonomy to a world viewed as a machine.

3. It is perhaps paradoxical that just, when in the deepest sense man has ceased to believe in — let alone to trust — his own autonomy, he has begun to rely on autonomous machines, that is, on machines that operate for long periods of time entirely on the basis of their own internal realities. If his reliance on such machines is to be based on something other than unmitigated despair or blind faith, he must explain to himself what these machines do and even how they do what they do. This requires him to build some conception of their internal "realities." Yet most men don't understand computers to even the slightest degree. So, unless they are capable of very great skepticism (the kind we bring to bear while watching a stage magician), they can explain the computer's intellectual feats only by bringing to bear the single analogy available to them, that is, their model of their own capacity to think. No wonder, then, that they overshoot the mark; it is truly impossible to imagine a human who could imitate ELIZA, for example, but for whom ELIZA's language abilities were his limit. Again, the computing machine is merely an extreme example of a much more general phenomenon. Even the breadth of connotation intended in the ordinary usage of the work "machine," large as it is, is insufficient to suggest its true generality. For today when we speak of, for example, bureaucracy, or the university, or almost any social or political construct, the image we generate is all too often that of an autonomous machine-like process.

These, then, are the thoughts and questions which have refused to leave me since the deeper significances of the reactions to ELIZA I have described began to become clear to me. Yet I doubt that they could have impressed themselves on me as they did were it not that I was (and am still) deeply involved in a concentrate of technological society as a teacher in the temple of technology that is the Massachusetts Institute of Technology, an institution that proudly boasts of being "polarized around science and technology." There I live and work with colleagues, many of whom trust only modern science to deliver reliable knowledge of the world. I confer with them on research proposals to be made to government agencies, especially to the Department of "Defense." Sometimes I become more than a little frightened as I contemplate what we lead ourselves to propose, as well as the nature of the arguments we construct to support our proposals. Then, too, I am constantly confronted by students, some of whom have already rejected all ways but the scientific to come to know the world, and who seek only a deeper, more dogmatic indoctrination in that faith (although that word is no longer in their vocabulary). Other students suspect that not even the entire collection of machines and instruments at M.I.T. can significantly help give meaning to their lives. They sense the presence of a dilemma in an education polarized around science and technology, an education that implicitly claims to open a privileged access-path to fact, but that cannot tell them how to decide what is to count as fact. Even while they recognize the genuine importance of learning their craft, they rebel at working on projects that appear to address themselves neither to answering interesting questions of fact nor to solving problems in theory.

Such confrontations with my own day-to-day social reality have gradually convinced me that my experience with ELIZA was symptomatic of deeper problems. The time would come, I was sure, when I would no longer be able to participate in research proposal conferences, or honestly respond to my students' need for therapy (yes, that is the correct word), without first attempting to make sense of the picture my own experience with computers had so sharply drawn for me.

Of course, the introduction of computers into our already highly technological society has, as I will try to show, merely reinforced and amplified those antecedent pressures that have driven man to an ever more mechanistic image of himself. It is therefore important that I construct my discussion of the impact of the computer on man and his society so that it can be seen as a particular kind of encoding of a much larger impact, namely, that on man's role in the face of technologies and techniques he may not be able to understand and control. Conversations around that theme have been going on for a long time. And they have intensified in the last few years.

Certain individuals of quite differing minds, temperaments, interests, and training have — however much they differ among themselves and even disagree on many vital questions — over the years expressed grave concern about the conditions created by the unfettered march of science and technology; among them are Mumford, Arendt, Ellul, Roszak, Comfort, and Boulding. The computer began to be mentioned in such discussions only recently. Now there are signs that a full-scale debate about the computer is developing. The contestants on one side are those who, briefly stated, believe computers can, should, and will do everything, and on the other side those who, like myself, believe there are limits to what computers ought to be put to do.

It may appear at first glance that this is an in-house debate of little consequence except to a small group of computer technicians. But at bottom, no matter how it may be disguised by technological jargon, the question is whether or not every aspect of human thought is reducible to a logical formalism, or, to put it into the modern idiom, whether or not human thought is entirely computable. That question has, in one form or another, engaged thinkers in all ages. Man has always striven for principles that could organize and give sense and meaning to his existence. But before modern science fathered the technologies that reified and concretized its otherwise abstract systems, the systems of thought that defined man's place in the universe were fundamentally juridicial. They served to define man's obligations to his fellow men and to nature. The Judaic tradition, for example, rests on the idea of a contractual relationship between God and man. This relationship must and does leave room for autonomy for both God and man, for a contract is an agreement willingly entered into by parties who are free not to agree. Man's autonomy and his corresponding responsibility is a central issue of all religious systems. The spiritual cosmologies engendered by modern science, on the other hand, are infected with the germ of logical necessity. They, except in the hands of the wisest scientists and philosophers, no longer content themselves with explanations of appearances, but claim to say how things actually are and must necessarily be. In short, they convert truth to provability.

As one consequence of this drive of modern science, the question, "What aspects of life are formalizable?" has been transformed from the moral question, "How and in what form may man's obligations and responsibilities be known?" to the question, "Of what technological genus is man a species?" Even some philosophers whose every instinct rebels against the idea that man is entirely comprehensible as a machine have succumbed to this spirit of the times. Hubert Dreyfus, for example, trains the heavy guns of phenomenology on the computer model of man. /7/ But he limits his argument to the technical question of what computers can and cannot do. I would argue that if computers could imitate man in every respect — which in fact they cannot — even then it would be appropriate, nay, urgent, to examine the computer in the light of man's perennial need to find his place in the world. The outcomes of practical matters that are of vital importance to everyone hinge on how and in what terms the discussion is carried out.

One position I mean to argue appears deceptively obvious: it is simply that there are important differences between men and machines as thinkers. I would argue that, however intelligent machines may be made to be, there are some acts of thought that ought to be attempted only by humans. One socially significant question I thus intend to raise is over the proper place of computers in the social order. But, as we shall see, the issue transcends computers in that it must ultimately deal with logicality itself — quite apart from whether logicality is encoded in computer programs or not.

The lay reader may be forgiven for being more than slightly incredulous that anyone should maintain that human thought is entirely computable. But his very incredulity may itself be a sign of how marvelously subtly and seductively modern science has come to influence man's imaginative construction of reality.

Surely, much of what we today regard as good and useful, as well as much of what we would call knowledge and wisdom, we owe to science. But science may also be seen as an addictive drug. Not only has our unbounded feeding on science caused us to become dependent on it, but, as happens with many other drugs taken in increasing dosages, science has been gradually converted into a slow-acting poison. Beginning perhaps with Francis Bacon's misreading of the genuine promise of science, man has been seduced into wishing and working for the establishment of an age of rationality, but with his vision of rationality tragically twisted so as to equate it with logicality. Thus have we very nearly come to the point where almost every genuine human dilemma is seen as a mere paradox, as a merely apparent contradiction that could be untangled by judicious applications of cold logic derived from a higher standpoint. Even murderous wars have come to be perceived as mere problems to be solved by hordes of professional problemsolvers. As Hannah Arendt said about recent makers and executors of policy in the Pentagon:

> "They were not just intelligent, but prided themselves on being 'rational' . . . They were eager to find formulas, preferably expressed in a pseudo-mathematical language, that would unify the most disparate phenomena with which reality presented them; that is, they were eager to discover laws by which to explain and predict political and historical facts as though they were as necessary, and thus as reliable, as the physicists once believed natural phenomena to be . . . They did not judge; they calculated. . . . an utterly irrational confidence in the calculability of reality became the leitmotif of the decision making." /8/

And so too have nearly all political confrontations, such as those between races and those between the governed and their governors, come to be perceived as mere failures of communication. Such rips in the social fabric can then be systematically repaired by the expert application of the latest information-handling techniques — at least so it is believed. And so the rationality-is-logicality equation, which the very success of science has drugged us into adopting as virtually an axiom, has led us to deny the very existence of human conflict, hence the very possibility of the collision of genuinely incommensurable human interests and of disparate human values, hence the existence of human values themselves.

It may be that human values are illusory, as indeed B. F. Skinner argues. If they are, then it is presumably up to science to demonstrate that fact, as indeed Skinner (as scientist) attempts to do. But then science must itself be an illusory system. For the only certain knowledge science can give us is knowledge of the behavior of formal systems, that is, systems that are games invented by man himself and in which to assert truth is nothing more or less than to assert that, as in a chess game, a particular board position was arrived at by a sequence of legal moves. When science purports to make statements about man's experiences, it bases them on identifications between the primitive (that is, undefined) objects of one of its formalisms, the pieces of one of its games, and some set of human observations. No such sets of correspondences can ever be proved to be correct. At best, they can be falsified, in the sense that formal manipulations of a system's symbols may lead to symbolic configurations which, when read in the light of the set of correspondences in question, yield interpretations contrary to empirically observed phenomena. Hence all empirical science is an elaborate structure built on piles that are anchored, not on bedrock as is commonly supposed, but on the shifting sand of fallible human judgment, conjecture, and intuition. It is not even true, again contrary to common belief, that a single purported counter-instance that, if accepted as genuine would certainly falsify a specific scientific theory, generally leads to the immediate abandonment of that theory. Probably all scientific theories currently accepted by scientists themselves (excepting only those purely formal theories claiming no relation to the empirical world) are today confronted with contradicting evidence of more than negligible weight that, again if fully credited, would logically invalidate them. Such evidence is often explained (that is, explained away by ascribing it to error of some kind, say, observational error, or by characterizing it as inessential, or by the assumption (that is, faith) that some yet-to-be-discovered way of dealing with it will some day permit it to be acknowledged but nevertheless incorporated into the scientific theories it was originally thought to contradict. In this way scientists continue to rely on already impaired theories and to infer "scientific fact" from them.*

The man in the street surely believes such scientific facts to be as well-established, as well-proven, as his own existence. His certitude is an illusion. In his praxis, he must, after all, suspend disbelief in order to do or think anything at all. He is rather like a theatergoer, who, in order to participate in and understand what is happening on the stage, must for a time pretend to himself that he is witnessing real events. The scientist must believe his working hypothesis, together with its vast underlying structure of theories and assumptions, even if only for the sake of the argument. Often the "argument" extends over his entire lifetime. Gradually he becomes what he at first merely pretended to be: a true believer. I choose the word "argument" thoughtfully, for scientific demonstrations, even mathematical proofs, are fundamentally acts of persuasion.

