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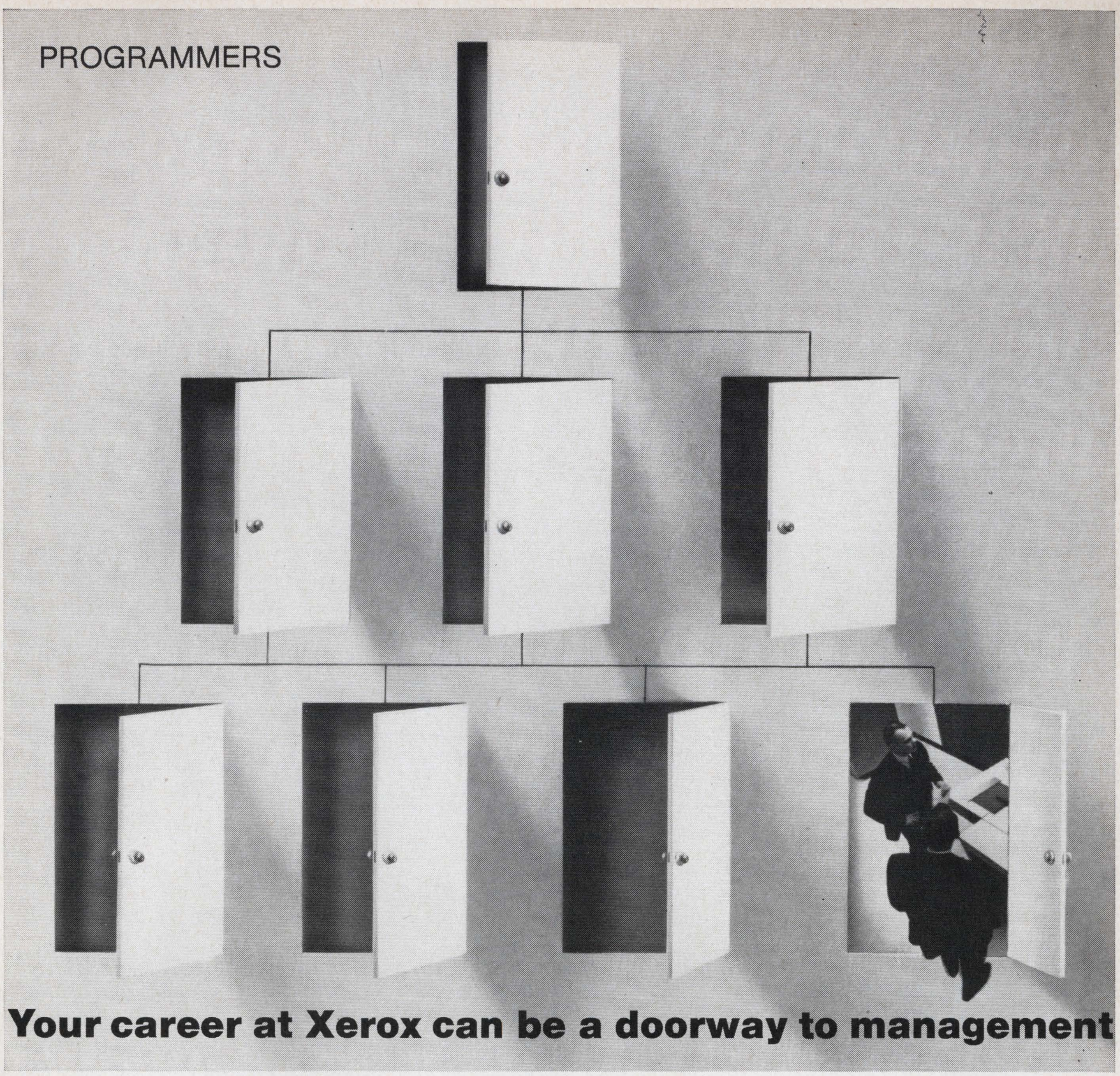

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new installations

The Control Products Division of Texas Instruments Inc., Attleboro, Mass. received a computer-centered circuit designer/calibrator from IRA Systems Inc. The system will speed up the process of economical control of industrial processes.

■ ■ ■

The University of Indiana has ordered a SDS (Scientific Data Systems) Sigma 5 computer to aid in analysis of high-energy physics experiments. The Sigma 5 will be used initially to monitor a precision encoding pattern recognition system. Dr. Jack Martin, Professor of high energy physics at the university stated that the computer is expected to allow the physics group to handle nuclear data five to ten times faster than present methods.

■ ■ ■

North Hudson Hospital in Weehawken, New Jersey, acquired a General Electric 115 computer system to cut costs of hospital administration and to aid in analyzing medical records. First applications for the computer system are for payroll and accounts payable. In the future, the computer will also be used for diagnostic analysis on discharged patients.

■ ■ ■

The Boston Globe has completed installation of a million-dollar computer system to automate hot-metal typesetting and photocomposition. Two Honeywell computers have been connected to 20 photoelectric keyboards and two teletypewriters to control printing functions, while other applications are being directed toward financial management.

■ ■ ■

Applied Data Research, Inc., a computer, software and service company, has contracted to buy 50 PDP 8/I computers from Digital Equipment Corp. during the next 10 months. ADR plans to use the computers in many ways including leasing them to computer users, leasing them in conjunction with its proprietary software product ESI, and using them internally on various ADR research and development programs.

■ ■ ■

United Air Lines' suburban Chicago computer center has installed three Univac 1108–11 computer systems. The systems are part of real-time electronic information network. The network is expected to be fully operational by the fall of 1968.

■ ■ ■

Florida Technical College is installing four IBM 360, model 20 computers. The computers will be of 8000 memory positions equipped with multi-function card machine, printer, two tape drives. It will be available for student application.

■ ■ ■

Interstate Electronics Corporation of Anaheim, Calif., has received two FORTRAN systems from Computer The systems, for use on Interstate's IEC-1010 Computer, include compiler executive, run-time package, library of functions, loader, and run-time monitor.

■ ■ ■

A McDonnell–Douglas Corp. division will use a new RCA Spectra 70/55 computer for the design of aircraft and space vehicles. The system will also be made available to the McDonnell Automation Co's clients.

■ ■ ■

The U. S. Naval Electronics Laboratory received three multi-purpose data communication system units from Communitype Corp. of New York City. The system is a data storage and communication terminal capable of high-speed transmission and reception of digital data.

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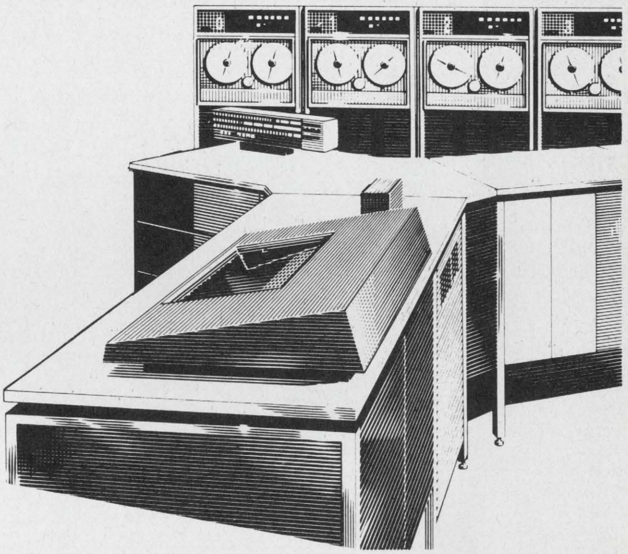

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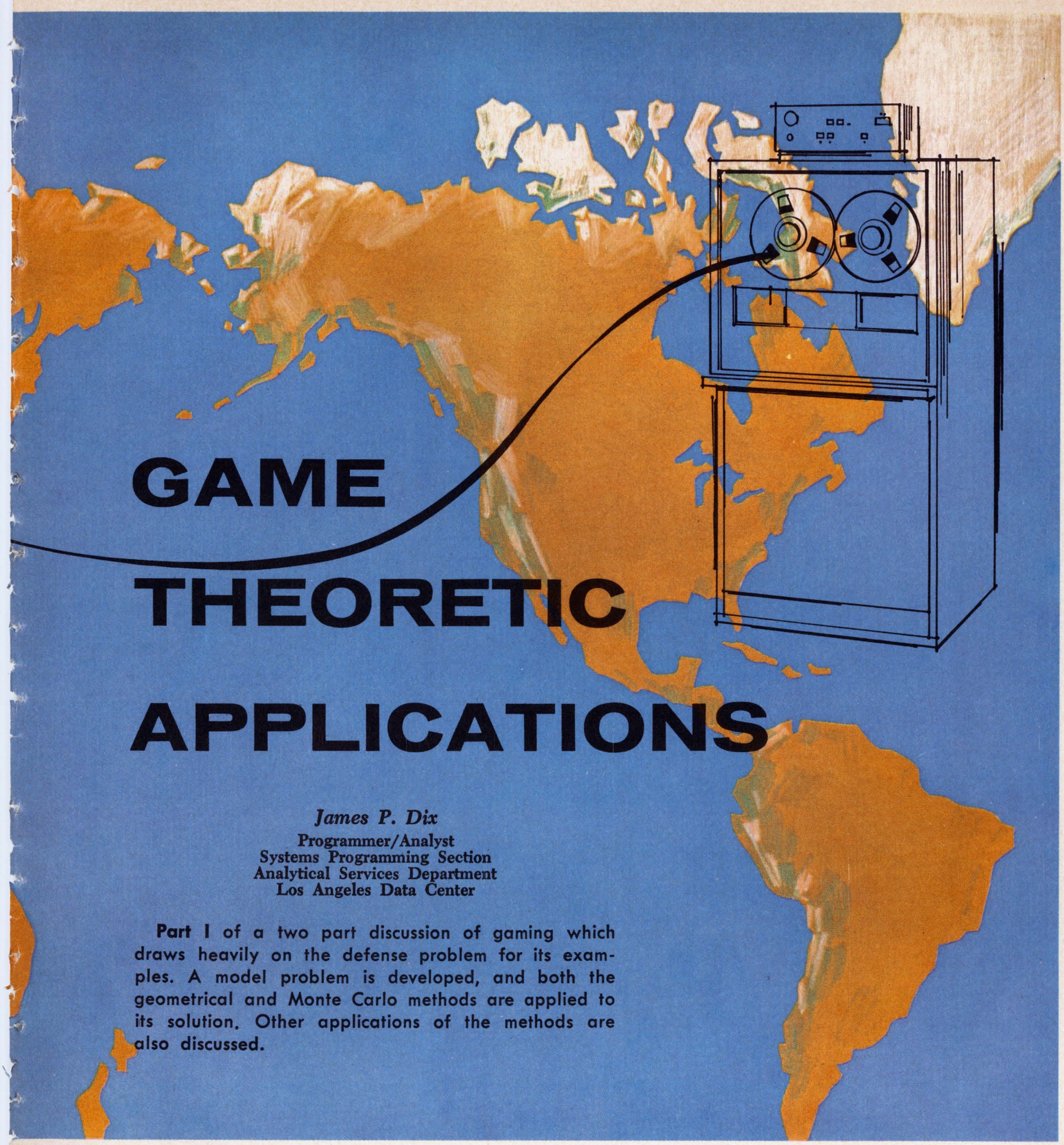
Artist John Desatoff, in illustrating the article by James Dix of Control Data Corp., shows that the incredible complexity of three-dimensional chess is child's play compared to "the ultimate game" of war.

Out of the growing need to better man's grasp of the real world in this technological revolution of today, game theory has emerged. It has given us a new tool on which we can rely when decisions are so difficult. The purpose of this article is to enlighten the reader on a problem with which he might never come in contact but is nevertheless as important a problem as he might ever encounter. Namely, how to cope with rapidly changing military warfare in our times where thousands or millions of people's lives are in the balance.

This article does not pretend to be so general that at once a whole new world of ideas regarding solutions to other applications appear but rather it makes an attempt to find some underlying principles on which problems of this sort can be approached.



GAME THEORETIC APPLICATIONS

James P. Dix
Programmer/Analyst
Systems Programming Section
Analytical Services Department
Los Angeles Data Center

Part I of a two part discussion of gaming which draws heavily on the defense problem for its examples. A model problem is developed, and both the geometrical and Monte Carlo methods are applied to its solution. Other applications of the methods are also discussed.

■ Games of strategy are important. Consider for a moment if you will, some situation (important) for which you, as an adversary, do not know the outcome of your actions before you begin them. A moment's thought should reveal a great number of such situations. But let's not dwell on these; let's think of decisions on which the life or death of millions or thousands of people or even just one person ride on the correct action. This is part of the problem in gaming.