Scientific statements can never be certain; they can be only more or less credible. And credibility is a term in individual psychology, i.e., a term that has meaning only with respect to an individual observer. To say that some proposition is credible is, after all, to say that it is believed by an agent who is free not to believe it, that is, by an observer who, after exercising judgment and (possibly) intuition, chooses to accept the proposition as worthy of his believing it. How then can science, which itself surely and ultimately rests on vast arrays of human value judgments, demonstrate that human value judgments are illusory? It cannot do so without forfeiting its own status as the single legitimate path to understanding man and his world.

But no merely logical argument, no matter how cogent or eloquent, can undo this reality: that science has become the sole legitimate form of understanding in the common wisdom. When I say that science has been gradually converted into a slow-acting poison, I mean that the attribution of certainty to scientific knowledge by the common wisdom, an attribution now made so nearly universally that it has become a commonsense dogma, has virtually delegitimatized all other ways of understanding. People viewed the arts, especially literature, as sources of intellectual nourishment and understanding, but today the arts are perceived largely as entertainments. The ancient Greek and Oriental theaters, the Shakespearian stage, the stages peopled by the Ibsens and Chekhovs nearer to our day — these were schools. The curricula they taught were vehicles for understanding the societies they represented. Today, although an occasional Arthur Miller or Edward Albee survives and is permitted to teach on the New York or London stage, the people hunger only for what is represented to them to be scientifically validated knowledge. They seek to satiate

(please turn to page 26)

* Thus, Charles Everett writes on the now-discarded phlogiston theory of combustion (in the *Encyclopaedia Britannica,* vol. VI, p. 34): "The objections of the anti-phlogistonists, such as the fact that the calices weigh more than the original metals instead of less as the theory suggests, were answered by postulating that phlogiston was a principle of levity, or even completely ignored as an accident, the change in qualities being regarded as the only matter of importance." Everett lists H. Cavendish and J. Priestley, both great scientists of their time, as adherents of the phlogiston theory.

Management Information Systems in Shipping Company Operations

Eugene D. Story
Marine Management Systems, Inc.
300 Broad St.
Stamford, CT 06901

"It is imperative to recognize that shipping management is as much a science as ship building."

With the current world economic conditions, there are increased pressures on all business organizations to operate at reduced costs, and increase the utilization and efficiency of assets. The world shipping community has been particularly hard hit because of the increase in fuel costs and depressed freight rates. Management is being called upon more than ever to look at new technologies to help them solve their problems.

The marine industry has spent considerable resources in major advances on the ship technology side, such as developing container ships and gas carriers, for lower cost transportation. But there has been relatively little expended on advances in management techniques. In fact, when one looks at the various educational institutions serving the marine industry, they all provide advanced courses on the technical side but very little is offered from the shipping management side. Perhaps this is due to the traditions of the industry and the nature of the independent ship owner who has built his fortune by his wits and outguessing the market. Unfortunately, most of today's shipping companies cannot operate in this fashion.

It is imperative to recognize that shipping management is as much a science as ship building. The major difference between management science and technical science is the number and rate of change in variables with which the management science must deal. A ship is designed and built to meet a particular service and must operate within its design limitations. But during its service, it can operate within a predictable speed and fuel consumption. The physical environment it will operate in is also fairly predictable.

Managing a shipping company today involves operating in a continually changing environment. This may include major changes in demand for transportation, such as seen with the large crude oil carriers today, changes in political conditions, social demands, currency restrictions, extensive inflation, rate structures, etc. Management must react to all these factors and not only maintain the services, but try to do so at a profit.

Based on a paper given at the Fourth Pan-American Congress of Naval Engineering, Ports Engineering, and Maritime Transportation in Lima, Peru, November 1975.

A Management Information System

What does a scientific approach to management entail?

First, management must deal with information. When the ship owner was the ship captain and trader, he could deal firsthand with all his problems. But today, the manager must rely primarily on information that is sent to him by others. The volume of this necessary information has reached a level where he cannot assimilate it in a traditional fashion. The manager's desk is not big enough to hold all the reports he must read; and he does not have the time to read them all, much less classify and analyze them.

What is obviously needed is an organization of the information, so that the manager receives it in a form he can use and act upon. The modern computer-based management information systems are designed to do just this. This system should also employ the new developments in the data communications area which can be particularly related to the international marine industry.

There are various approaches to the implementation of a management information system. Some companies have tried to design large total systems and implement within in a relatively short period of time. Many of these attempts have failed, not because the systems were poorly designed from a computer standpoint, but because the people or end users were not ready for them, or more importantly, were not consulted in their development.

A more realistic and successful approach within the marine industry has been to design total data systems, but implement the various parts in a step-by-step manner, proceeding to the next step when the previous one has been accepted and successfully implemented.

Other systems have failed because the modular step-by-step approach was taken in implementation, but the various modules did not fit together when the total system was completed. This is typical when planning a system is done by one group quite separate from the operations people or accounting system people.

What is needed is an Integrated Marine Data System that is designed specifically to carry out the functions of a marine shipping operation. This entails first, defining the functions required to carry out a total marine operation and then developing subsystems to carry out these functions. A definition of a structured approach to defining an Integrated Marine Data System follows.

Marine Function Charts

The Marine Function Charts (please see Figures 1 through 4) demonstrate the progressive relationship between basic management objectives and an integrated data system to accomplish these objectives. The charts show a breakdown of departmental responsibilities and information needs within a marine organization, and include finally a listing of those Integrated Marine Data System elements which support these responsibilities and information needs.

The Function Charts are divided vertically according to functional responsibilities within the organization. (For copies of these charts in larger type, please write the author.)

BASIC BUSINESS FUNCTIONS	BASIC COMPANY OPERATIONS		
	PLANNING & FINANCIAL CONTROLS	BUSINESS OPERATIONS	EQUIPMENT OPERATIONS
MANAGEMENT	MONITORING OF COMPANY FINANCES	MONITORING OF BUSINESS OPERATIONS	MONITORING OF EQUIPMENT OPERATIONS
PLANNING	ASSESSMENT OF FUTURE BUSINESS ENVIRONMENT	ASSESSMENT OF CURRENT MARKET CONDITIONS	ASSESSMENT OF CURRENT OPERATING CONDITIONS
OPERATIONS	LONG TERM CORPORATE PLANNING	DAILY BUSINESS OPERATING DECISIONS	DAILY EQUIPMENT OPERATING DECISIONS
ACCOUNTING	BUDGETS & CONTROLS	BUSINESS ACCOUNTING	OPERATIONS ACCOUNTING

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Figure 1: Management Functions

BASIC BUSINESS FUNCTIONS	BASIC COMPANY OPERATIONS		
	PLANNING & FINANCIAL CONTROLS	BUSINESS OPERATIONS	MARINE OPERATIONS
MANAGEMENT	The monitoring and evaluation of financial aspects of business and marine operations culminating in a *Summary of Financial Reports.*	The monitoring and evaluation of performance of a company with respect to current operations and their effect on overall company profitability, culminating in *Summary Activity Report.*	The monitoring and evaluation of the fleet and the actual operation of specific vessels — as compared to budgets and standards, culminating in a *Summary Status Report.*
PLANNING	The assessment of future markets and world economic conditions and how they willl affect the ability of the company to perform on a profitable basis. Includes assessment of current and future internal operations standards.	The assessment of current market conditions and the projection of relatively short term management decisions, noting their effect on departmental profitability	The assessment of current operating conditions, and the projection of operating policies, noting their effect on future operating costs and vessel productivity.
OPERATIONS	The projection of new business on a long term basis from a voyage, fleet and company standpoint based on company operating standards. Includes a simulation of the company operation.	The day to day performance of company business such as sales, charters, booking and assignment of cargos, and ships, determining the effect on company profits.	The daily operation of vessels and terminals for minimum cost and maximum productivity.
ACCOUNTING	The setting of departmental and company budgets, the collection of actual accounting data and an analysis of actual vs. budget, and preparation of company financial statements.	Maintenance of departmental accounting records as they apply to cargo revenue, billing, and chartering costs.	Maintenance of accounting records as they apply to ship and terminal operations.

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Figure 2: Marine Management Functions

BASIC BUSINESS FUNCTIONS	BASIC COMPANY OPERATIONS		
	PLANNING & FINANCIAL CONTROLS	BUSINESS OPERATIONS	MARINE OPERATIONS
MANAGEMENT	GENERAL MANAGEMENT Summary Financial Reports Profit and Loss Cash Flow Budget Analysis Variance Analysis	GENERAL MANAGEMENT Market Summary Charter Performance Summary Fleet Status	GENERAL MANAGEMENT Ship Performance Summary Port Performance Summary
PLANNING	PLANNING DEPT. Industry Information Ships, ports, owners, commodities, ship sales, etc.) Company Operating Standards (Ships, ports, routes, operating costs) Market Forecasting	SALES DEPT. Current Market Information Time Charter Market Voyage Charter Freight Market Commodity Market Port Congestion Information Casualty Information Vessel Availability Shippers/Forwarder Information Inland Carrier Information	SHIP OPERATIONS DEPT. Port & Terminal Information Weather Information Navigation Hazards Information Bunkering Information Repair Yard Status Fleet Personnel Information Ship Technical Evaluation Stevedoring Information
OPERATIONS	PLANNING DEPT. Voyage Estimate Transportation Cost Analysis Cash Flow/P&L Projection Fleet Projections Company Financial Model New Ship Evaluation	CHARTERING & TRAFFIC DEPT. Ship Scheduling Fleet Performance Charter Performance Ship Position Cargo Requirements Contract Performance	SHIP OPERATIONS DEPT. Crewing Maintenance & Repair Insurance Provisions & Stores Vessel Performance Report Port Performance Reporting Ship/Shore Communications Inventory Purchasing Stowage Planning Port/Terminal Operations
ACCOUNTING	CONTROLLER'S DEPT. Company P&L Cash Flow Reports Tax Reports Balance Sheet Accounts Payable Accounts Receivable	ACCOUNTING DEPT. Freight Billing Charter Accounting Voyage Accounting Office Overhead Accounts	ACCOUNTING DEPT. Crew Cost M&R Insurance Provisions & Stores Fuel Port Charges Terminal Costs Stevedoring Costs