Note that, under this guise, a most important fact about game theory has pushed its way outward. This fact is called value or objective. In order to qualify as a game, the objective(s) of the adversaries must be established. Now then, certain aspects of the play are considered more important than others. These aspects are essentially what we are searching for in gaming. As can be easily seen, though, the importance of a play depends very directly on the rules by which the game is played. Take chess. Suppose the objective of each side is to win the game. The rules state that in order for one side to win he must mate his opponent's king or force him to resign (which states that he concedes that the mate is inevitable). One result of this rule is that "safety of the king" is an important principle. Were the rules changed to, say, make one side, in order to win be forced to capture all the opponent's material, I dare say that the corresponding principle of "safety of the king" would be severely modified. Note also that a change in the objective forces changes in the importance of the plays. For example, you can play the game to have as a result a "good" game. The rules, unfortunately, are not given for this objective and hence the principles one can derive from this are limited. This does not imply that there *are* no rules because in fact there are, but that it would take an application of Psychology or perhaps Philosophy to discover them. It is interesting to note that these rules (laws of nature) in which man is seeking are being mirrored by the importance with which man attributes his plays.

To the subject of real life games, consider a war game where the question of what weapon should be used on this target comes up. Military strategists who seek answers to this question should really say: Assuming that this target's destruction is important, what is the "best" means by which we can destroy this target taking into consideration the overall objective?

What could some of these considerations be?

- **Cost of weapon that would destroy the target**
- **Side effects**
- **Counter attack**

In addition, because of uncertainty, some degree of "confidence" must be attached to the answer.

Taking into consideration these factors, we could come up with an answer. But there is more. What about righteousness? Did Genghis Khan actually lose all his wars even though there were no side effects (essentially), no counter attack and the cost (to his side) was within his economical objectives. The rules of life will probably remain a mystery for a long time.

Back to the strategists who feel compelled to make a decision. They say to themselves: "Let's not worry about what's right or wrong. That's the job of someone higher up than ourselves. Let's merely answer the problem as best we know how without consideration of righteousness." What they are really doing is constraining the game by making an additional rule, thus reducing or eliminating the imporance of the world outside this constraint.

All this is to say that the most important aspects of decision making from a practical standpoint are those which are knowable or observable. For the remainder, we let our "conscience" be our guide. In computer models, we cannot measure this "conscience," hence we must ignore or code around it.

Let us carry the problem further. Cost is a factor which at best is difficult to describe, but in which strategists seem to be most at home. This is mainly due to the simplification that we can reduce every play to a dollars and cents amount or, if necessary, to a number of people not saved or to some other convenient measure. Further, since, during destruction, at least one stockpile is drained at every play (namely, the weapon) a minimization of this cost is usually employed when investigating alternatives.

On the other side of the coin we have retaliation. This is where the gaming comes in. Two factors influence his play. One is ability; the other is motivation. In fact, since it is a reaction, each play of ours can be expected to generate its own reaction based upon his ability or motivation. Motivation in some respect is based upon the change in the ability to retaliate as in the following graphs. Figures 1a, b, and c give a possible representation of this dependence. Figure 1c is a composite of the other two.

This last graph reduces motivation and ability to react to a cost equation. This procedure (or one like it) is always done by strategists before they make their decisions. It is essential if they are going to make any comparison of the opposing forces. Note here that it is beginning to resemble a game with only offensive type weapons. Each side making the next move, in turn, until one side wins. Add to this complications like defensive weapons, passive shelters, backfiring, immoral acts (killing civilians, etc.) and you have some of the elements of a brilliant (and important) game.

Thus in the back-back lines (back in the States) a game of strategy and tactics is taking place long before the play is made or, for that matter, before any play is made. Consider the decision which Secretary MacNamara has been facing for about six years; whether or not to deploy an antimissile defense system, and if so, what size. At first, he said "no" because of ability. The NIKE ZEUS system could not defend against a decoyed attack. Then when NIKE X came along, it was important to decide if we should spend as much as proposed to deploy the system. Of course, it would mean more jobs in defense work in every state in the Union. Congress might even pass such a bill because of this. MacNamara hedged saying that now was not the time to decide. Now, under the influence of President Johnson, he explains that there is a strong chance that Russia (considered as the main opponent) and the United States would be locked in an arms race at a point in history which could lead to great instability and because of the possibility of total disaster would all be wasted effort. Our side is even going so far as to throw in a tactical shot at convincing the other side of the futility of such effort on both sides. This is true gamesmanship!

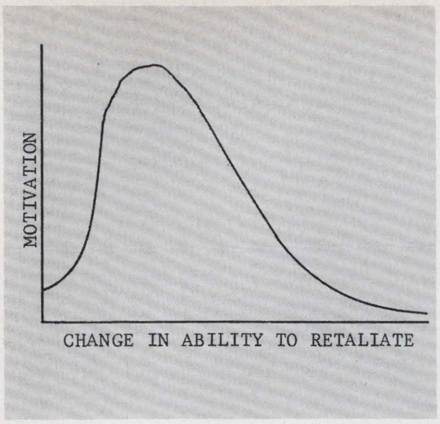


Figure 1a

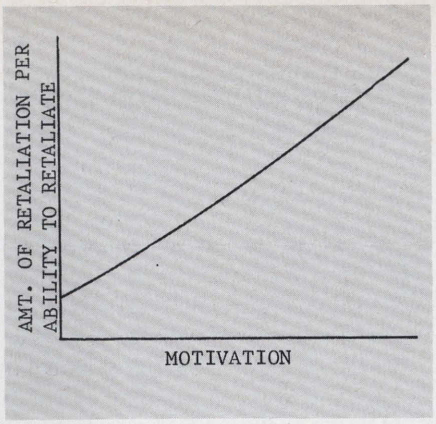


Figure 1b

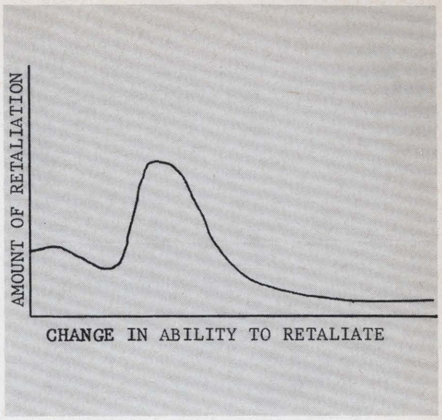


Figure 1c

We have come to an era in warfare where decisions are based not on the outcome of the next battle or the next campaign, but on the entire complex of the socio-political area years in advance. The decision to "escalate" the war in Vietnam is a difficult one. There are many and subtle nuances to each decision. The blockading of the Haiphong port, for instance, could spell disaster if Russia were motivated to retaliate.

The question that comes to mind next is how in the vastness of the technological expansion can we cope with these decisions. How do we know we would even have the ability to make the plays? How do we know that, if we are able to make the plays, they would succeed in their intentions? How do we know what would happen if they failed? What enables us to make decisions about events which have not yet happened and are based upon knowledge of technology which is not yet upon us (both our side and theirs)? Secretary MacNamara has said that our side can defeat their side in missile warfare even though they have deployed an ABM defense system. He continues that this is true regarding any system that they could develop over the next five years.

How does he know this? You say he doesn't really. Can you afford to assume that he does not know this if you were a strategist on their side? Now he certainly does not have any experience in the matter. All the simulation raids in the past have not added one drop of experience. All past wars are outdated. What makes him so sure?

The answers to these questions are in part the subject of this paper. The decision makers, themselves, however, must take great care when finally passing judgment. Four areas come to mind where a decision is concerned regarding the subjects. He must be able to:

- **trust his delegated advisors to make correct judgments**
- **trust his ability to have an overview**
- **trust his ability to understand charts and figures**
- **trust his ability to interpret so-called demonstrations of effectiveness.**

In the following, the reader will see just how important each one is. The methods given are, by no means, the only ones that are available. I'm sure there are many others. It so happens that these are the ones with which I am most familiar. My experience dates back to my tour in the service at Colorado Springs, Colorado. There, at the Headquarters, Army Air Defense Command, one of our major tasks was to deploy a NIKE X Weapons System around the Continental U. S. at the major cities. Depending on dollars spent, we could deploy X number of sites. I cannot go into great detail about the system as much of it is still classified, but I will attempt to discuss methods that were known on solving this problem.

I have not had the opportunity to work on a generalized computer solution using any of the methods; hence only suggestions and possibilities are given. On a cursory examination of the problem of generalization, I find that it is a most difficult one. One, in fact, that might take years to develop.

THE GAME-THEORETIC MODEL

This method proposes an exact solution—the so-called minimax. That is, if the opposition applies the best strategy against all of my strategies, which strategy gives him the least value even though he has applied his best strategy. However, in most cases, the problems are so complex that we cannot delimit all the strategies and so we are stuck with merely finding the important principles.

In the following, I will be using some terms with which many of you are not familiar. I will give some brief definitions now so that they can be used as a reference. I will not depend on many without prior warning.

- **Firing Doctrine:** A set of rules by which the defense assigns missiles to objects and determines where and when to launch them.
- **Cloud Pattern:** An ICBM (or other ballistic missile) is launched from a site that is far away. As it approaches the target, it breaks up in a predetermined

fashion. The result is called a Cloud Pattern or a Cloud. It contains warheads, decoys, scrap metal, jamming devices, and what have you. The purpose of the defense is to single out the warheads from the rest.

- **Fusing Distribution:** This is a term used by the offense when setting up the timing for the actual fusing and detonating of the warhead. It is usually rigged by altitude and so can be called a Fuse Altitude Distribution.
- **Payoff Per Warhead:** This represents how much damage a warhead does. Over many warheads, this is used as a goal by both sides. The offense wants as high a payoff per warhead as it can get while the defense wants as small as it can get.
- **Price of Admission:** This represents the number of ICBM's necessary to accomplish a specific goal.
- **Penetration:** This term is used many times and refers to the ability of the offensive warhead to burst at an altitude low enough to do more than a specific amount of damage.

In examining the alternatives for selecting a certain firing doctrine, you consider that the opposition knows exactly what cloud pattern and fusing distribution is best against each one. Now, knowing this, you select the firing doctrine so that no matter which cloud pattern and fusing distribution he selects, he will be able to do no better than the worst of the bests. Let us consider some of the important aspects of both sides.

First of all, the objective of the defense is to defend as many people as possible. This could be changed to defend as many goods or retaliation capability or whatever. The point is that the assumption given to the offensive objective is that he must desire to destroy as many people as possible or as many goods or as many retaliation capabilities or whatever the defense (our side) has as an objective. If not, you are essentially fighting separate wars, which, in that case, you could win or lose depending on whose viewpoint you took. Although this might happen in reality, it is clear that if you are not prepared for all of the most probable eventualities, the opposition can crush you. The mathematical equation describing this is:

(1) $v(o) = -v(d)$

$v(o)$ = measure of value of offense

$v(d)$ = measure of value of defense

This is often called a zero-sum game since $v(o) + v(d) = 0$

The second assumption you make is that, with a fixed number of dollars on the defense and an infinite number of dollars on the offense, the offense will, with enough money, defeat the defense. Saying this, I must add that fixed defense dollars are the only practical way of judging the merits of the system because in this case the sites once deployed are fixed and the opposition can then observe and adjust before making their attack. Various fixed dollar defenses can be tried to determine which is the most attractive. Moreover, it is not practical to vary this dollar amount in any convenient manner because of the method by which appropriations are made in Congress. This rule restricts play a great deal, but in turn makes the decisions easier. The assumption above, then, implies that you want to get the most for your money. That is, your objective is to find the deployment that makes the offense pay the highest price of admission at a reasonable cost to your side. This approach is often referred to as optimizing the cost-effectiveness ratio.

The third assumption is that due to integral restrictions, some cities will not be defended at all. (Let us assume that our objective is to defend people.) That is, since you cannot spread a local defense system so thin that it covers everyone (there is no such thing as a half of an ABM) there will be one city that is ranked highest (in population) among those which are undefended. This city is usually used as the key. The principle is to avoid overprotecting the large cities since the offense can get what they want (i.e., what the defense doesn't want them to have) at minimum cost by going to the undefended cities. Similarly, don't underprotect the large cities. A balanced defense then is the objective. By noting the key city's population, one can then say that the objective of a balanced defense is to limit the offense to a payoff per offensive warhead less than or equal to this population.

(2) $p_w \leq POP(k)$

k = is the number of the first undefended city

This is a restriction which, when coupled with the next, states that you must achieve a sufficiently strong defense to make his price of admission, $P_a \geq POP(i)P_w$, where $POP(i)$ is the population of the i^{th} local defense (if any). This assumption states that once the offense has "penetrated", he has wiped you out (that is, one good blow is sufficient to incapacitate the defense). This implies that the missile defense system must be extremely reliable and accurate as long as there is a stockpile. It further states that penetration depends entirely on defensive stockpile of ABM's rather than any inherent weakness. This assumption is in part based on the fact in nuclear warfare that, in general, surface damage increases the deeper the penetration.

With these basic assumptions, we then draw up a plan for setting up a game-theoretical model which will lead us to solve the problem of siting. Because of the correlation above regarding penetration and stockpile, it turns out

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Team leaders to design and implement programming systems for the reduction and analysis of aircraft and spacecraft telemetry and instrumentation data. BS (or equivalent) required with minimum 3 years experience in programming large-scale scientific computer systems. Fundamental knowledge of test vehicle instrumentation valuable.