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Figure 3: Marine Information Requirements

BASIC BUSINESS FUNCTIONS	BASIC COMPANY OPERATIONS		
	PLANNING & FINANCIAL CONTROLS	BUSINESS OPERATIONS	MARINE OPERATIONS
MANAGEMENT	GENERAL MANAGEMENT EXECUTIVE SUMMARY Budget Variance Analysis Financial Operations Marine Information	GENERAL MANAGEMENT EXECUTIVE SUMMARY Charter Performance Ship Schedule Voyage Summary Marine Information Port Schedule Requirements Cargo Statistics	GENERAL MANAGEMENT EXECUTIVE SUMMARY Ship Performance Fleet Performance Port Performance Fleet Personnel
PLANNING	PLANNING DEPT. MARINE INFORMATION SYSTEM Ships, ports, owners, Ship sales Commodity trade data STANDARDS FILING Ships Ports Routes Operating Costs Commodity trade data	SALES DEPT. MARINE INFORMATION SYSTEM Charter Market Sales & Purchase Contracts of Affreightment Vessel Casualties Vessel Availability Commodity Movements Shippers TRADE ROUTE SIMULATOR	SHIP OPERATIONS DEPT. MARINE DATA CENTER INFORMATION Port & Terminals Weather Navigational Aids Bunkering Medical
OPERATIONS	PLANNING DEPT. ECONOMICS & PLANNING Transcost Voyage Analysis Time Charter Analysis COMPANY SIMULATOR MODEL	CHARTERING & TRAFFIC DEPT. CARGO BOOKING Cargo Statistics CONTAINER CONTROL VOYAGE ESTIMATOR VOYAGE REPORTER Profit & Loss Charter Performance Port Performance Position Reports Vessel Performance Voyage Summary	SHIP OPERATIONS DEPT. VESSEL PERFORMANCE REPORTING STOWAGE PLANNING SEAMENS PERSONNEL CARGO LOADING TERMINAL CONTROL PURCHASE ORDER INVENTORY CONTROL SHIP/SHORE COMMUNICATIONS MAINTENANCE & REPAIR
ACCOUNTING	CONTROLLER'S DEPT. GENERAL LEDGER ACCOUNTS RECEIVABLE ACCOUNTS PAYABLE BUDGETS FINANCIAL REPORTS	ACCOUNTING DEPT. CARGO FREIGHT BILLING CHARTER ACCOUNTING VOYAGE ACCOUNTING	ACCOUNTING DEPT. SEAMENS PAYROLL SHIP OPERATIONS ACCOUNTING

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Figure 4: Integrated Marine Data System

PLANNING AND CONTROLS: The long term company planning function, including investment analysis, budget projection, financial controls, and market forecasting.

BUSINESS OPERATIONS: Those business functions that are usually handled in the home office such as daily booking of business, cargo documentation, billing, ship scheduling and cargo/vessel performance and control.

EQUIPMENT OPERATIONS: The function of operating the vessels and the terminals including crewing, M & R, vessel support, communications, and actual performance monitoring.

The Function Charts are divided horizontally according to managerial or operational activities.

MANAGEMENT INFORMATION: This gives summary reports/displays showing the company performance from both financial and operations standpoint. It is used primarily by top management and department heads.

PLANNING: This represents the functions and systems concerning planning for both long term corporate financial planning as well as short term as applied to daily business and vessel operations.

OPERATIONS: Those functions and related systems that apply to the daily operation of the company.

ACCOUNTING: Those functions and systems involved with the record keeping and analysis of daily business activities.

Therefore, the blocks formed by the intersection of columns and rows are identified with the specific departments or key executives within the marine organization. Figure 1 shows in broad terms the basic objectives of the various areas of the function chart. Figure 2 describes in more detail the objectives of the various functional areas. Figure 3 shows the information requirements of a total system by departmental functional areas. Figure 4 describes the specific elements or program/systems that make up an Integrated Marine Data System.

Following are brief discussions of typical marine systems, representative of these types of application.

Elements of an Integrated Marine Data System

The components or subsystems of an Integrated Marine Data System can be classified according to how they are appled, i.e., their purpose. Actually, most components are so interrelated that they serve multiple purposes. The most important attribute of an integrated system is the all-encompassing nature of the data base upon which all the components feed. For example, usually one component is given the principal responsibility for updating a single file or section of the data base, but the same data base section is accessible to all, and indeed, used by many of the components. Therefore, a more meaningful classification of each component of the integrated marine system would be according to its purpose rather than according to the section of the marine data base with which it is primarily associated. These application classifications fall into the four categories described in the Function Chart.

1. Management Systems: These components or subsystems provide a marine executive with consolidated information on the status and performance, operational and economic, of the marine and general business activities for which he is responsible. The purpose of these components is to provide the tools for measuring the capacity and effectiveness of the marine enterprise, as well as the response of the organization to management decisions.

2. Planning Systems: These components provide marine industry management and planning staffs with tools for sorting the options available for making a business or operational decision or for testing the effect of alternative decisions. The planning system also maintains information on the business environment in which the company operates and also maintains standards on company vessels and operating data. Also included are training and simulation systems which are used as tools in management training. Closely related to planning systems, the training and simulation systems serve as models or simulations of the marine enterprise with which management trainees are able to react to various situations posed by the instruction staff.

3. Marine Operating Information System: These components collect, present, and control basic operational information of the marine enterprise. Their purpose is to provide information tools to the operating staff and to present up-to-date detailed data on the status of the fleet and other marine operations.

4. Accounting Systems: These components collect, maintain, and use basic business data to satisfy record-keeping requirements of marine oriented firms. The purpose of these systems is to maintain the necessary records needed to allow the primary day-to-day business functions to proceed, and provide information for actual vs. planned or budget analysis.

Actual Systems Making Up An Integrated Marine Data System

A. Management Systems

1. Executive Summary Monitor: This is a program that has access to all of the major operating system files. It allows top management to display or print out summary reports on various critical aspects of the company operation on an "on-line" basis. The system does not input or maintain any data files of its own, but uses data supplied by other elements of the system. The following are examples of reports retrievable by the executive summary monitor.

2. Financial Reporting: Although this reporting system is really a collection of summary reports associated with the marine accounting system, it is classified here to emphasize the principal rationale to provide marine industry management with summary financial information. Management is thereby able to estimate the current financial status and measure the performance of their companies and to make sound business decisions. These reports are, in addition to normal P & L and balance sheets, annual income trend analyses, comparisons of revenue and cost forecasts against actual performance, cash control analysis, profit center analysis, budget projection, and variance analysis, etc.

3. Cargo Statistics: This reporting system allows shipping company management to analyze trends in the company's principal sources of cargo revenue. Input sources to this system would be the data bases created by the cargo booking and cargo documentation/billing systems. The system would report cargo trends broken down by any of several class combinations of shipper, consignee, sales agent, commodity load port, and discharge port.

4. Port Analysis: This application system is also closely related to the voyage reporting and vessel performance reporting system. It reports on port performance from the standpoint of revenue trends, costs, operations, and the quality of service. Source input to this system would be by direct data collection with regard to port facilities, from the cargo documentation and booking systems for revenue data, from the marine accounting system with regard to costs, and from the vessel performance reporting system for operational performance data.

B. Planning Systems

1. Marine Information System: This system collects and retrieves industrial and economic data obtained from sources external to the company. This data is available in the following areas.

a) Industry Planning Information System: This system collects and maintains industry data on the characteristics of all ships of the world, port, and route information, standard operating costs and new vessel order book and prices. It is the information necessary to carry out effective long term planning.

b) Business Operating Information: These data systems include information on the daily charter market, freight market, owners' activities, ship sales and purchases, commodity movements, reported casualties by vessel, etc. It is useful for both short and long term business planning.

c) Vessel Operating Information: This data grouping includes information on weather conditions, port facilities and conditions, shipyard availability, bunker availability, navigational hazards, medical and health information, etc. It is useful for short term operating decision planning.

2. Economics and Planning: This system is most useful to marine industry planners concerned with tanker, bulk carrier/tramp operations. It aids them in assessing transportation cost, analyzing the economics of typical voyages, and estimating return on investment of the various planning options they are reviewing.

3. Voyage Pro Forma/Fleet Simulation: This system provides shipping company's management with the capability to project profitability of various alternative courses of action on a single cargo liner voyage or a set of voyages, or a shipping company as a whole. Typical options would involve decisions to add or drop a port in a single voyage or trade route or would involve decisions on the mix of cargo to load on an overbooked voyage. This voyage pro forma analysis can be performed at any stage of a projected voyage, i.e., far in advance of a sailing, prior to sailing but after closing of booking, after sailing, or even soon after voyage completion. Sources of input data for this system are derived from revenue and cost standards input submitted directly by the planner or from actual revenue and cost data captured by the cargo documentation and marine accounting systems. This evaluation concept is extended to investigate similar alternatives on a fleetwide basis.

4. Training and Simulation Systems: These application systems are tutorial modifications of the voyage reporting, vessel performance, voyage pro forma, and economics and planning systems. Their purpose is to allow prospective marine industry management to test their fleet knowledge and learn by their errors upon their simulation of shipping company operation processes rather than upon the shipping companies themselves.

C. Operations Systems

1. Cargo Booking: This application is an operational information system representing the procedure associated with the booking function. It is of great value to booking agents, cargo receiving clerks, and other dockside personnel. A cargo booking system features the entry, modification, deletion and transfer of bookings, and can implement the assignment of booking priorities and cargo "shut-outs" procedures. It provides status reports and booking lists which can list bookings by load port, destination port, port pairs, shipper, and consignee. Another goal of a well-designed cargo booking system is to provide source data for the voyage pro forma and cargo documentation systems.

2. Container Control: This application system is closely related to cargo booking and brings order to the task of tracking a container's movement, from both a physical and revenue standpoint. The system is used as a locator and for container reporting, thereby providing container control clerks with current information on available units, and as the facility for calculating both "per-diem" charges and intermodal leasing costs. The system can also provide management information services by producing reports on container utilization rate, "bottlenecks," and other exception reporting.