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To assist in development of state-of-the-art applications programs for the reduction of aircraft and spacecraft test data. BS required, 1-3 years programming experience. Current operations include: evaluation of aircraft weapons systems, radar and electronics, structures and total performance, spacecraft checkout, thermal vacuum testing and total mission performance.

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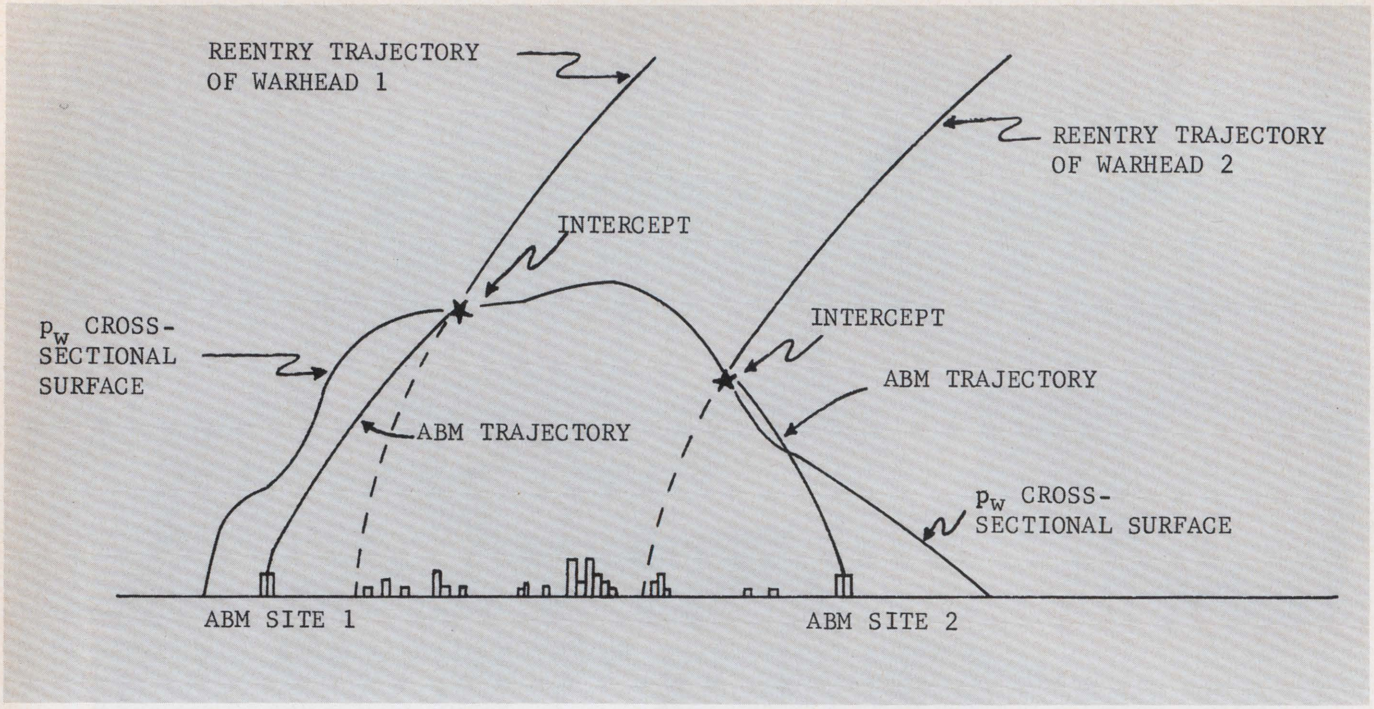

Figure 2

that the best plan is to give each city a fixed number of ABM's to work with and to deploy them as it chooses. Further, since sites are governed by terrain and government owned land or acquirable land, it turns out that the number of plays that can be made are fairly limited.

The next question to ask is given a deployment, how good is it? I.e., given sufficient stockpile for the assigned site locations, could it adequately defend the city whose population is distributed in some known manner. The question amounts to: Where are the intercepts (if any) going to take place and who is going to do the intercepting.

This question is a natural one since (a) the intercept has to take place and (b) because of the objective of a balanced defense, it cannot allow a penetration below the p_w line. The offense wants to know the answer to that question, too. He is anxious to get his burst off, but would also like to penetrate the p_w surface. The p_w surface is that surface which, if a burst of the assumed weapon took place, would just kill p_w people. Since in order to make an intercept, you must first "see" your target, you must wait as long as possible before making the shot. Also, because you are more accurate the closer the intercept, you must wait longer. But you are in a dilemma because of (a) and (b) above to get him as soon as possible.

Figure 2 is an illustration of the defense's plan.

It turns out after some rigorous mathematics using game-theory that under all the above assumptions, if you select your intercepts exactly on the p_w surface, you can best determine which sighting scheme prevails.

In the simplified model just presented, this last answer is surely a significant one since with it you have obtained an extremely valuable siting criterion. In other words, you place your sites so as to be nearest your intercepts. Further, because the intercept (p_w) surface is fixed insofar as the size of the warhead is fixed, you have almost solved your problem.

There are, however, overriding criteria all of which push this surface higher and farther away. Since these are tactical rather than strategical, they cannot be given too much weight. Also, they are not given too much coverage in this report. Among them, though, are firing doctrine requirements like avoiding suicide, avoiding a bad crossing angle (angle of attack versus ABM angle of intercept), offense reentry maneuvering vehicles, and blackout of radars due to precursor bursts.

Before launching into various computer models, I must say a few words about the offensive threats.

You must, on the defense, be capable of defending against all reasonable attacks. Any weakness will surely be discovered and all your efforts to defend the city will be wasted.

What are some of the options of attack that he has?

(1) He can vary his warhead size or number of warheads. Yes, but the deterring factor is weight of the ICBM (or other type of ballistic missile).

(See Figures 3a, 3b, 3c and 3d)

The payoff, however, might make it worth the risk.

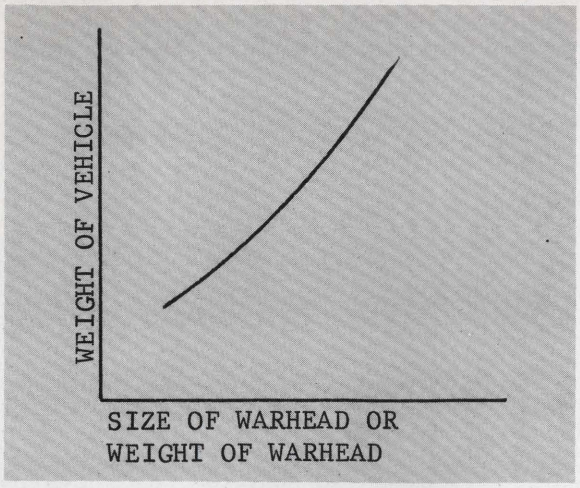

Figure 3a

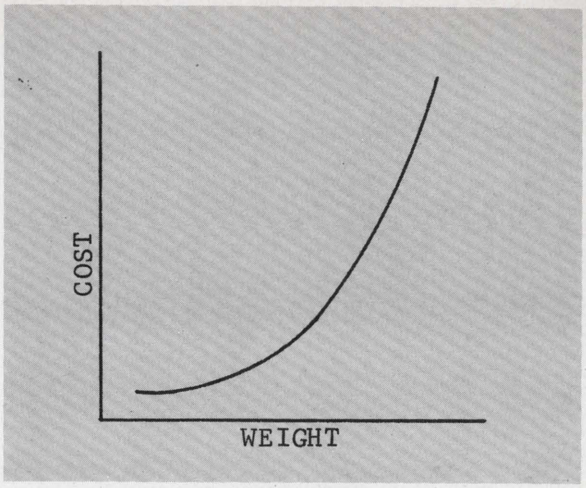

Figure 3b

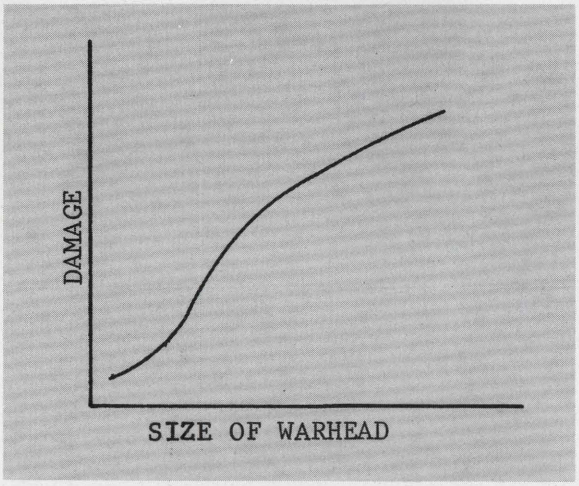

Figure 3c

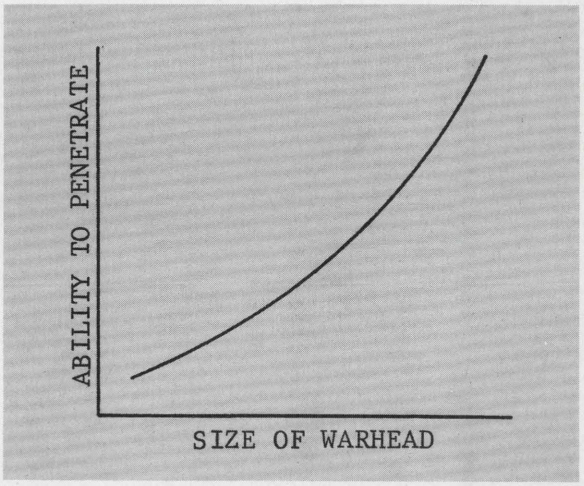

Figure 3d

(2) He might vary his reentry angle. Here too. his penalty is weight. The payoff curve is also given.

(See Figures 4a and 4b)

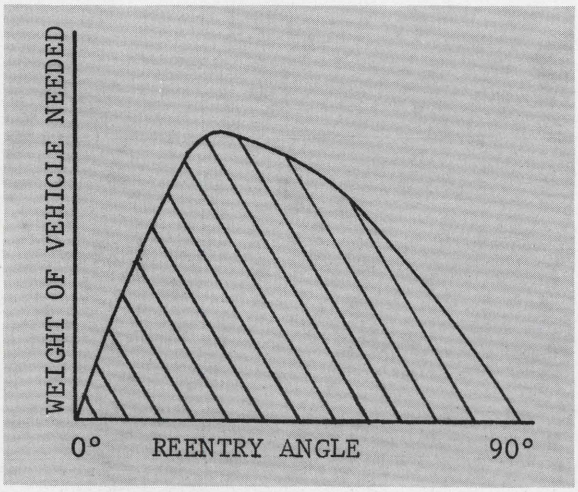

Figure 4a

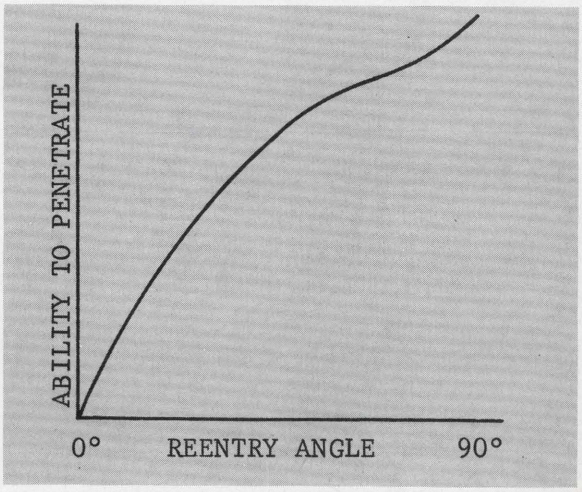

Figure 4b

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Now we seek a topflight Director for this Center, to supervise and coordinate all of its activities. You will plan, recommend and promulgate educational policy, doctrine and procedures related to instruction; prepare programs of instruction; and formulate instructional standards for courses involving the application of information science to specific intelligence problems. Other, related responsibilities are also involved.

The successful candidate must have extensive data processing and software expertise. Hopefully, academic credentials will include a PhD and college-level teaching experience. Hopefully, too, the candidate will have some experience with one or more sectors of the defense-related community.

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(3) He might vary his reentry azimuth. Here, though, the weight penalty is severe. That is, you either fire the great circle or don't fire.