3. Ships Scheduling/Voyage Reporting: This extensive application system, although primarily an operating information tool, also has planning and management information system qualities. Its planning capability is exercised by the scheduler being able to make tentative decisions on scheduling his ships first and then examining the impact upon overall fleet operations. With it, fleet scheduling staffs are able to set up new voyages, post changes to voyages currently under way or already scheduled, and allow the system to adjust automatically those parts of the schedule which chronologically follow changed events. From this system, shipping company management acquires up-to-date reports on current fleet status and position, vessel schedule, and voyage operational performance and profitability.

4. Vessel Performance Reporting System: In addition to its role as the principal ship-sourced data retrieval module of the marine data system, it provides marine industry management with consolidated reports on most aspects of fleet operations. The system monitors actual performance of vessels at sea, providing reports on abnormal operation on a "management-by-exception" basis. It also provides ship's daily position, ETA, cargo and fuel status, as well as other operational data, such as machinery status and performance information identified as important by the operations department. Capture of shipboard data is a function of the sophistication of the overall system design, ranging from transcription of ships' logs upon completion of voyages to daily data collection via satellite communications.

5. Maintenance Scheduling System: This application system implements the generation and tracking of preventative maintenance schedules for both shipboard equipment and shoreside facilities. It provides an update to shipping companies' management as to the status of their fleet preventative maintenance program.

6. Cargo Documentation/Billing: This application system, common to all liner operations, reconciles bookings, bills of lading, and load lists to produce ship manifests and invoices thereby completing the cargo document cycle. Another purpose of this system is to generate automatic posting to a journal entry file in the general ledger package and to the accounts receivable package, of the marine accounting system, as well as to provide source input to a cargo statistics system.

7. Seamen's Personnel File System: This record-keeping system is used to maintain information on the pool of seagoing personnel eligible for employment within the industry as well as of those currently assigned billets on ships. The system could also support personnel record-keeping on nonseagoing marine industry staff. The system will provide rapid access to personnel data often required; for example, an individual's rank, qualifications, insurance coverage, dependent information, assignment status, etc. The system is also used as a searching tool to find candidates for a specific assignment, as a function of qualification or availability.

D. Accounting Systems

1. Marine Accounting System: Although marine accounting procedures resemble standard business accounting practices, the differences are significant enough to render standard accounting packages marginally useful for the marine industry. One special feature of a shipping company's general ledger is the method of maintaining consolidated statements and subsidiary accounts. By this it is meant that the accounting system must view the financial structure of the shipping firm as a consolidation of statements of several operating companies, then of individual vessels, then finally (from an income standpoint), of individual vessel voyages. At the same time, an overall shipping company statement is viewed as derivative of its chart of accounts each of which possesses subsidiary accounts, by operating companies, then by ship, then by individual voyage.

2. Inventory Control/Purchasing and Receiving: This application system is quite flexible as to the level of sophistication which should be implemented. One version would be an inventory reporting system in which stocking and withdrawal activities are captured as input data and inventory status, inventory valuation, summary inventory withdrawal activity, and reorder requirements are reported. More elaborate systems would tie into purchase order and accounts payable.

In addition to its general ledger package, a marine accounting system contains accounts receivable, accounts payable, and payroll (both normal and off-shore) packages.

The Integrated Marine Data System has been shown in terms of interrelated components or subsystems, each component responsible for assisting management in accomplishing one or more functional tasks. What is stressed is that the individual components can be implemented one at a time in a modular fashion. The concept of an integrated system at the outset is important so that whatever subsystems or components are initially implemented, they will fit into the overall integrated systems without costly revisions and modifications. It is important to initially focus on the end objectives of a total marine system and the selection of an approach to reach the final objectives will be acceptable so long as the overall system has been designed to be implemented in a modular fashion.

Use of an Integrated Marine Data System for Training Purposes

One of the limitations, if not the greatest limitation in the use of management systems, is the acceptance by the various company personnel who would be involved in its operation and use. This goes all the way from the general manager to the clerical personnel. The use of these new systems involves learning new techniques, such as how management will use the large amount of data immediately available which should be used in the decision-making process. In the past, the manager could often make his decisions based on intuition or past experience, but now he is forced into a more complex process. In fact, surveys have found that there is a fear of receiving too much information rather than not enough. The forced discipline of entering operational data on a daily basis is often resisted by clerical people who previously had the option to collect and file the information when they felt it should be done.

It is obvious that these new techniques will require additional training within the company. It is unfortunate that very few educational institutions give today's student the required practical background in this area. New methods must be developed to provide this required training both within the company and the educational institutions. The use of a shipping company simulator is one of the answers to this training problem. A shipping company simulator is essentially a duplicate of an Integrated Marine Data System previously described. Since these systems are multi-user, time-sharing systems, where a number of people are interacting with the computer at the same time, the use as a simulator does not mean adding additional equipment but simply separating data files. The modular system approach would allow training on a departmental level and also on a company level.

As an example of how it could be used, the data files may contain actual characteristics of the company's vessels, as well as other relatively fixed operating data. Proposed voyages and cargoes are entered, and the student may try various courses of action and note the immediate effects on profitability or cash flow. Any number of standard cases may be set up, representing typical operating conditions for a trade, and then operating variables changed, representing possible decision cases that must be met. The instructor may set up a standard schedule and then eliminate cargo or close a port because of a strike. The student must then react to these changing conditions by rescheduling vessels, cargoes carried, etc. Figure 5 gives a simplified diagram of such a simulator.

The system may be used to any level of sophistication required since it, in effect, represents the actual operating variables of the company. This would include changes in bank interest rates or currency exchange rates or the purchase of new vessels for a particular trade.

The main difference here, as compared to past efforts in this area, is that we are dealing with actual operating management systems rather than company economic planning models developed quite separately from the actual operation.

It is anticipated that these techniques will be used in the future in educational institutions to teach shipping management, as well as in the start up of new shipping company ventures, where the management system can be designed and used as a training

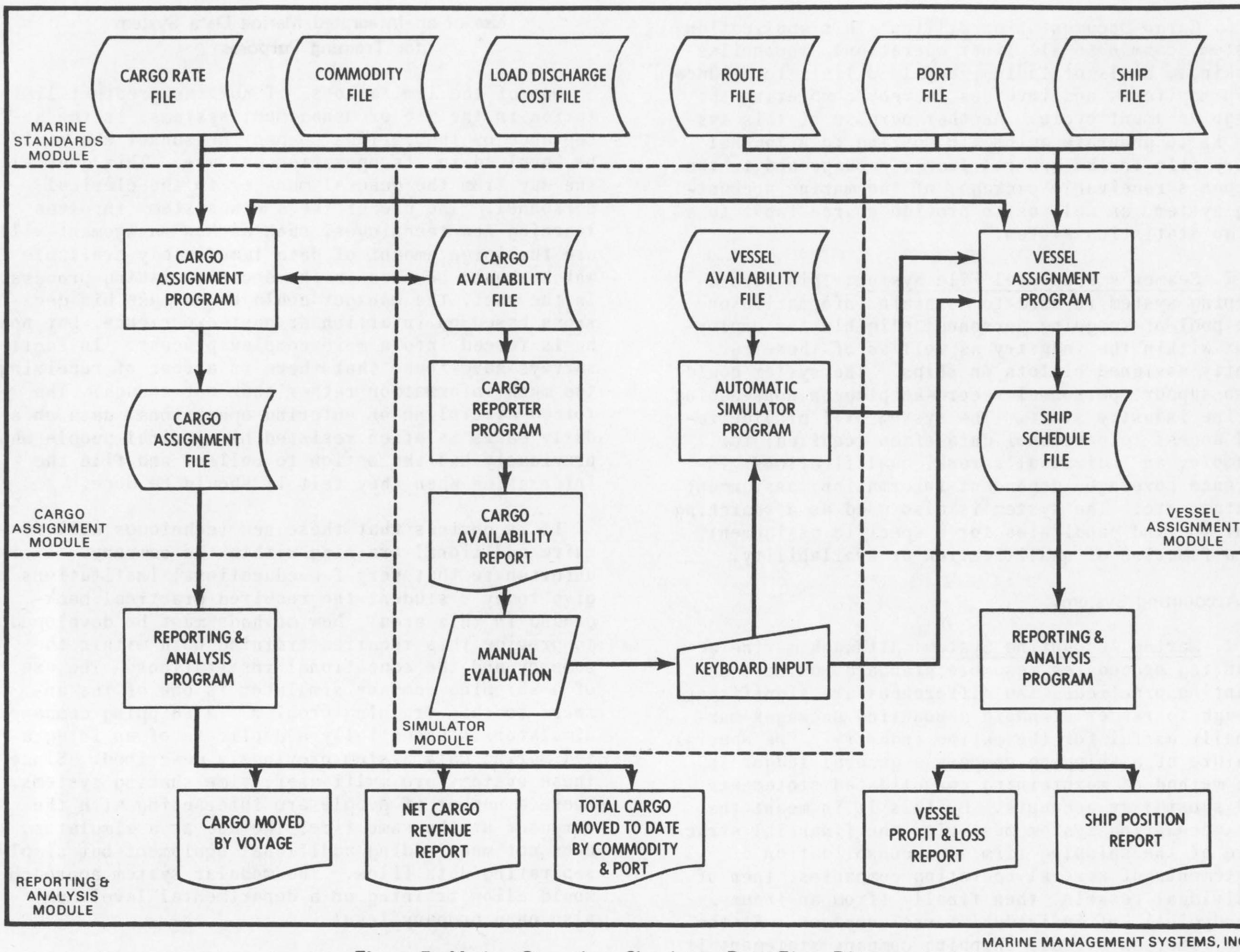

Figure 5: Marine Operations Simulator, Data Flow Diagram

tool prior to the actual start of the operation. It is obvious that it is more economical to practice on a shipping company simulator than on actual vessels.

Management Information System Costs

An obvious question is whether the described management information systems can be economically implemented within a shipping company. There are no quick, easy ways to implement these systems, but the amounts of money involved in shipping operations today are so large, that better management decisions can provide big pay-outs. The first step in answering this question is to look at a breakdown of what the costs are. A common mistake in the past was to look at the computer equipment as the major cost item. This is not true today because the computer costs have been steadily dropping at the same time the capabilities are increasing. The major cost is the design and development of the software (programs) to carry out the required functions on the computer. If the shipping company chooses to develop their own programs completely themselves, then an estimate of the programming cost to the computer equipment cost would be about five to one. If the shipping company can use standardized programs already developed, then this ratio can be considerably reduced.