(See Figures 5a and 5b)

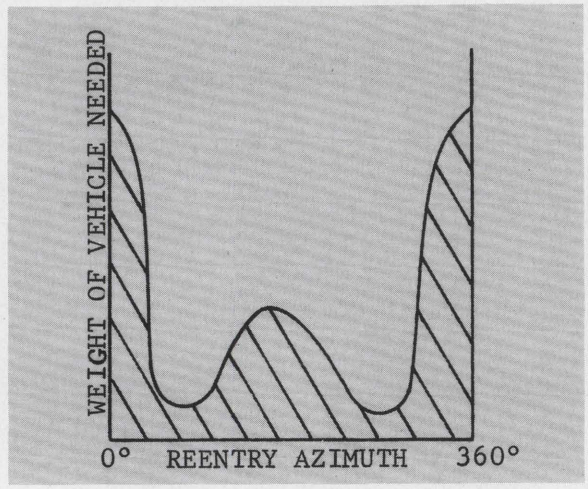

Figure 5a

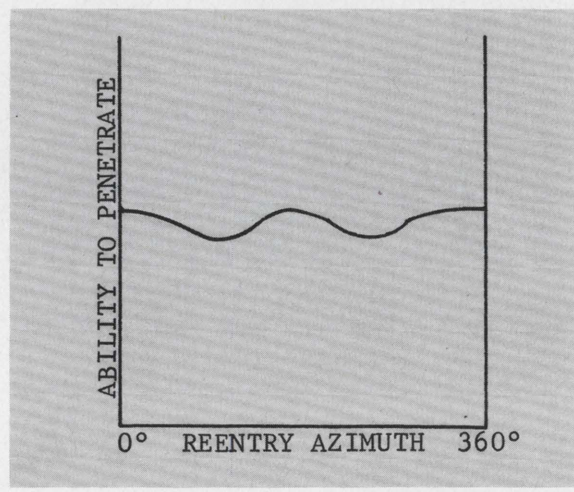

Figure 5b

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(4) Another possibility is to select various aim points in the city to do one's damage.

(See Figures 6a and 6b)

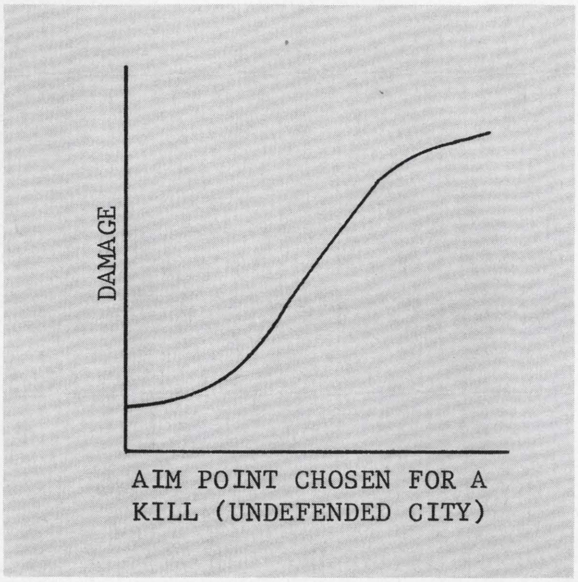

Figure 6a

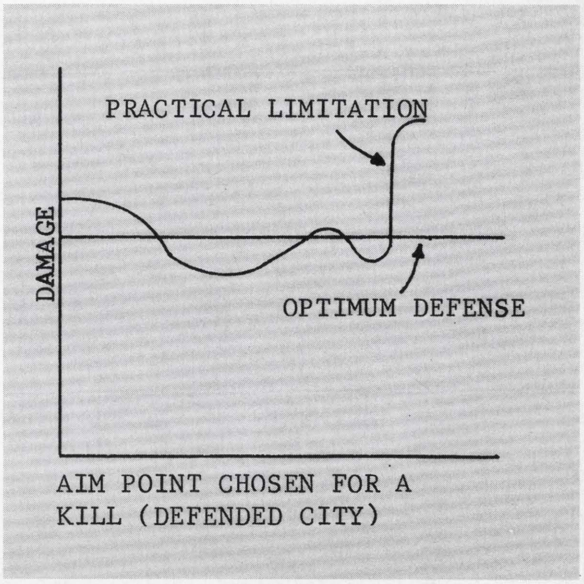

Figure 6b

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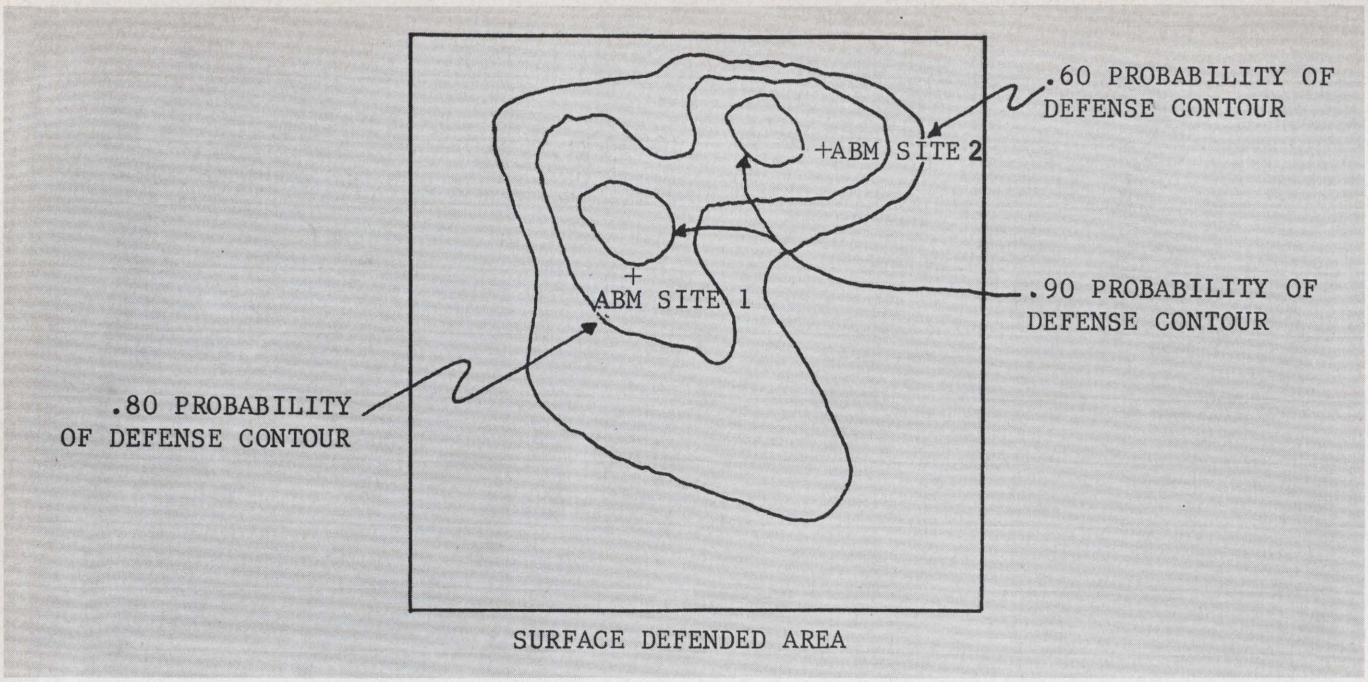

Figure 7

The ability to put all of these together is a formidable task, but not unsolvable (at least to the satisfaction of most). I plan to resolve the problems in two ways.

The first is a simple one which is perhaps misleading by its simplicity. It tackles the problem by finding one or two key factors which can be computed moderately easily. These factors can be arrived at through searching the physical spacial world and coming up with geometrical shapes that are inherent to the problem. These are not necessarily easy to find, but once formed, a much simpler computer program can be written. It is called as the above suggests, the Geometrical Approach.

The second is a more complex one and is better because of its flexibility. It is called the Monte Carlo Approach and as the name suggests, is more geared to gaming. It uses a simulation of the Weapon's system as the backbone of the model. Success or failure is measured by drawing random numbers.

There is one other approach which deserves mention, but with which I am not too familiar. It is called the Probabalistic Approach. I will mention only a few of the important points here.

Since every event or aspect of play is subject to uncertainties, a method can be developed which produces an uncertainty of defense. The long mathematical procedure of finding this probability turns out to be a reasonable way to conceive the real world. Figure 7 gives an example of what is meant.

(See Figure 7)

This is as much as I will say about this approach. I will proceed to discuss the other methods in the next two sections.

PART TWO of Game Theoretic Applications will appear in the April issue of Software Age.

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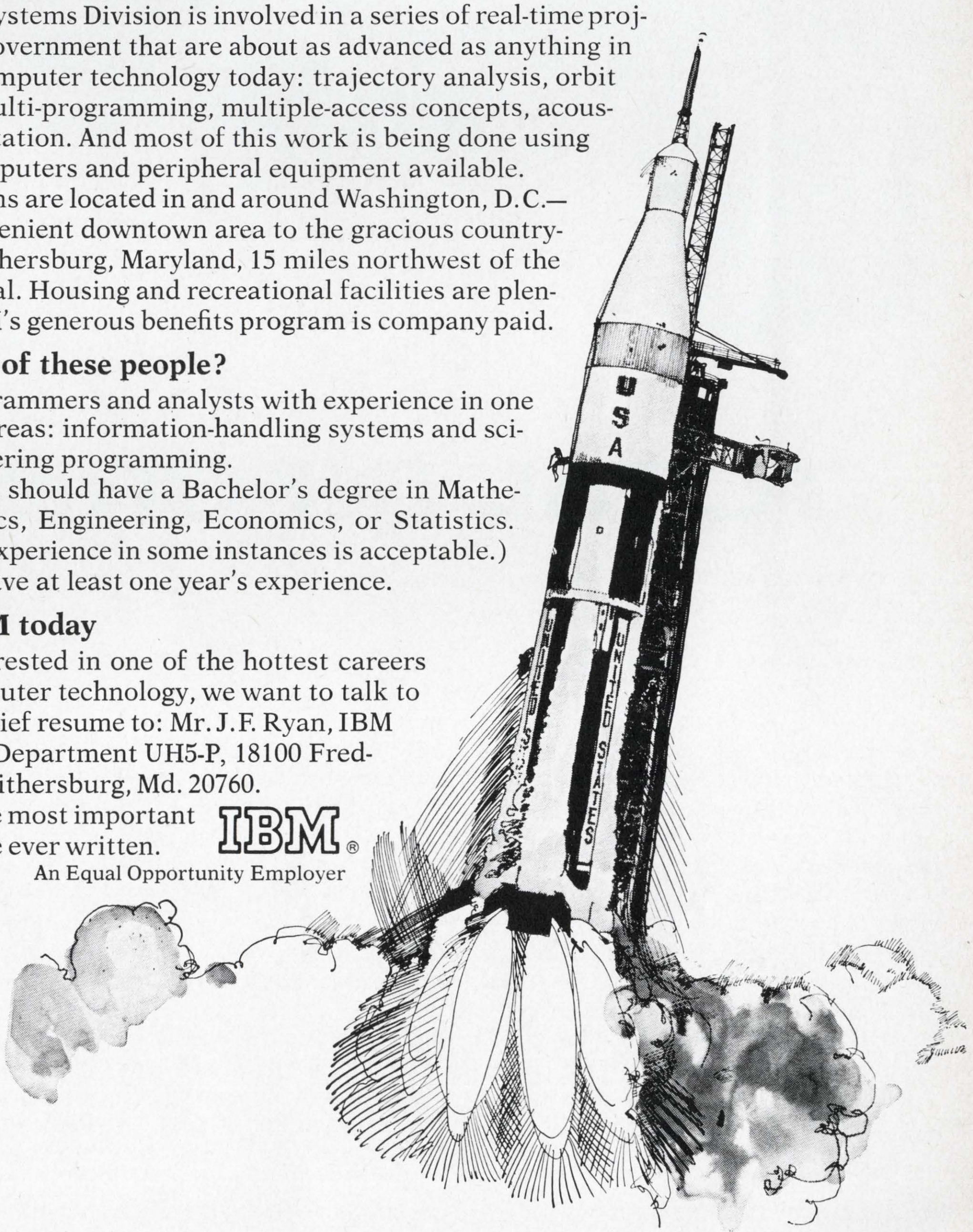

First Step Towards . . .

TOTAL INFORMATION

The new GE-400 Parts Explosion System, first step toward a total integrated manufacturing information and control system, will operate on any medium-scale GE-400 Series information system with 16K memory and disc storage capability.

A revolutionary new approach to computerized manufacturing information and control has been introduced with the new GE-400 Parts Explosion System being announced by General Electric Co. this month.

In actuality, the System has been thoroughly pre-proven at several customer sites, where it already is in use at this time.

The GE-400 Parts Explosion System is the first increment in a fresh, new concept in manufacturing control developed by GE's corporate Manufacturing Services experts. This concept is called MIACS (Manufacturing Information and Control System). Where most manufacturing systems *report* what is happening in a given manufacturing area, the MIACS approach reports *and controls.* It looks at the entire manufacturing business as a complete, integrated system, and provides a means by which the system can be tied together more efficiently and effectively.

The Parts Explosion System offers the user the first step in achieving this control. It is a random access application package that is oriented to an integrated data base. It will work in virtually any type of manufacturing operation—in job shops (specialized products), in flow shops (high volume products) and in the process industries. It functions equally well whether the manufacturer produces a single product or a whole set of product lines.

In most manufacturing businesses, literally thousands of raw materials, parts, sub-assemblies and assemblies are used to make up final products. These create extremely complex data relationships between material item and product structure files. Through the use of GE's exclusive Integrated Data Store (IDS) technique for actual, practical data base management, the GE-400 Parts Explosion

System eliminates the need to carry part numbers in several file locations, and as a result, permits the most efficient use of valuable disc storage space in other such systems.

The use of COBOL in the system is a key factor in permitting the user to understand the logic used in developing the programs, and to modify them as necessary to meet changing business needs.