It should be recognized that the industry and organizations are continually changing and, therefore, some management systems requirements are continually changing. A management system cannot remain static and system support costs to incorporate these changes should be included in the overall cost estimates.

Another cost item concerns data communications. Since most marine operations are international in nature, the information should be collected in a quick and effective method both from foreign offices as well as the vessels themselves. This is an area that is changing very quickly because of new technology, particularly in the satellite communications area.

All these items should be carefully evaluated in a realistic manner before proceeding with the implementation of a system.

Computer and Communications Equipment Today

New technologies have had a major impact in the last few years. Where in the past the batch accounting computer was the least expensive way of processing data, with the familiar punch card input, today the higher cost of labor and lower cost of computers is making the multi-user on line systems more economic. The goal is to reduce the number of people handling the information and have the end user react directly with the computer through keyboard/display terminals on their desk. This, of course, gives the user a much faster response which is considered necessary in the marine business environment.

Today, low cost, multi-user, mini-computer, timesharing systems are being installed in shipping companies. These systems have the advantage of very flexible communications capabilities to other computer and communications systems. They may be connec-

(please turn to page 26)

Natural Language Access to a Large Data Base

Dr. D. L. Waltz
Coordinated Science Laboratory
University of Illinois
Urbana, IL 61801

"PLANES includes an English language front end with the ability to understand and explicitly answer user requests and to carry on clarifying dialogues with him, as well as the ability to answer vague or poorly defined questions."

Introduction

A prime obstacle for non-technical people who wish to use computers has been the need to either learn a special language for communicating with the machine or communicate via an intermediary. We feel that the time is ripe for computers to be equipped for natural language systems which can be used by persons who are not trained in any special computer language. In order for such systems to be of value to a casual user, the systems must tolerate simple errors, must embody a degree of "common sense," must have a relatively large and complete vocabulary for the subject matter to be treated, must accept a wide range of grammatical constructions, and of course must be capable of providing the information and computations requested by the user.

Researchers at the University of Illinois Coordinated Science Laboratory are developing such a system called PLANES (for Programmed LANguage-Based Enquiry System) under ONR sponsorship. PLANES includes an English language front end with the ability to understand and explicitly answer user requests and to carry on clarifying dialogues with him, as well as the ability to answer vague or poorly defined questions. We are also building a library of associated programs which includes functions for recognizing patterns within the data base and for alerting a user when certain patterns of data occur which are of interest to him. This work is being carried out using a subset of the Navy 3-M data base of aircraft maintenance and flight data, although the ideas can be directly applied to other record-based data bases, both military and non-military.

Historical Perspective

Systems which retrieve information requested in English from a data base have long been a subject of interest for computer scientists. For example, BASEBALL /1/, written in 1961, answered questions about baseball data containing month, day, place, teams and scores for each game in the American League for one year. In this limited context, a very small vocabulary was sufficient, and relatively few types of questions could be asked at all. Furthermore, a user's language was severely constrained. Sentences could contain no dependent clauses, no logical connectives (like "and," "or" and "not"), no constructions with relations like "highest" and "most," and no reference to sequential facts, as in "Did the Red Sox ever win six games <u>in a row</u>?" Some examples of questions BASEBALL could answer are:

> Who did the Red Sox lose to on July 5?
> Did every team play at least once in each park in each month?
> What team won 10 games in July?

BASEBALL operated by parsing its questions, and then transforming the parsed question into a standard "specification list." The question-answer routine took this canonical form as the meaning of the question. Thus, "Who did the Red Sox lose to on July 5?" was transformed into the specification list:

Team (losing)	=	Boston
Date	=	July 5
Team (winning)	=	?

Aside from its grammatical limitations within its domain of expertise, BASEBALL had the following limitations:

1. It could only be extended to new domains by extensive reprogramming.
2. It either understood a sentence fully, or did not understand it at all — no provision was made for saving partially understood sentence portions or for interacting with the user to ask clarifying questions.
3. It could not understand pronoun reference.
4. It had no ability to accept declarative information; it was not possible to add to its data base by telling it "The Red Sox beat the Yankees on July 10."
5. A user could not add procedural information, e.g. one could not add to its linguistic ability, nor could one give it advice in any form.
6. Because its universe of discourse was so limited, BASEBALL's writers simply never had to worry about handling ambiguous requests.

In contrast, there exist programs today which exhibit all of these abilities that BASEBALL lacked, at least to some degree. I will briefly describe

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two such programs, those of Woods et al. /2/, and Winograd /3/, and will then describe our work on PLANES. A number of references to other related work are provided at the end of this article for readers interested in learning more about this area.

Woods's LUNAR System

The LUNAR system /2/, written by William Woods and a number of co-workers at Bolt, Beranek, and Newman, Inc., answers questions about a fairly large data base of samples of lunar rocks and soils. While the data base, like BASEBALL's data base, contains only a small number of data types, the LUNAR system is much more flexible than BASEBALL, most dramatically in its linguistic ability.

It is able to accept grammatically complex sentences, involving nested dependent clauses, comparative and superlative adjective forms and some types of anaphoric reference. As examples, Woods's system can answer all of the following questions:

— What is the average concentration of aluminum in high alkali rocks?

— Has the mineral analcite been identified in any lunar samples? What are those samples?

— Give me all model analyses of lunar fines.

— List the rocks which contain chromite and ulvospinel.

— What minerals have been identified in lunar samples?

— What is the concentration of La in rock S10034?

LUNAR was demonstrated at a geology conference only six months after work had begun on the project; the system was able to answer 78% of the questions solicited from the audience, and was judged to be able to anwer 90%, save for bugs remaining in the program code.

Woods's system uses an augmented transition network (ATN) to parse sentences /4/, and then generates a formal query by patching together the code fragments which represent each phrase in the sentence. Like BASEBALL then, it attempts to produce something like a specifications list, except that it has a much larger set of lists to choose from, and is more clever about concatenating them.

Winograd's SHRDLU

A program called SHRDLU /3/ complete in 1971 by Terry Winograd at the Artificial Intelligence Laboratory, MIT, is able to answer questions, some quite complex, about a simple data base representing a visual scene in a blocks world (see Figure 1). SHRDLU can display its world on a CRT screen, and simulate the manipulation of blocks in the world with its own "hand." In addition to questions, SHRDLU can understand declarative sentences (e.g. "I like pyramids") and imperative sentences ("Pick up a red cube") as well as procedural statements (e.g. "A steeple is stack containing two green blocks and a pyramid"). SHRDLU keeps a record of its goals and subgoals, so that it is able to carry out dialogues like those below, given the sequence of actions from Figure 1.

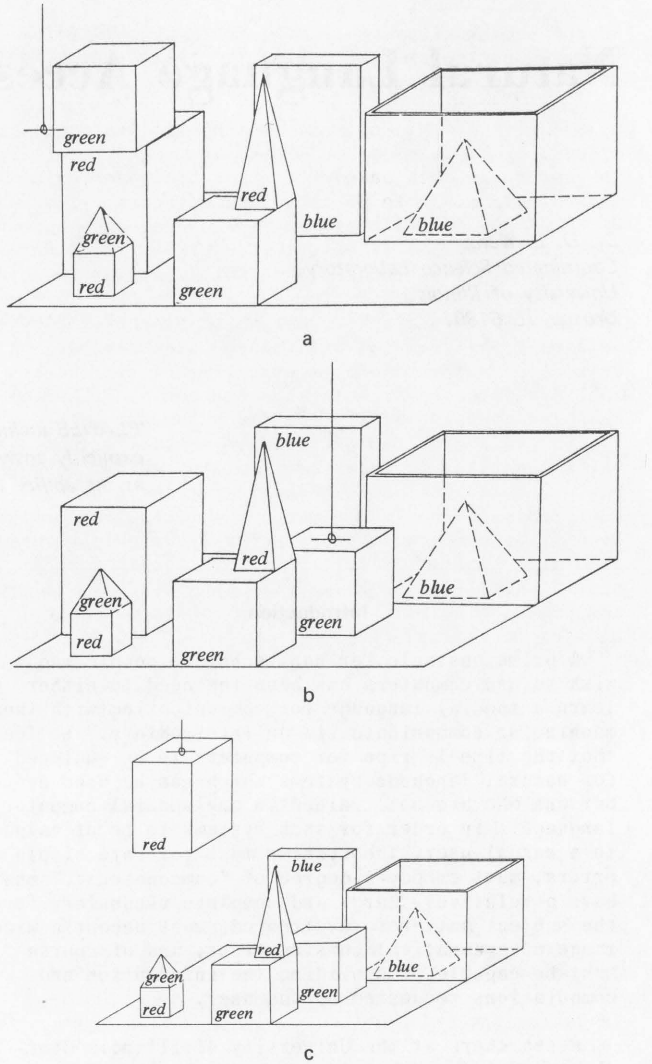

Figure 1: Block World

User:	Why did you pick up the green block?
SHRDLU:	To get rid of it.
User:	Why did you do that?
SHRDLU:	So I could pick up the red block.
User:	Why did you do that?
SHRDLU:	Because you asked me to.

Furthermore, it records declarative information in a form that allows it to use the information either to answer questions or to carry out instructions. Thus, after being told what a steeple is (as above) a user may ask, "Are there any steeples on the table now?" to which SHRDLU will answer, "yes" or "no" appropriately, using the procedural information to check for an instance of a steeple in the data base. Alternatively, the user may say, "Build one," in which case SHRDLU will do so, using the same definition to construct a program to carry out the building of the structure.

SHRDLU can carry out a dialogue with a user to disambiguate sentences. For example, if asked, "Are there any purple pyramids on the red block?" it may in turn ask the user, "Do you mean (1) directly on top of or (2) supported by?" unless the answer in both cases is "no."

Finally, as illustrated throughout this section, SHRDLU can handle pronoun and phrase reference (e.g. "Why did you do that?" "Build one.") and it can accept arbitrarily complicated sentence structures. (E.g. "Does the shortest thing the tallest pyramid's support supports support anything green?")

SHRDLU does this by interpreting all sentences as procedures (i.e. programs) which are then executed to search its data base, or to run block manipulation programs, or to generate new programs. It uses MICROPLANNER /5/, a programming language designed especially to make it easy to find items which satisfy a goal, like (GOAL (?X IN BOX)), either by searching the data base for an item ?X which is in the box (pattern directed data base search), or by calling programs which will change the scene and data base so that there is some item ?X, in the box (pattern directed procedure invocation). MICROPLANNER also contains facilities for automatic backup, so that variables can be assigned tentative values which can later be taken back if they do not work out. Thus, the MICROPLANNER program shown below represents the English sentence, "Pick up any yellow block in the box which supports a pyramid;" the program will automatically try various values for ?X and ?Y until it either succeeds in satisfying all the goals or until it has exhausted all possible choices for ?X and ?Y.

```
(GOAL (?X IN BOX))
(GOAL (?X IS-A BLOCK))
(GOAL (COLOR ?X YELLOW))
(GOAL (SUPPORTS ?X ?Y))
(GOAL (?X IS-A PYRAMID))
(GOAL (PICK-UP ?X) (USE FUNCTION-PICK-UP))
```

The PLANES System

Like LUNAR, PLANES /6/ is designed to operate on a real data base, but PLANES operates on a much larger data base with a wider universe of discourse. In addition, PLANES will perform much more complex data base operations, and is able to use strategy in searching.

To provide an idea of our long range goals, a sample scenario of what we hope to be the eventual operation of our system is given below:

User: How many Phantoms required unscheduled maintenance in April 1975?

PLANES: Thirty Phantoms. Do you want to see them?

User: No. Did any of these require radar maintenance?

PLANES: Yes, three of them. Do you want to see them?

User: Yes.

PLANES: Phantom 159829 required a new radar screen. Phantom 159772 required a new power supply. Phantom 158336 crashed as a result of radar failure.

User: Did any other planes crash?

PLANES: I assume you mean during April 1975. Two other planes crashed: a Phantom and a P3.

User: Is it true that in both cases and April flights occurred while on the fuselage?

PLANES: I cannot understand your question. It is non-grammatical and meaningless.

User: Is it true that both Phantoms were fron the same squadron?

PLANES: I assume you mean "from" instead of "fron." Yes both planes were from the same squadron.

User: Is there anything else in common between the two planes?

PLANES: Yes, both were serviced on April 24th by maintenance group HEBRON FMFPAC.

The following sections describe the data base and our progress on problems which must be solved in order to realize the scenario; this includes progress on representation of common sense information and procedures on problems of pronoun reference and storage of partial results on the ability to answer vague or poorly defined questions, and on the ability of the system to recognize when requests are meaningless or too poorly formulated to answer.

The PLANES Data Base

We have obtained a data base from the Navy 3-M Data Base for Aircraft, Mechanicsburg, Pa., consisting of detailed records of aircraft maintenance and flight information extending over a period of time. Each time a plane is serviced, a record is made including such information as the time and duration of the maintenance, who performed it, what action was taken, which parts were used or cannibalized, the manufacturers of these parts, whether or not the service was scheduled or unscheduled, and so on. Records on the number of flights and the number of hours in the air are also kept for each plane. There are roughly thirty different record formats which occur in the data base, each containing between ten and twenty separate "fields," where each field encodes information like the date of the action, type of aircraft, serial number of the aircraft, type of malfunction, component serviced, the work station performing maintenance, and so on. A library of search routines for extracting records and fields has been compiled /7/.

Pronoun Reference

Pronouns and referential phrases can be handled by the system in the following way. Whenever the system matches a phrase referring to time (such as "April 1975") or a type plane (e.g. "A7"), etc., the system stores this information in context registers. When pronouns occur, the system identifies the type of item (or items) to which that pronoun could point, and if the type of item is unique, the system substitutes the value of the appropriate context register for the pronoun. The system can decide what type of items could be referred to by a pronoun by matching the sentence against its prestored request forms. Context registers are also maintained for a answers to earlier questions, so the system can answer follow-up questions, as in:

(S1) How many engine maintenances did Phantom number A49283 have during April 1975? or

(S2) Of these, how many were unscheduled?

Figure 2 shows a portion of the prestored request network, and Figure 3 shows the prestored request form associated with the network of Figure 2. To show how pronoun reference is handled, suppose that the request:

(S3) Please tell me if Phantom number A49283 had any engine maintenance during April 1974.

is given to the program. This request will match the nodes leading to prestored request form 1, will set context registers *specific-planes to ((plane-type F4)(tail-number A49283)), *maintenance-actions to ((type-equipment engine)(type-maintenance any)) and *time-period to (time-period April 1 1974 April 30 1974).

The request meaning skeleton will then be instantiated, and the message:

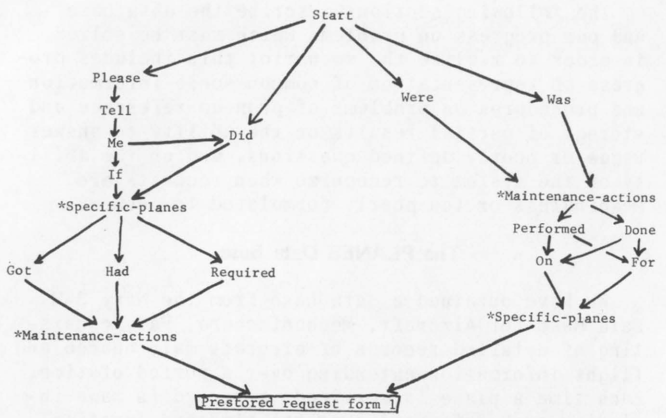

Figure 2: Portion of Prestored Request Network. Nodes visited in matching (S1) are circled (see text).

(S4) Is it correct to assume that you want to know if the F4 with tail number A49283 had any engine maintenance between April 1, 1974 and April 30, 1974?

typed out to the user. If the user types "yes," then the program will execute the instantiated search function skeleton and fill in the spaces of the answer skeleton to produce something like:

(S5) Yes, three engine maintenances were performed on F4 number A49283, one on April 6, 1974, one on April 10, 1974, and one on April 27, 1974.

Suppose that sentence (1) is then followed by:

(S6) Did it have any unscheduled landing gear maintenance?

This will match the same prestored request form as did sentence (1), but in this case, "it" will match *specific-planes, and the contents of the current context register for *specific-planes will be assumed to apply for this sentence also.

To complete the example, when the program attempts to fill out the request meaning skeleton (see Figure 3), it will note that a value for *time-period is needed, and will obtain this from the *time-period context register also. Of course, as always the program will check with the user to make sure that it has correctly interpreted his meaning before continuing.

"Common Sense"

We would like to trap certain types of "unreasonable" requests without actually performing a data base search for answers. For example the requests:

(S7) Did any Phantom have more than 500 engine maintenances during August 1973? or

(S8) Did any Skyhawk crash more than three times last month?

are suspicious. Whenever a request form includes a comparison with a number, a check can be added to the request form, using simple tables giving an order of magnitude estimate for items like the number of man-hours for various types of maintenance, average frequency-of-failure rates, and information about the fact that certain events, e.g. crashes, typically happen only once to a particular airplane.

```
1. Request meaning skeleton:

     (IF *SPECIFIC-PLANES HAD *MAINTENANCE-ACTIONS  *T-P)

2. Data base search function:

     (FOR ALL XI/(*SPECIFIC-PLANES (*P-TYPE  *MAINT  *T-P)):
          (MEMBER (MAINT-FIELD)  *MAINTENANCE-ACTIONS);
          (RETURN (LIST  (TAIL-NUMBER) (MAINT-FIELD) (DATE))))

3. Answer skeleton:

     ((NOT (NULL ANSWER))(LIST "YES (LENGTH ANSWER)
          *MAINTENANCE-ACTIONS "WERE "PERFORMED 'ON
          *SPECIFIC-PLANES  (ENUMERATE ANSWER '(ONE ON))))

     (T  '(NO))
```

Figure 3: Prestored Request Form 1

It is a long range goal of this research to have the system answer vaguely formulated questions like:

(S9) Are there any common factors in the maintenance histories of the two Phantoms which crashed last month?

In order to answer such questions, the system must have an understanding of what "common factors" are: similar events or event sequences, servicing by the same shops, the missing of periodic services, failures of the same subsystems, etc. Clearly, we do not want the system to provide an answer like:

(S10) Both aircraft have 7 as the fourth digit in their serial numbers.

Search Strategies

We are in the process of adding the ability of using simple strategies to make searches for data more efficient. Using the same facts which allow the system to abort searches in the event of "unreasonable" requests (see the preceding section) the system can order its search procedures for fastest operation. For example, suppose PLANES is asked:

(S11) Which of the Phantoms which crashed in May had engine maintenance in April?

There are three possible strategies:

STRATEGY 1:
Find the set of all Phantoms which had engine maintenance in April, then find the set of all Phantoms which crashed in May, and intersect the two sets.

STRATEGY 2:
Find the set of Phantoms which had engine maintenance in April, then look through May data; for each Phantom which crashed, see if it belongs to the engine maintenance set.

STRATEGY 3:
Find the set of Phantoms which crashed in May, then look through April data; for each Phantom which had engine maintenance, see if it belongs to the crashed set.

Clearly strategy 3 is the best; if no planes crashed, then we do not even need to look through April engine maintenance data at all.

We are also examining methods for allowing a user to interactively specify strategies to the program, and ways of having the program use knowledge about a user (e.g. whether he is a manager or an engineer) to help interpret user input and questions.

Alerters and Pattern Recognition

One special type of search strategy we are investigating involves identifying "interesting" patterns of data, and setting up programs which watch for such patterns to occur. (Programs which watch for patterns are usually referred to as "demons.")

Our work in this area has so far been concentrated on data analysis; we would first like to have a good idea of the types of patterns and relations which exist and which are of interest. To this end we ordered and received detailed descriptions of serious aircraft accidents involving mechanical failures from the Naval Safety Center, Norfolk, Virginia. These descriptions contain a narrative of follow-up accident investigations, and attempt to identify causes of the accidents, based in part on the maintenance records of the aircraft involved. We are using these descriptions as a model of the type of action we would like our system to be able to perform automatically.

Once we are able to identify and characterize patterns which lead to problems, we intend to investigate and program demons which can watch for such patterns to occur, and notify a user when a potentially dangerous situation exists. In the long run, we would like to program systems which will "browse" through the data base, looking for new cause-effect relationships, and automatically setting up their own demons to watch for possible trouble.