Using both IDS and COBOL, the GE-400 Parts Explosion System:

- Automatically establishes master and detail material record relationships.
- Greatly simplifies the traditional data chain relationship problem when adding, deleting or modifying parts list records.
- Gives more accurate and consistent product structure information, regardless of where parts list information is used.

Furthermore, the system is geared for growth. All the information the user needs is stored in a single integrated file. Changing or expanding records is greatly simplified.

The system offers unparalleled access and flexibility. It:

- Lets the user manipulate product structure information easily.
- Builds and maintains a Bill of Materials file.
- Accepts demands and existing order information against raw materials, parts, sub-assemblies or assemblies in file.
- Explodes demands down through the structure by levels, considering the quantity on hand and existing orders. Establishes net material requirements for up to 52 time periods.
- Explodes demands vertically through a product structure, providing an indented explosion report.
- Furnishes single and multi-level parts list and component where-used lists.

FILE MAINTENANCE REPORT

FILE MAINTENANCE RADIOS -30-

	MATIDN		ITEM NO.	CMPIDN	PERQTY	PERCOD
STO COMPNT 00006880	T01400D000	C	031	86880922–0101	1	1
STO COMPNT 00006881	T01400D000	C	032	86880922–0103	1	1
STO COMPNT 00006882	T01400D000	C	033	86880923–0223	1	1
STO COMPNT 00006883	T01400D000	C	034	86880923–0225	1	1
STO COMPNT 00006884	T01400D000	C	035	88100692–0001	1	1
*** INPT ERR	44400T01420D000 1	1		T014200000	0	0

TRANCODE

AND CONTROL

By S. B. Williams

Manager—Application Software Engineering

General Electric Company

SUMMARIZED TRANSACTION ANALYSIS REPORT

RADIOS 11/30/67 PAGE 20

*** IDS–FILE ACTIONS	
STO MATITM	557
DUP MATITM	10
CALOUT	0
MOD MATITM	0
DEL MATITM	0
CALOUT	0
WRUSED	0
MOD INVEN.	27
ADD INVEN.	0
STO COMPNT	177
MOD COMPNT	0
DEL COMPNT	2

*** INPUT TRANSACTIONS	ACCEPTED	REJECTED	TOTAL
030	567	3	590
032	27	0	27
033	179	5	184
UNDEF.	0	1	1
TOTALS	773	9	782

23:02.7

Stanley B. Williams is Manager—Application Software Engineering, General Electric Special Systems Department, Phoenix, Ariz.

A native of Utica, N.Y., he received a Bachelor of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute in 1945 and joined General Electric as a student engineer in 1946. He has worked for several components within the company over the years.

Williams is a member of the IEEE and the ACM and holds two patents.

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SWA-3

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Once installed, the GE-400 Parts Explosion System provides a wide variety of printed reports. These are pre-programmed in the system, not individually generated by the user.

Included among these reports are:

A comprehensive file maintenance log which shows the action performed, material items parts number, quantity used per assembly, and other pertinent data.

A summarized analyses report of transactions, file actions, and error conditions. This is helpful in achieving maximum product structure accuracy and easier error correction.

A wide variety of **bill of material inquiry reports**, including:

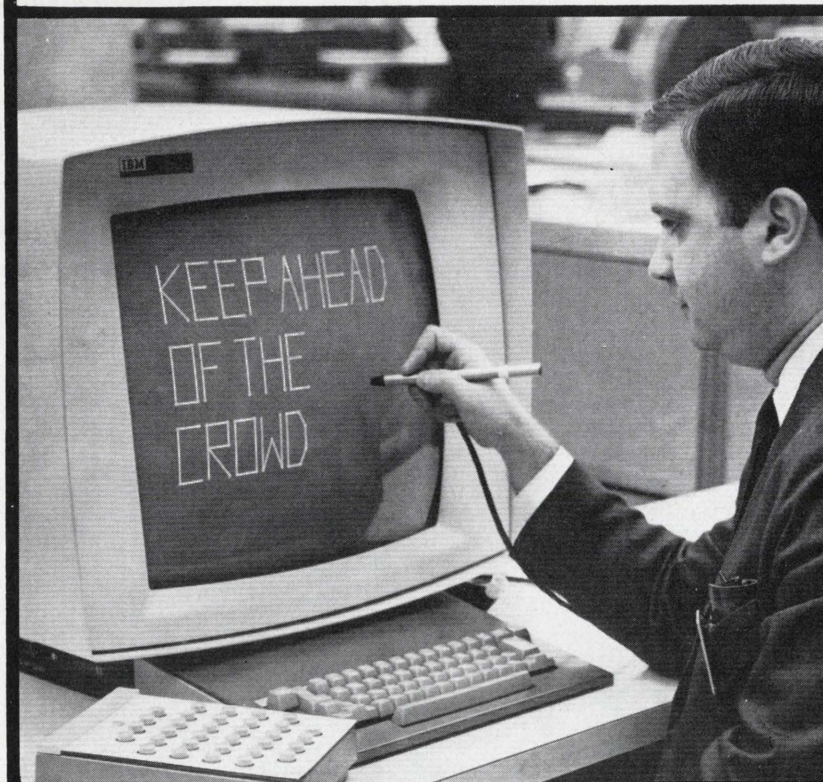
- A bill of material report which shows assembly and part content information.
- A **where-used inquiry report** showing the part number requested and all the places in which it is used. This report is extremely valuable to businesses in which profit potential depends on cost reductions in materials or part standardization.
- An **indented parts list inquiry** report which portrays the product structure down to the lowest level.
- A **vertical explosion inquiry report** which is an extension of the indented parts list report.

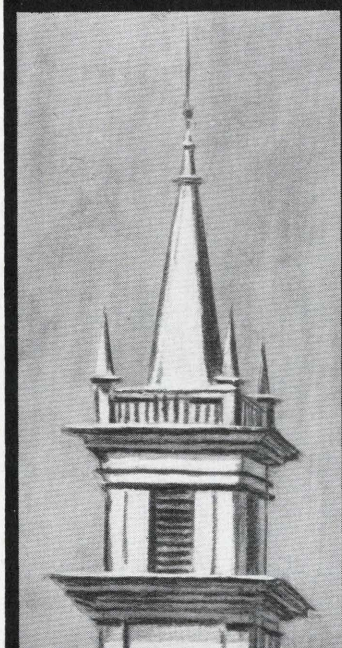
Several types of explosion reports are under the user's control through the use of input parameter cards, including:

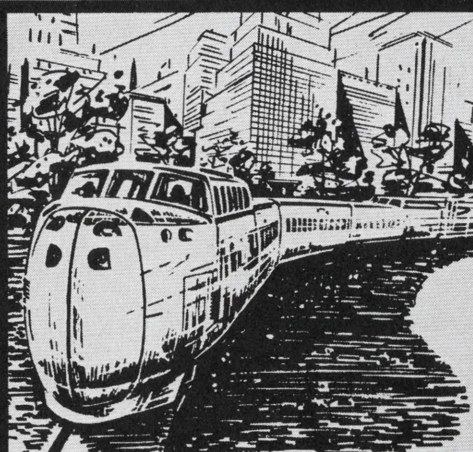
- **A net explosion summary report** which shows the material items required, their description, material quantity on hand, unit of measure, and most important, material lead time. Under each time period is the net material requirement value or quantity needed. Up to 52 time periods may be selected.
- A **total information explosion report** has time periods arranged vertically, and shows complete information on all elements involved in a particular explosion. Information shown is material on hand, inventory balances, available inventory, gross and net requirements.

Of particular importance, however, is the fact that the GE-400

• PROGRAMMERS AND ANALYSTS •







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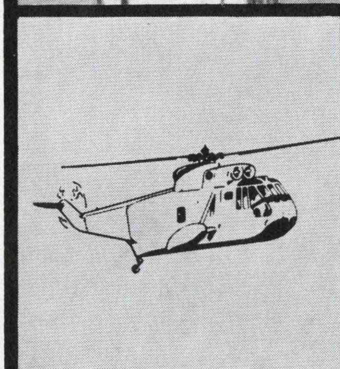

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001	106C2035–0001	SPEAKER	2	1	PC
002	106C2467–0006	BOARD ASSY	1	1	PC
003	109C6176–0001	TRANSFORMER	2	1	PC
004	113A6284–0002	RC NETWORK	1	1	PC
005	113A6425–0001	TERMINAL	2	1	PC
006	113A6584–0167	SCREW	1	1	PC
007	113A7154–0003	TUBE SOCKET	1	1	PC
008	113A7154–0004	TUBE SOCKET	2	1	PC
009	113A7216–0011	VACUUM TUBE	1	1	PC
010	113A7216–0012	VACUUM TUBE	1	1	PC

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T01410D000	0	RADIO ASSY	001	1	1	PC
T01430D000	0	RADIO ASSY	001	1	1	PC

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172104 RADIO

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1	T01410D000	RADIO ASSY	001	1	1	PC
2	T01400D000	CHASSIS	001	1	1	PC
3	106C2035–0001	SPEAKER	001	2	1	PC
3	106C2467–0006	BOARD ASSY	002	1	1	PC
3	109C6176–0001	TRANSFORMER	003	2	1	PC
3	113A6284–0002	RC NETWORK	004	1	1	PC
3	113A6425–0001	TERMINAL	005	2	1	PC
3	113A6584–0167	SCREW	006	1	1	PC
3	113A7154–0003	TUBE SOCKET	007	1	1	PC
3	113A7154–0004	TUBE SOCKET	008	2	1	PC

Parts Explosion System develops the data base—the foundation—for a truly complete and integrated manufacturing information and control system. The use of IDS and COBOL permits the user to build up a complete system in less time and in a well-planned and organized way. Starting with Parts Explosion, the integrated data base becomes the basis for such future business system requirements as inventory management, shop scheduling and monitoring, order processing, purchasing, accounting, sales forecasting, and other functions.

The MIACS concept, of which the GE-400 Parts Explosion System is a part, forms an information network through various control centers, each of which corresponds directly to a work center in the plant.

MIACS recognizes that there is a common physical flow of materials in *any* manufacturing business and that this flow can be identified readily, managed and controlled. It breaks down manufacturing into a simple three-part framework:

1. The shop.
2. The main line information system.
3. The advance planning system.

The shop is the manufacturing arena. Typically, purchased materials, either raw or finished, move into a shop from outside suppliers. After receiving and inspection, labor is applied at manufacturing centers. Finally, a completed product is formed and warehoused or shipped directly to customers.

The main line information system is the logistics planning and controller used to accomplish the manufacturer's objectives, serving as the basis for other related activities in manufacturing. It starts with customer orders or sales forecasts and incorporates them into business requirements. The requirements then are compiled into a dynamic master plan through the use of master scheduling functions.

The master plan is split apart into detailed lower-level elements. Here, a procedure called net explosion checks the material requirements against previous plans, and requirements that cannot be satisfied by those plans are divided into two categories: "stock" items and "requi-

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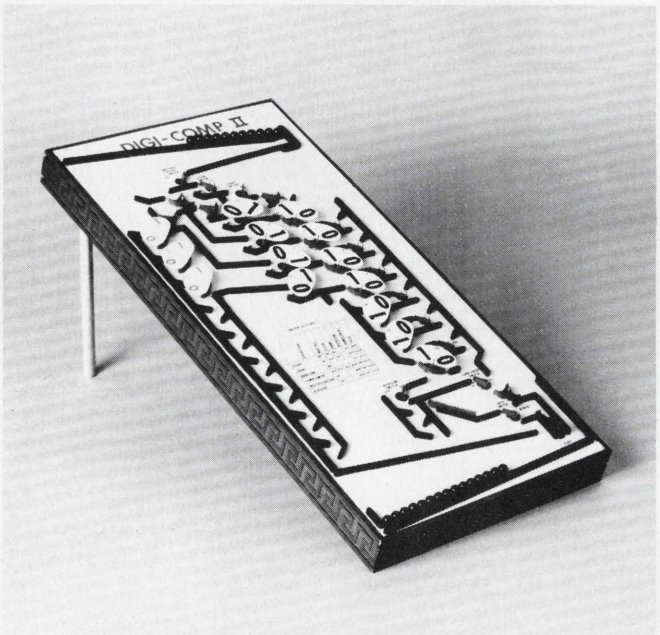

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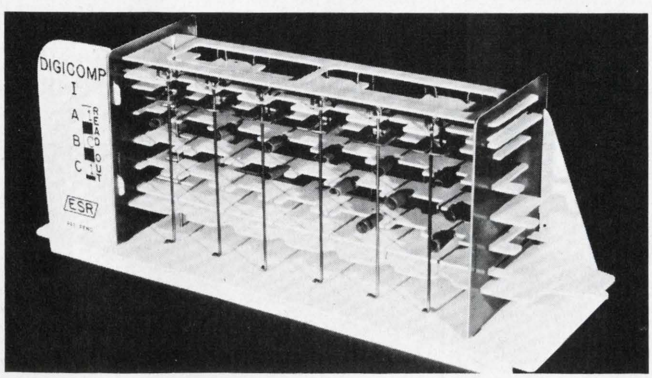

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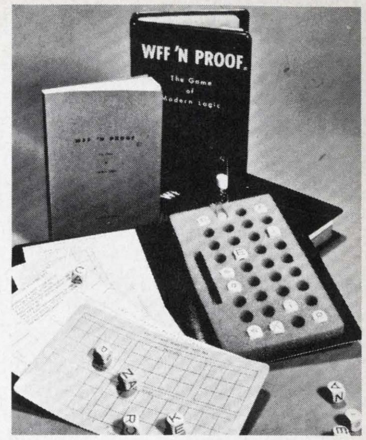

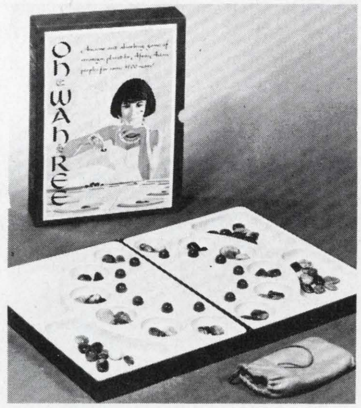

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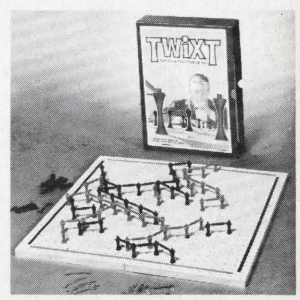

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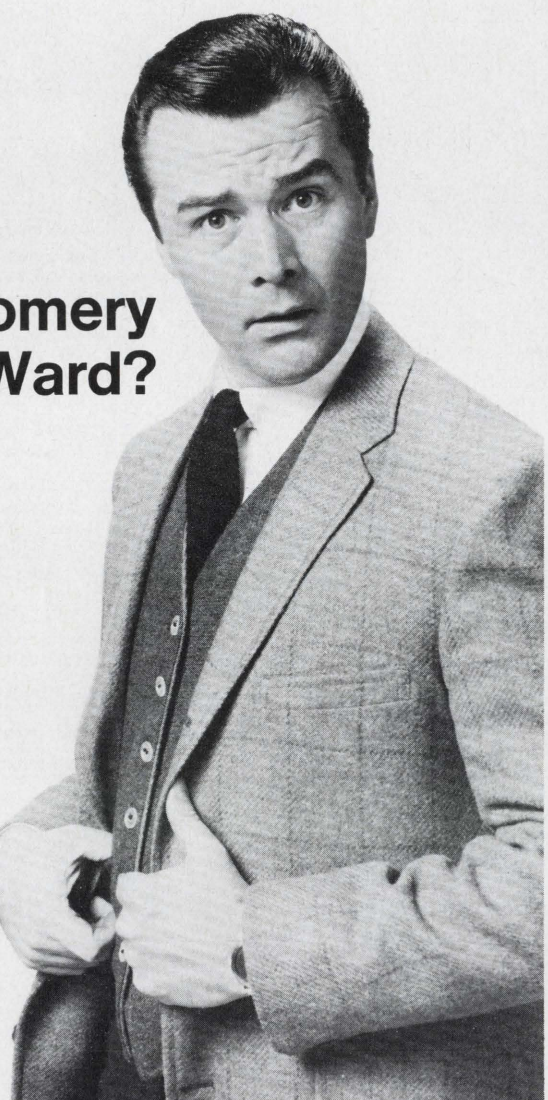

Montgomery Ward?

sition" items. If either type of requirement calls for the purchase of materials, it moves through an ordering process which prepares vendor purchase orders. If it calls for materials to be manufactured in-house, the system generates the necessary shop papers (instructions).

Advance planning is the creative, long-range direction of the business —business, product, process, facilities, and financial planning. It also involves product, process, and materials flow engineering, and establishes the management policies, such as the control parameters, product design data, etc.

MIACS' three-part framework makes up a detailed master plan—the architecture around which a manufacturer's overall objectives and time schedules can be met. The feedback link between the shop and the system enables the shop to report back on its accomplishments relative to the plan; and the results then are matched against the main line information system plan and adjustments are made.

MIACS integrates materials, resources and work tasks into a single data bank. It uses three basic planning and control models to completely describe the material flow in a manufacturing business, and these models plan, schedule and control:

- The flow of materials (raw materials, parts, sub-assemblies and products).
- The use of resources (man, machines, space).
- Activities (work tasks that go into making a completed product).

This concept develops integrated business data networks using the three models to describe all the materials, resources and activities required to produce what the customer wants. Plans and schedules provide the basis for control once work is released.

THE MATERIAL INVENTORY MODEL

The material inventory model situation pertains to a particular material item, which can be anything from an end product to a raw material, stocked or otherwise, high cost or low cost. It is modeled in terms of quantity on hand at the present, and the quantity and times of forecasted supplies and demands. Each expected withdrawal (demand) and each expected replenishment (supply) is assigned a time and quantity figure, so that a quantity-time profile of net inventory can be generated whenever desired.

THE WORK PROCESS MODEL

The work process model consists of one or more activities (work tasks) that goes into replenishing a given quantity of a material item. As these activities process material from one inventory stage to the next, they make demands on lower-level material items depending on the needs of the higher-level items. Material work activities also create demands on men, machines and facility resources.

This model is used for receiving, inspecting, machining, punching, forming, treating, fabricating, winding, assembling, testing, packaging, shipping, and transporting material items. The process is modeled between inventory points with each activity having an anticipated elapsed time and definite relationship with its sister activities.

THE RESOURCE INVENTORY MODEL

Under the MIACS concept, resources may be a single operator or machine, a group of operators or machines, or a factory floor space or assembly area. Each situation is modeled three ways: in terms of its gross capacity, and time and quantity of withdrawals (loads) and replenishments. Each withdrawal and replenishment of a resource associated with an activity is assigned a quantity time load against that resource. The sum of all these loads results in a load "profile," which can be available instantly and is altered whenever activities are scheduled or rescheduled. Under this concept, resources are not consumed or altered by an activity; instead, they are returned after a period of use to the resource inventory in exactly the same form. Resources are withdrawn from inventory as a result of process activities and are returned upon completion.

These three material flow models are structured to completely describe *all* situations required to produce a customer's order or to replenish stock based on a forecast. With MIACS, there is no limit to the degree or

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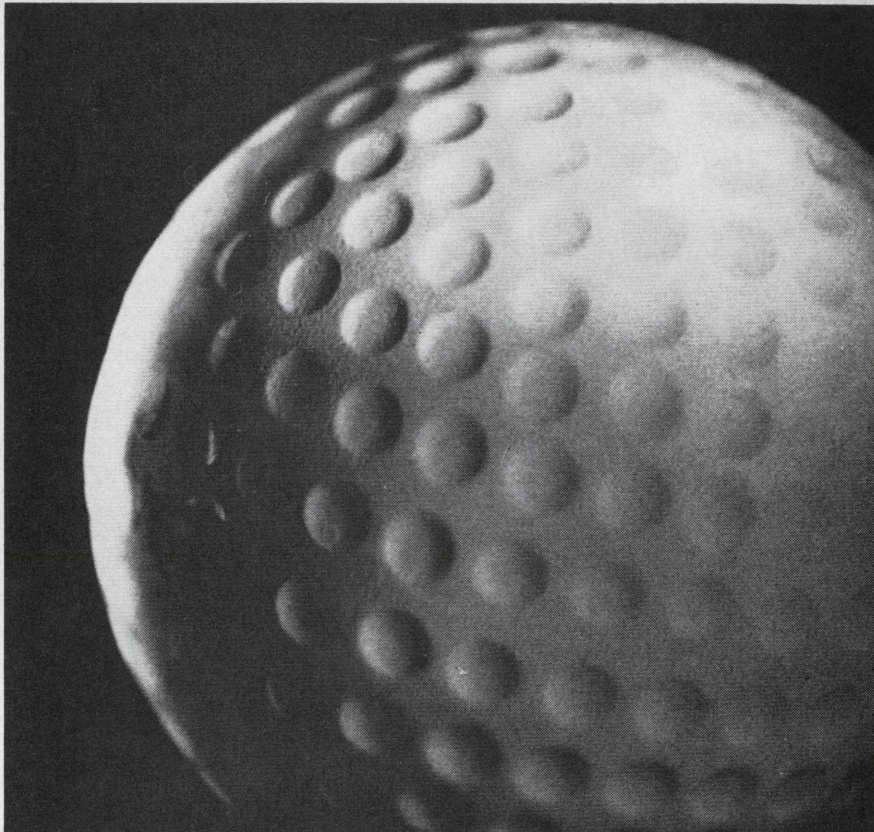

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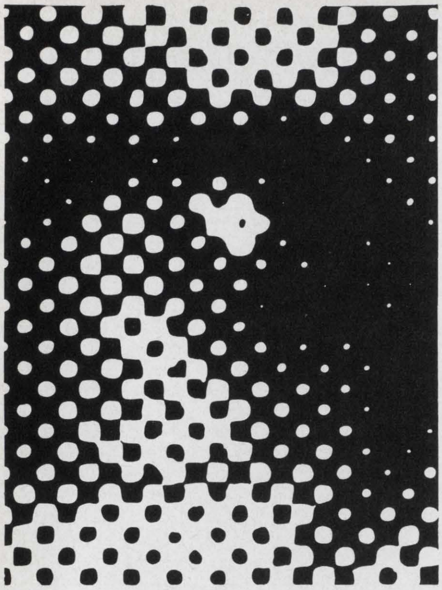

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VERTICAL EXPLOSION:
172 104 RADIO ORDER QUANTITY – 50 ORDER NUMBER 16791

POSITION	COMPNT	DESCRP	ITEM NO.	PERQTY	PERCOD	MUMEAS	EXP QTY
1	T01410D0000	RADIO ASSY	001	1	1	PC	50
2	T01400D0000	CHASSIS	001	1	1	PC	50
3	106C2035–0001	SPEAKER	001	2	1	PC	100
3	106C2467–0006	BOARD ASSY	002	1	1	PC	50
3	109C6176–0001	TRANSFORMER	003	2	1	PC	100
3	113A6284–0002	RC NETWORK	004	1	1	PC	50
3	113A6425–0001	TERMINAL	005	2	1	PC	100
3	113A6584–0167	SCREW	006	1	1	PC	50
3	113A7154–0003	TUBE SOCKET	007	1	1	PC	50
3	113A7154–0004	TUBE SOCKET	008	2	1	PC	100

NET EXPLOSIONS SUMMARY REPORT

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EXPLOSION         RADIOS              10/26/67       .    PAGE 4
LEVEL 01                            TIME PERIODS 01–52
88100692–0001   CKT BOARD     MQTYOH:  O    MUMEAS:    PC    LDTIME:  2     17:28.6
                T1   T2   T3 T4   T5   T6   T7   T8   T9   T10   T11   T12   T13
                         175      300            150              600
86880923–0225   RESISTOR      MQTYOH:  O    MUMEAS:    PC    LDTIME:  2     17:28.6
                T1   T2   T3 T4   T5   T6   T7   T8   T9   T10   T11   T12   T13
                         150      300       200       400
86880923–0223   RESISTOR      MQTYOH:  O    MUMEAS:    PC    LDTIME:  5     17:28.6
                T1   T2   T3 T4   T5   T6   T7   T8   T9   T10   T11   T12   T13
                75       200      300            200
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TOTAL INFORMATION EXPLOSION REPORT