Figure 4 shows a block diagram for the overall organization of our system. Both strategies and pattern recognizers/alerters are associated with the box marked "Interpreter (Standard Functions-Different Realizations)." Strategies in PLANES are merely different search realizations of the same logical request.

Relationship to Other Work

I have referred to our work as an enginerring approach because it falls outside the boundaries of traditional linguistics. There is no dictionary entry for a large fraction of the words "understood" by the system; in general, words are defined implicitly within each pattern in which they occur in the prestored request network. Transformations are

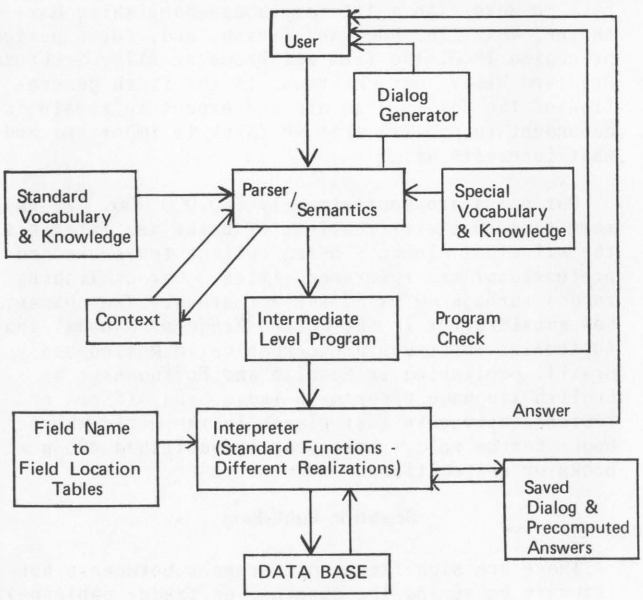

Figure 4: Block Diagram of PLANES

not used; for example, both active and passive forms of requests are prestored.

Some parsing ability does exist within the matching programs for phrase types. Phrase types are in general either prepositional phrases or noun phrases, and are analyzed in a manner directly drawn from Winograd's noun phrase analysis /3/. Some other linguistic mechanisms are also based on Winograd's work.

The way in which the meanings of requests (i.e. prestored request forms) are stored is very similar to the way meanings are stored in Woods's LUNAR program /2/. Overall, Woods's program is the most simular precursor in intent and operation, though the data base we are using and the variety of questions which can be asked in our system is much greater.

It should be obvious that this system does not attempt to model the internal mechanisms of human language understanding; it is an attempt to solve the problem of making a large body of data accessible via natural language, using no more mechanisms than are absolutely necessary. The environment of the program is quite remote from that of a general language understanding system. Questions are all either in the past tense or present tense, and present tense is used only to refer either to the dialogue or to things which are always true. The number of objects, events, and relations in the program's universe of discourse can be easily enumerated. The role of the program with respect to a user is always that of a data retriever.

Nonetheless, there are certain common issues which a general understanding system must face. One particularly pertinent issue concerns the appropriate unit of knowledge. Should words be defined explicitly, as in dictionary definitions, or implicitly, as in this system? Should world knowledge and linguistic knowledge be stored separately or should they be merged as in this system? I believe that a general language understanding system can benefit from some of the ideas in this paper.

In order to have available the knowledge contained in the prestored request network, something akin to it must be constructed. Certainly, such facts as "Airplanes require maintenance" do not emerge from concatenating isolated word definitions of "airplane," "require," and "maintenance," unless these facts are somehow made part of these or related definitions (i.e. machines require maintenance, and an airplane is an airplane is a machine).

Similarly, one cannot write a program in which data base search functions can be incrementally constructed (as in SHRDLU /3/), and in which at the same time meaningless requests can be trapped, without writing a program larger and slower than ours.

Whether or not one should transform all input sentences into a canonical form to save on world knowledge storage space, or whether all surface forms should be matched directly is much more debatable, but the storing of surface forms does allow non-grammatical or partial input sentences to be tolerated easily.

Advantages for Data Base Question Answering Systems

There are some distinct advantages to the type of system described in this article.

(please turn to page 26)

Publishing and Technological Developments: An Interim Report – Part 1

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

"Scientific and technical publishers cannot afford to be sedentary, awaiting the arrival of a literary agent or an unsolicited manuscript. . . . They must be the intellectual companions of young and developing teachers."

Publishers apparently hold the illusion that the world is fascinated by their business. I suspect they delude themselves, but perhaps this group is more than ordinarily concerned with books and authors, if not with the day-to-day operations of our Dickensian trade. I will talk about several disparate and perhaps, seemingly, unconnected topics. First, I will make some comments on the publishing industry and the special nature of the part of publishing that I represent; then I will cover some recent developments that affect our books and markets: computers, new technology, copyright and censorship; and finally, the state of the college textbook market.

In order to bring historical perspective to my discussion of these topics, I have searched the literature for comments on the publishing trade, one that William Jovanovich has called "one of the most civilized of worldly pursuits."

Cervantes: "There are men that will make you books and turn 'em loose upon the world with as much dispatch as they would do a dish of fritters."

Mark Twain: "All publishers are Columbuses. The successful author is another America. The reflection that they — like Columbus — did not discover what they started out to discover, doesn't trouble them. All they remember is that they discovered America; they forgot that they started out to discover some patch or corner of India."

Lord Byron remarked, "Now, Barabbas was a publisher —," not presumably, in the context of his overall interest in the New Testament.

Sir Stanley Unwin, the famous British publisher, said: "It is doubtful whether, in proportion to their numbers, any other class in the community comes in for so much criticism or has so much publicity given to its every shortcoming. The sins of the blackest of the flock are visited upon the whitest. Columns of The Author left one with the impression that all publishers at all times and upon all occasions are activated wholly, solely and necessarily by evil motives."

Based on an address given to the Friends of the Emory University Library, in Atlanta Georgia on November 13, 1974, and published by John Wiley & Sons, Inc., Copyright©1975.

Publishing, whether one considers it a business or a profession, is a complex activity. The publisher is an entrepreneur, trafficking in ideas. An inordinate number of his ventures fail in the market place. (A trade publisher told me the other day that two-thirds of his books make no money.) The sales life of the books he publishes may be as short as a season; for some there is no life at all. The volatile nature of publishing bewilders bankers and turns Wall Street analysts away, mumbling to themselves. And, yet, this modest-sized industry, whose total annual sales equal one month's billing at General Motors, exerts a substantial influence on education, commerce, the arts and sciences, and on international trade. Frequently, posted notices of its death have been, thus far, exaggerated.

On John Wiley & Sons

To put my remarks in context, I will give you some background on my employer, John Wiley & Sons. Wiley, established in 1807, is one of the oldest publishers in the country. Our reputation is strongest in science and technology, although we have broadened our line in recent years to include all the social sciences, business, history, and English, and now medicine and the health sciences. In the past we were also a literary house publishing Hawthorne, Melville, Poe, and Irving, and, for a period preceding 1848, the firm was known as Wiley & Putnam. Bradford Wiley, our chairman, is the fifth generation of the family. We are and expect to remain independent to publish what we think is important and what interests us.

Our sales are approximately $50,000,000. We have more than 20 classifications of books and materials, the principal elements being college textbooks and professional and reference titles. Our publishing ranges through 60 major subject areas. The company has subsidiaries in the United Kingdom, Canada, and Australia; joint-venture companies in Mexico and Brazil, publishing in Spanish and Portuguese; an English-language program in India; and offices or representatives in most places in the world where books can be sold. Last year we published 425 new books or new editions.

Scientific Publishing

There are significant differences between a nonliterary house and the general, or trade, publisher. We do not enjoy the rare experience of discovering a William Styron or James Agee. The life span of our books tends to be longer. We sell more of them to institutions and by direct mail than to booksellers. Our overseas markets are essential to our successes; at Wiley, a third of our sales volume is international. Our markets are circumscribed by the relatively small number of specialists to whom most of our books are addressed, for example, the national enrollments of seminars in quantum chemistry.

Our titles are stimulating, redolent of romance and far places as, for example, Lewis's Stochastic Point Processes: Statistical Analysis, Theory and Application; Kantowitz's Human Information Processing: Tutorials in Performance and Cognition. Others include Oxidases and Related Redox Systems; Cloud and Bubble Chambers; Aversive Maternal Control: A Theory of Schizophrenic Development.

"Present at the Creation"

Probably the most attractive aspect of publishing is that it is often possible for us to be "present at the creation." Our greatest satisfactions come from projects we initiate and develop with our authors.

Our prices tend to be high, and statistics indicate we tend toward more stable profit margins than other segments of the industry.

Polymer science, now a thriving part of the chemical industry, was in its infancy in 1938. Eric Proskauer, one of my colleagues, sat for a day in a hotel room in Montreal with Dr. Herman Mark, recently arrived from Germany, and laid plans to create a body of literature for this science. From this meeting, in due course, came textbooks, a monograph series, two successful journals, and an encyclopedia.

Organic Syntheses, a series of small books published annually, came from an idea developed at the University of Illinois between Roger Adams and Edward Hamilton of Wiley. They are now the standard reference of every graduate student in chemistry; Volume 54 will be published this year.

About 25 years ago Dr. Walter Shewhart of Bell Laboratories came to us with the idea that mathematical statistics was about to burst forth on the world. From this discussion we jointly developed two series of books — theoretical statistics and applied statistics — totaling 95 titles to date. Statistics courses now abound in the physical and social sciences, and even the study of history moves toward quantification. For example, one of the most controversial books of 1974 was Fogel and Engerman's Time on the Cross (Little, Brown), a statistical economic study of slavery, which won a Bancroft prize.

In the frantic days of curriculum reform after Sputnik, Charles Kittel, the renowned physicist from the University of California, Berkeley, addressed the National Science Foundation. Kittel noted that Wiley and its authors, Resnick and Halliday, had effected a more profound change in the teaching of college physics by a completely nonsubsidized investment of time and money than had any government program backed by lavish public funding.

Experimentation and Innovation

Experimentation and innovation are characteristic of any good publisher, although the failure rate is substantial. We are just now introducing some new concepts for teacher training based on two years of development in Georgia by our author and the State Department of Education. We call it introspective learning. I have seen it change the attitudes and behavior of teachers and students in a dramatic way, with measurable results in the classroom and a sharp decline in drop-out rates. Whether it will be commercially feasible remains to be seen, but it is an exciting concept.