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EXPLOSION         RADIOS             10/26/67            PAGE 1
LEVEL 04                          TIME PERIODS 01–52
T01430D000   RADIO     MQTYOH: 50  MUMEAS:  PC      LDTIME:  1       17:19.7
             PERIOD   ON HAND   ON ORD    AVAIL   GR REQ   NET REQ
               TO3      50        150      200      300      100
               TO8       0         75       75      300      225
T01420D000   RADIO     MQTYOH: 0   MUMEAS:  PC      LDTIME:  1       17:19.7
             PERIOD   ON HAND   ON ORD    AVAIL   GR REQ   NET REQ
               TO3     –0–        100      100      100      –0–
               TO8     –0–        –0–      –0–      200      200
T01410D000   RADIO     MQTYOH: 150 MUMEAS: PC       LDTIME:  1       17:19.7
             PERIOD   ON HAND   ON ORD    AVAIL   GR REQ   NET REQ
               TO3     150         50      200      100      –0–
               TO8                         100      150       50
```

FIRST STEP TOWARDS TOTAL INFORMATION AND CONTROL

(Continued on page 35)

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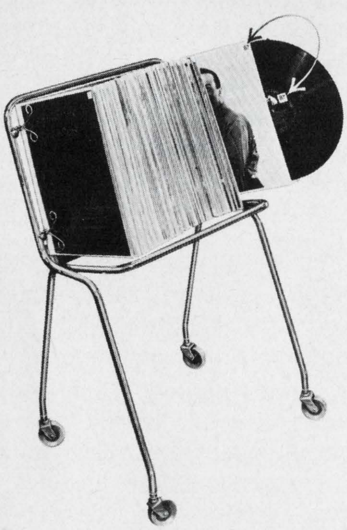

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26	27	28	29	30
31	32	33	34	35

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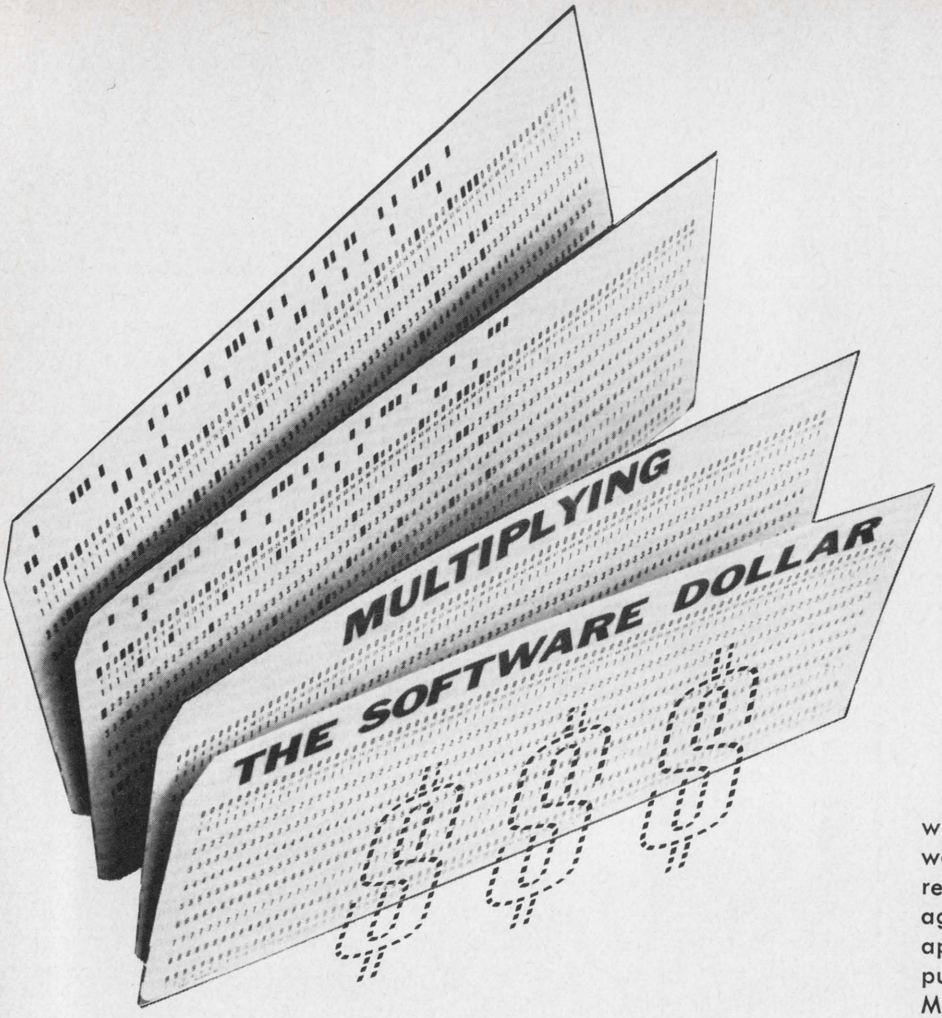


Computer hardware has evolved with lightning speed, leaving software in the clouds. Industry is currently facing a programming shortage in meeting a myriad of software applications which advanced computer technology has germinated. Meeting this shortage through effective management is the "software multiplier" detailed in this article.

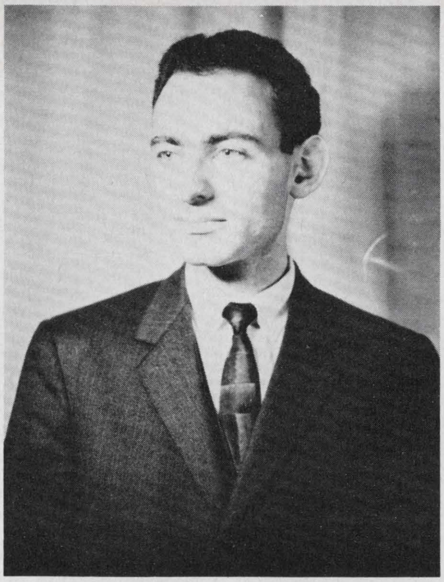
The Upward Software Spiral

In the primitive days of the computing industry programming was done at the machine by a one-man team. He was a combination of engineer or accountant, systems analyst, and programmer. Computers were slow, relatively cheap, small, and could reasonably be used by a one man effort. As computers advanced in technology, size, and cost, this primitive one-man show had to be abandoned. A special technology was created—software—and along with it programmers and systems analysts.

Programming assumed the role of a specialized art and occupation. Computer users were removed from the programming end of computer problem solving by hiring programmer analysts. This introduced a second party between the computer and the originator of a computer-solvable problem. Since thinking is highly abbreviated in transmitting a problem description from one party to another, the programmer had to assume the role of super sleuth, or analyst, in accurately defining a customer's computer application. This analysis frequently took longer to perform than the actual coding of the well defined application. The time required to define a problem, program and debug it, and communicate the results back to the source in intelligible form, turned out to be quite considerable and made programming a very time consuming technology.

It became apparent that problem analysis by a disinterested party (programmer) resulted in communication problems between the computer customer and programmer. Why not simplify this problem by eliminating the programmer and placing the onus of programming back in the hands of the user? To do this, sophisticated procedure oriented languages were developed to replace clumsy assembly languages. Theoretically, these languages could be easily learned and used by the computer customer himself. For engineers, the computer industry offered the procedure oriented languages of FORTRAN, ALGOL, JOVIAL, BLODI and others. For business, COBOL was offered. Recently PL_1 for both the business and scientific communities has made its appearance.

Procedure oriented languages, it was thought, would permit program writing analogous to an individual's normal expression of a business or scientific problem. In actual practice, these powerful languages were not as easily or instantly applied to computer problem solving, as had



Donald S. Rich

Donald S. Rich does research work for Univac in the area of automation of the programming process. He is currently working on automatic coding.

been expected. Debugging persisted as a major time consuming process, even though programming language facility could be developed in two months by a trainee, scientist, or business engineer. Some problems proved to be insolvable by higher order languages, and had to be tediously coded in machine language by programmers. At best, the procedure oriented language provided a partial solution to the programming crisis.

The most recent attack on the software shortage has been the Time Shared System (TSS). While time sharing is a great breakthrough, the old ills of the programming process (training, debugging, communication) are ever present. Now they can be dealt with, however, in a real time environment, and thus expedited more rapidly than previous 'batch' mode systems.

Having exhausted most hardware and software devices as not being up to the current programming crisis, the path to at least an interim solution, parallels classical cost cutting. In this case, multiplying the effectiveness of a given software staff is suggested through skillful management.

Software and the Programmer

A computer system or problem can be designed in countless ways to accomplish a given goal, but one truth common to all is that they must be programmed. An architect can design a structurally and aesthetically gorgeous dwelling, but his design in the hands of a clumsy builder can result in a shack rather than a stately house. In software, the most brilliantly designed system can turn into a computerized nightmare if the programming aspects are improperly managed. Just as a house needs a skillful builder, so too, a software system requires an articulate programmer(s) carefully coordinated into the complex mosaic of software management.

Optimizing the Variables of Software Management

Efficient management of a software effort, regardless of its size, should attempt to optimize the variables of system programming. Before considering optimization, the variables that are central to this goal must be identified. Heading the list is problem definition; i.e., is the aim of a software effort clearly and consistently defined? Intrinsically related to this is the second variable —communication; i.e., is there a professional attitude towards communication among the participants of a software effort? Selecting a programming language is the third variable; i.e., for a given task and computer configuration, what programming language is most suitable? Once a language is selected, the fourth variable to emerge is that of orderly debugging and documentation; i.e., is debugging planned in advance and is documentation simultaneous with coding? A molar variable is the tradeoff between development time and computer space; when should space be sacrificed for time? Last, but not the least, is the human variable of motivation; i.e., is management providing a motivating force sufficient to propel the programming staff? All of these variables must be considered in scheduling the development of a software package and fulfilling this schedule.

Problem Definition involves two stages—the definition itself and the verification of the validity of the definition. To insure accuracy and clarity in problem definition, a professional attitude toward communication between programmers, analysts, and customers should be encouraged. Some props for attain-

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ing this goal include orderly documentation, clearly defined communication channels, copious flow charts, and dictaphones. The last item is an invaluable aid in accelerating the documentation effort and provides a nice change of pace for the programmer who is at pencil and paper a good part of the day.

A verification prop to 'cross foot' the problem definition generated by a software team with the problem as the customer visualizes it, is accomplished most professionally by an auditing technique. An outside party, the auditor, should review the problem definition generated by the Software Team and the Customer's problem specifications for consistency. As a final check before coding starts, a formal verbal-graphic presentation should be given to the customer by the software participants, covering the molar aspects of the problem as well as any subtle but significant aspects.

Selection of a Programming Language

Reduction of the problem definition to flow charts to coding for a particular computer configuration which has the capacity to process more than one programming-language, necessitates the selection of a suitable programming language. The plurality of programming languages available eliminates a simple algorithm for selecting a language. To live with this situation, the following considerations are suggested for selecting the most appropriate programming-language.

If a tight schedule must be met, choose the language of least resistance. In general, this is the language best known by the programming staff.

Should the problem/application be of an extended nature likely to involve long range future modifications, choose the most easily patched language.

A rule of thumb is to work with the languages available that offer a good debugging facility.

The trade-offs in language selection are generally program development time and computer space. Tight storage dictating lower level assembly language and extended development time, while larger storage allowing higher level compiler languages and an accelerated pro-

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gramming pace. To meet a close schedule, it is expedient to sacrifice elegant coding, time and space in lieu of a slightly more cumbersome solution which can help meet a schedule.

Debugging

Debugging, regardless of the language used, is one of the most time consuming elements in the software process. The most valuable debugging prop is a well developed constantly updated flow chart. The flow chart is often the most neglected child in programming; it should be the most pampered. Management must insist on detail level flow charts from their programming staff before a line of coding is generated. To be included in each flow chart should be well annotated explanations of 'those boxes' as well as 'check points.' These check points should occur at crucial stages and be related to a development schedule. They should consist of a printout, to be reviewed by management, which demonstrates proper functioning of the program up to the check point. This technique has proved very effective in checking out electrical circuits in everything from airplanes to satellites to moon rockets. It is time to apply this engineering technique to program debugging to prevent the cascading of multiple errors and costly un-met delays and deadlines.

Motivating Programmer Productivity

Motivating the programming staff means giving them work inducing pellets. The first pellet is privacy; literally let the programmer work in his own office. If space and cost restrict, provide dividers to suggest the dignity of a private office space, or time share one private office among several programmers. Included in privacy is a minimum of supervision; do not stand over his shoulder while he works. Productivity is inversely related to the closeness of a supervisor.

Create a feeling of responsibility in the programmer. Make him aware of the significance of his parcel in the total package, regardless of how small it might be. Praise him whenever the opportunity avails itself. Avoid duplication of effort; nothing is more deadly. (If security in the problem dictates duplicate effort, make sure the efforts are totally independent and preferably different in approach).

If the programmer is talented, personable, and presents a neat appearance, let him do the work of two or more people. This is to say that the programmer and systems analyst should, where talent permits, be encompassed in one job. Not only will this stretch manpower and simplify communication, but it will engender a strong responsibility in the programmer and motivate him in a total picture.

Conclusion

Communication, motivation, time and space, and debugging have been identified as the crucial variables of software management. By careful treatment of these variables as this article has suggested, the current acute shortage of programming and systems personnel may be compensated for and the software dollar stretched to new dramatic dimensions. ■

FIRST STEP TOWARDS TOTAL INFORMATION AND CONTROL

(Continued from page 28)

number of interrelationships that can be handled.

These modeling concepts approximate how the business is going to operate in the future and makes an excellent vehicle for recording plans. These plans are communicated to the shop, or "real world," as work progresses. When the real world has completed its task of withdrawing and replenishing materials and resources and performed its work, the status of these events in terms of time and quantity is fed back and compared. If the comparison indicates deviation from control limits, the system will determine the need for corrective action.