Scientific and technical publishers cannot afford to be sedentary, awaiting the arrival of a literary agent or an unsolicited manuscript. Our success rests on the ability of our procurement editors to anticipate the growth and development of new curricula, sciences, and industries — ahead of our competitors, if possible. They must be the intellectual companions of young and developing teachers.

The Business of Publishing

Total dollar volume of book publishing in the United States has grown in ten years from \$1,686,000,000 to \$3,500,000,000. Scientific, technical, and college publishers now represent approximately \$977,000,000, or 28% of the total. United States publishers last year put out 40,846 new books and new editions compared with 25,000 in 1963. By comparison the British published 33,915 new books; the Russians about the same number as we did.

Twenty years ago Bennet Cerf predicted that because of absorption of independent houses through merger and acquisition, there would be only 10 or 12 publishers left in the country by today but, although his own Random House has become a part of RCA, today's Literary Market Place lists 999 publishing companies compared with 554 in 1954.

Booksellers, reviewers, and some librarians are concerned with the excessive number of books published. Indeed, there are more books than the distribution network can absorb. In the last ten years literary publishers increased the number of titles by about 50%; the scientific and technical group about doubled to 14,931 last year.

Too many books? Possibly yes, but with occupational specialization our authors tend to write more specialized books — what Curtis Benjamin of McGraw-Hill calls, "the twigging phenomenon." Of the development of special topics there appears to be no end, and who is to say where publishers should call a halt? One recalls John Wanamaker's comment about his advertising: "I know I'm wasting half of my money, but I don't know which half." But a natural form of population control may be at hand: the size of investment in new books in the face of rising costs will slow down output.

Developments in the 1950s and 1960s

The years following World War II were good ones, particularly for those of us involved with education. Enrollments grew from preschool levels through the colleges. Advanced degrees were more attainable with government grants and loans, and the Master's and Ph.D. seemed almost to displace the bachelor's degree as a prerequisite to some occupations.

Continuing education became a national habit, not only for adults reaching out for the education they had earlier missed, but for the professional — doctor, engineer, computer designer — who might easily find himself obsolescent as new technologies burgeoned.

(To be continued in next issue)

Waltz — *Continued from page 23*

1. Idioms can be handled very neatly and easily.

2. The system can operate very rapidly and need never do backtracking.

3. The prestored request network allows pronoun reference to be handled in a way that seems intuitively clear and which is simple to implement.

4. Complex search functions can be neatly associated with sentences intended to invoke them.

5. Perhaps most important, the system is simple to write, although the writing may be time consuming, and each application to a new data base would require a substantial amount of rewriting.

Summary

The preceding sections have described a number of parallel, interrelated parts of our work on PLANES, which is aiming toward a much more intelligent, user-oriented system to interface a user with a large data base. While we are working with a specific data base of Naval aircraft data, we feel that the ideas and programs we are generating can be of wide value in both military and non-military applications.

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Weizenbaum — *Continued from page 12*

themselves at such scientific cafeterias as <u>Psychology Today</u>, or on popularized versions of the works of Masters and Johnson, or on scientology as revealed by L. Ron Hubbard. Belief in the rationality-logicality equation has corroded the prophetic power of language itself. We can count, but we are rapidly forgetting how to say what is worth counting and why.

Notes to Introduction

/1/ M. Polanyi, <u>The Tacit Dimension</u> (New York: Doubleday, Anchor ed., 1967), pp. 3-4.

/2/ This "conversation" is extracted from J. Weizenbaum, "ELIZA — A Computer Program For the Study of Natural Language Communication Between Man and Machine," <u>Communications of the Association for Computing Machinery</u>, vol. 9, no. 1 (January 1965), pp. 36-45.

/3/ K. M. Colby, J. B. Watt, and J. P. Gilber, "A Computer Method of Psychotherapy: Preliminary Communication," <u>The Journal of Nervous and Mental Disease</u>, vol. 142, no. 2 (1966), pp. 148-152.

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/6/ J. Weizenbaum, 1972.

/7/ Hubert L. Dreyfus, <u>What Computers Can't Do</u> (Harper and Row, 1972).

/8/ Hannah Arendt, <u>Crises of the Republic</u> (Harcourt Brace Jovanovich, Harvest edition, 1972), pp. 11 et seq. ☐

Story — *Continued from page 18*

ted directly to existing accounting computers as well as directly to data communicative lines.

The major limitation of most modern computer systems today is the method of getting the information in and out of the computer. Since much of the marine operating data must be received from the vessels themselves, the new commerical Maritime Satellite Communications Systems (MARISAT) that will go into operation early next year will provide a major capability in this area. Ships equipped with satellite communications terminals will have the capability of sending operating data directly into their home office management computer systems for immediate analysis and action.

New data communications techniques, utilizing the telephone company/satellite systems, will allow direct transfer of data between foreign offices and the management computer.

(please turn to page 27)

GAMES AND PUZZLES for Nimble Minds – and Computers

Neil Macdonald
Assistant Editor

It is fun to use one's mind, and it is fun to use the artificial mind of a computer. We publish here a variety of puzzles and problems, related in one way or another to computer game playing and computer puzzle solving, or to the programming of a computer to understand and use free and unconstrained natural language.

We hope these puzzles will entertain and challenge the readers of *Computers and People.*

NUMBLES

A "numble" is an arithmetical problem in which: digits have been replaced by capital letters; and there are two messages, one which can be read right away and a second one in the digit cipher. The problem is to solve for the digits. Each capital letter in the arithmetical problem stands for just one digit 0 to 9. A digit may be represented by more than one letter. The second message, which is expressed in numerical digits, is to be translated (using the same key) into letters so that it may be read; but the spelling uses puns, or deliberate (but evident) misspellings, or is otherwise irregular, to discourage cryptanalytic methods of deciphering.

NUMBLE 764

```
              T H E R E
          x     I S N O
          -------------
            S T G N M C
          R T O A H A        C = R = G
        I T N M N S          M = O
      N T I T D H
      -----------------
    = I I E H C S O E G
```

67042 43712 14359 07198

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

MAXIMDIJ

In this kind of puzzle, a maxim (common saying, proverb, some good advice, etc.) using 14 or fewer different letters is enciphered (using a simple substitution cipher) into the 10 decimal digits or equivalent signs for them. To compress any extra letters into the 10 digits, the encipherer may use puns, minor misspellings, equivalents like CS or KS for X or vice versa, etc. But the spaces between words are kept.

MAXIMDIJ 764

SOLUTIONS

NAYMANDIJ 763: Sequence column 17.

MAXIMDIJ 763: There are many more ways than one to sway a woman.

NUMBLE 763: Satan comes in silk and satin.

Our thanks to the following individuals for sending us solutions: Dianne King, Warwick, N.Y.: Naymandij 761 – Frank E. DeLeo, Brooklyn, N.Y.: Naymandij 761; Maximdij 761; Numble 761 – Jean Robbins, Pasadena, Calif.: Maximdij 761; Numble 761 – T. P. Finn, Indianapolis, In.: Maximdij 761; Numble 761; Numble 762 – Maj. Gus Strassburger, Atlanta, Ga.: Naymandij 762; Numble 762.

Story – *Continued from page 26*

Conclusion

This article has attempted to highlight some of the application areas of modern management information systems to marine operating companies. The complexity of the marine industry today will require the mastering of these techniques if shipping companies are to remain competitive. This will require the top management of shipping companies to become involved in the development of these systems since the information coming out will affect their decision-making capabilities. The job cannot be handed to the data processing people because it is primarily a management problem, not a computer problem. The technology and techniques are here today waiting for the managers to apply them.

Unfortunately, there is no easy path to implementation. The first step is for management to educate themselves in what is involved in such a system. When it is recognized that it is not a technical problem but a management problem, then the elements can be quickly understood and the manager will be on his way to mastering these new techniques. □

Sussman – *Continued from page 3*

The privacy model reflects another step in the NBS program to develop guidelines and standards for computer security measures to protect personal data. Cost consideration is one important test of practicality that privacy safeguards must pass.

NBS presented the privacy model at the October workshop in order to invite comments from federal agencies on the model's completeness, accuracy, and ease of use. The privacy model will now be examined for its limitations, accuracy of assumptions, and sensitivity to errors in its input values.

The model was developed under an ICST (Institute for Computer Sciences and Technology) contract to D. P. Management Corporation, Lexington, Massachusetts. Dr. Henry H. Seward, D. P. Management; Dr. Robert C. Goldstein, University of British Columbia; and Dr. Richard N. Nolan, Harvard Business School, presented the model at the workshop. □

Announcing a new quarterly magazine:

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. . . .

March 15, 1976

Dear Colleague,

In our announcements, we said we hoped to publish the first issue of COMPUTER GRAPHICS AND ART, a new magazine on interdisciplinary computer graphics and computer art aimed at the college level, in the spring of 1976.

We have had to delay our original plan, due to a temporary illness and hospitalization of the editor. The first issue of COMPUTER GRAPHICS AND ART is **NOW PUBLISHED.**

An advisory board of distinguished people and a group of contributing editors well known in graphic fields has been assembled. We need your feedback concerning the graphic interests that you have and that you know of. We want this magazine to be useful to you and your colleagues.

Accordingly, this is your invitation to submit material and to begin subscribing to COMPUTER GRAPHICS AND ART. Or you may wish to enter a Library Subscription, whereby you and your colleagues may share this new quarterly.

You and your colleagues are cordially invited to submit papers, articles, computer graphics, photographs, reviews, computer art, ideas, etc. — no holds barred — for us to consider for publication. In addition, your suggestions about authors whom you would like to have papers from will be most welcome. One of our goals is to publish materials on computer graphics early; and then authors can more quickly establish their professional claims for origination of good ideas and programs. Every author receives permission to reprint his or her material unlimitedly, although the magazine is copyrighted by the publisher.

We look on subscribers as colleagues in a mutual effort, and not as listeners in a lecture room.

Your help and cooperation in this mutual undertaking is warmly invited and will be most appreciated. May we hear from you?

Cordially,

Grace C. Hertlein

Grace C. Hertlein
Editor, "Computer Graphics and Art"
Associate Professor
Department of Computer Science
California State University, Chico
Chico, Calif. 95926

Here is your chance for feedback to us:

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