Applications such as the GE-400 Parts Explosion System fit the total MIACS architecture. At first glance, this is not unlike many other systems of this type which automate such important business segments as scheduling, parts explosion, bill of materials, and inventory—on a subsystem basis. The unique element in MIACS is that all the parts are truly integrated into a single, common data base and changes in plans are immediately reflected throughout the entire manufacturing area. IDS makes single data base management a practical reality.

The newly-announced GE-400 Parts Explosion System forms the foundation—the product structure data base—upon which other MIACS capabilities can be added, building to a complete system. Once the product structure is established, for example, the next logical function to add is inventory management, which includes item replenishment scheduling, item release and completion feedback, and statistical forecasting. Building on this IDS-managed data base, shop scheduling and monitoring capabilities could be added. Further extensions logically would be order processing, purchasing, quality control, accounting, traffic, sales forecasting, and so on.

The GE-400 Parts Explosion System is a free-standing, fully programmed system, ready to use today. It can run on any 16K GE-400 Series medium-scale information system and is disc-independent, meaning that it can run on a variety of GE disc storage equipment. Users can grow without costly reprogramming and file redesign.

Because of IDS and COBOL, the system is easier to learn, apply and adapt, so that user's operating results show up sooner. Actual customer experience has shown a time/cost savings up to 50 percent through the greater efficiency, detailed system design, programming, debugging, implementation, and training benefits afforded by the system.

The specific product(s), materials used, or work performed by the manufacturer does not matter to the system under the MIACS concept. In this respect, MIACS is the first control concept specifically designed to work in almost any kind of manufacturing business.

The free-standing building block approach of MIACS permits the user to grow at his own pace. ■

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an algorithm for rapid calculation of products of boolean matrices

Dr. Thomas C. Lowe

Informatics, Inc.

■ Boolean matrices are used in connection with a variety of applications. Frequently the matrices are quite large. When large matrices are used in specific problems to be solved often, attention turns to the development of rapid algorithms to replace the slower straightforward methods. One example of this is the problem of finding the union of all powers of a Boolean matrix, which was investigated by Warshall (4), described by Ingerman (1) and most recently applied by Ramamoorthy (2, 3).

Considered here is the problem of finding the product of two Boolean matrices.

Algorithm

Given matrices A, B, and C, of dimensions m-by-n, n-by-r, and m-by-r, respectively, in order to compute the product A·B and place it in C:

1) Clear C to zeros.
2) For every row i ($1 \leq i \leq m$) of A, repeat step 3.
3) For every column k ($1 \leq k \leq n$) of A:
   a) If $a_{ik} = 1$, *OR* the k[th] row of B into the i[th] row of C.
   b) If $a_{ik} = 0$, continue.

In step (3a), *OR* is the *inclusive or*.

Explanation

First note that:

$$A = \begin{bmatrix} a_{11}, & a_{12}, & \ldots, & a_{1n} \\ a_{21}, & a_{22}, & \ldots, & a_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ a_{m1}, & a_{m2}, & \ldots, & a_{mn} \end{bmatrix}$$

$$\text{and } B = \begin{bmatrix} b_{11}, & b_{12}, & \ldots, & b_{1r} \\ b_{21}, & b_{22}, & \ldots, & b_{2r} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ b_{n1}, & b_{n2}, & \ldots, & b_{nr} \end{bmatrix}$$

It is desired to compute

$$C = \begin{bmatrix} c_{11}, & c_{12}, & \ldots, & c_{1r} \\ c_{21}, & c_{22}, & \ldots, & c_{2r} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ c_{m1}, & c_{m2}, & \ldots, & c_{mr} \end{bmatrix},$$

where the elements of C are given by the formal definition of Boolean matrix multiplication:

$$c_{ij} = \bigvee_{k=1}^{n} (a_{ik} \cdot b_{kj}).$$

Since the algorithm is stated in terms of operations on rows of matrices, the following row vectors will be useful. Let

$$A'_i = [a_{i1}, a_{i2}, \ldots, a_{in}],$$
$$B'_i = [b_{i1}, b_{i2}, \ldots, b_{ir}],$$
$$\text{and } C'_i = [c_{i1}, c_{i2}, \ldots, c_{ir}];$$

Thus A'_i is simply the original i[th] row of the matrix A.

Applying the definition of Boolean matrix multiplication and substituting for c_{i1}, etc., in the above definition of C'_i produces:

$$C'_i = \left[\bigvee_{k=1}^{n} a_{ik} \cdot b_{k1}, \; \bigvee_{k=1}^{n} a_{ik} \cdot b_{k2}, \ldots, \bigvee_{k=1}^{n} a_{ik} \cdot b_{kr} \right].$$

But this is equivalent to: $C'_i = \bigvee_{k=1}^{n} a_{ik} \cdot B'_k$. Which is exactly the formula described constructively by "If $a_{ik} = 1$, *OR* the k[th] row of B into the i[th] row of C".

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For either algorithm it is anticipated that mechanization would almost always be performed using one bit per element of an array. In both cases the basic loop would be a shift and sign test, with an index register used to keep track of the column position being tested and the end of word condition. On some machines, commands used for floating point arithmetic could be used to locate the bits that are set—for example, one specific machine* has a command called Shift Left and Count. ■

* Control Data Corporation RPC-4000.

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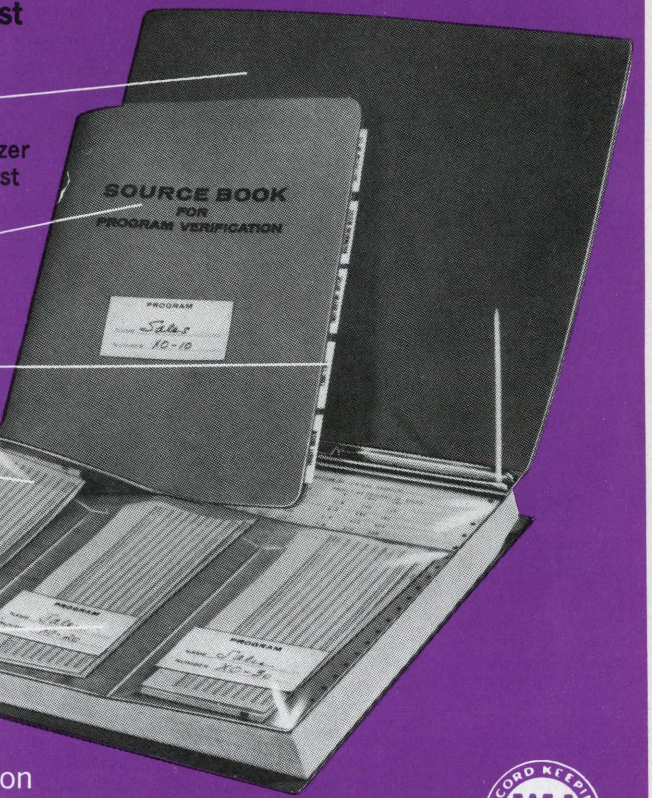

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New **disk pack library units** with full suspension drawers for safe handling and storage of 4″ or 6″ disk packs have been introduced by Wright Line, Worcester, Mass.

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* * *

Data Technology Corporation announced today a family of **digital panel meters** which will find application in electronic systems and control equipment.

The DT 340 features Nixie tube (TM Burroughs Corporation) read out, and solid state circuitry throughout (discrete semiconductors and integrated circuits). Front panel calibration permits zero adjustment to 20 digits and a full scale adjustment to 50 digits. In addition, there are overrange and wrong polarity indicators on the meter face. The product family has five DC volt ranges (from 0-199.9 mV to 0-999 V) and seven current ranges (0-199.9 nA to 0-199-9 mA). The dimensions of the DT 340 family are 2.4″ High X 5.2″ Wide X 7.5″ Deep. Weight is less than 20 ounces.

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Data-Control Systems, Inc., has announced a new **programmable FM demodulator.** Center frequency, deviation and low pass filter cutoff are independently controlled by thumbwheel switches or computer command. Up to six reference frequencies for tape speed compensation are also programmable.

Designated the Series 3000 Universal Demodulator, the system's oriented unit is capable of accommodating carriers in the 300 Hz to 1.5 MHz range, with deviations from 300 Hz to 250 kHz. Low pass filter cutoff may be selected from 1 to 25,000 Hz.

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* * *

A **X-Y recorder** has been introduced by Houston Instrument, Division of Bausch & Lomb, Inc. The new OMNIGRAPHIC$_{tm}$ 6756 X-Y recorder features a six pen X-Y or T-Y recording capability. The X or paper axis can be driven with an analog input or on a time base by means of push button selection. Speed ranges are .05, .1, .2, 15, 1 and 2 in/sec., in/min., and in/hr. The 6756 also utilizes the z-fold paper approach of moving the paper on

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United Computing Corporation of Redondo Beach has released its **Sigma 5/7 simulator** of the SDS 900 series computers. The package, called UNITE I, allows software written for 900 series computers to be run directly, without modification, on the Sigma 5/7.

UNITE I features include: trace, breakpoint, core dump, panel interrupts, and the ability to jump back and forth between 900 and Sigma code.

Spokesmen for United claim 900 series computers can be "on-the-air" instantaneously after the Sigma 5/7 is installed and have all of the software capabilities presently available on their 900 series machines.

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The new FO-200 series of six **FET-Input Positive Followers** featuring a gain accuracy of 1.0000 + 0, —.0003; bandwidth from 2 to 50 MHz and slewing rates from 3 V/usec to 60 V/usec is available from GPS Instrument Company, Newton, Massachusetts.

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A new **RCA all-electronic Videocomp typesetter** that can set the complete text for a magazine page in less than four seconds or write information for microfilm storage at computer speeds was announced today by RCA.

The Videocomp 70/830 generates characters at a rate of up to 6,000 per second —a thousand times faster than manual typesetting machines.

In addition, the new unit provides full page composition through its 70 pica (12 inch) line length and its ability to write in sizes from 4 to 96 point type (approximately 1⅓ inches high) with proportional reduction for 35mm micro-image output.

The new unit makes possible quality typeset printout of computer information at speeds well in excess of the 1,100 lines per minute typical of high-speed printers now used for computer readout. This could result in easier handling and reading of the business and scientific data now being processed by computers.

Videocomp 70/830, in processing data coming from a computer, could either produce short run offset plates that are press ready in only a minute, or with a simple lens change, write the data in

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Computer Communications, Inc., introduced a light **pen as an optional input device** for use with the CC-30 Communications Station. Designated the CC–304, the Light Pen provides the station operator with a direct means of entering information into a computer. It employs a phototransistor detector (eliminating bulky optic bundles) and is cabled to the CC-301 Display Controller via a light pen holder located near the CRT display.

For more information, circle No. 71 on the Reader Service Card

* * *

A new, **portable digital recorder for field data recording,** weighs less than 50 lbs.

The new unit, Model FT-153 is specifically designed and field-proven for geophysical field recording. Operating directly from a 12-Volt battery source with minimum power consumption, the unit writes and/or reads data in IBM-compatible, 7- and 9-channel (IBM 360- or ASCII-compatible) formats, at selectable tape speeds from 15 to 150 ips at packing densities to 800 bpi, NRZI. Data transfer rate is to 120 kc.

Equipped with standard 8½" reels, the recorder accommodates ½" tape. Although available for 19" rack mounting, the FT-153 can be supplied with a lightweight, molded fiberglass carrying case for safe, easy handling.

For more infomation, circle No. 70 on the Reader Service Card

* * *

A new generation of **integrated circuit sense amplifiers**—the Series 7520N—are designed for high-speed coincident-current computer memory systems.

The ICs detect bi-polar, differential-input signals from the memory, and provide a fast, stable interface between memory and logic sections. Low-level pulses originating in the magnetic-core memory are detected and translated into logic levels compatible with standard TTL or DTL circuitry.

The computer designer may choose from three basic circuit designs—two versions of dual preamplifiers driving common-output circuits, or two complete sense amplifiers in a single package. Two threshold levels for each of the three basic circuits provide additional design versatility.

Typical characteristics of the entire series are low propagation delay (25 nsec input-to-output and 15 nsec strobe-to-output), fast overload recovery time to both differential and common-mode signals (20 nsec with 2-volt input), and high d-c logic noise margin (1 V). Independent

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strobing of dual sense-input channels permits signal detection to take place when signal-to-noise ratio is at a maximum. Logical "1" output is 3.9 V and logical "0" is 0.25 V. Supply voltage is ±5 V.

For more information, circle No. 69 on the Reader Service Card

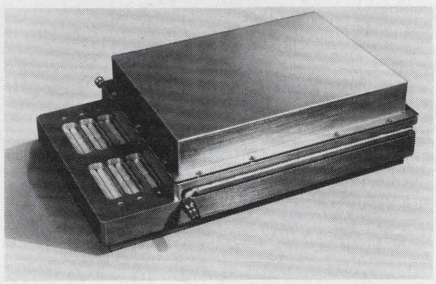
The NAVCOR Model 1262 **paper tape reader** is an asynchronous device readily adaptable to a wide variety of paper and mylar tape processing applications. The standard Model 1282 reads 8-level 1 inch tape; other models are available for 5, 6, and 7-level narrow tapes.

Compact and reliable, the Model 1282 offers positive interrogation of even those tapes that are well worn or that exceed ETA hole-to-hole tolerances. Paper or mylar tape is advanced and sensed at up to 30 characters per second, asynchronously. A pushbutton permits manual advance of tape.

The extremely small size of the tape reader (4" L x 3¾" H x 1½" W) permits it to be mounted on the same plane as the tape spools; no separate mounting plate or rear mounted driving motors are necessary. Shock mounting is available as an option.

No external drive mechanism is required. A single external advance pulse (45V, 6.5 amp peak) is used to feed and interrogate tape.

For more information, circle No. 68 on the Reader Service Card



A new, general-purpose **digital computer** for aerospace applications has been developed by Raytheon Company's Space and Information Systems Division, Sudbury, Massachusetts.

The RAC-230, less than a half cubic foot in volume and 20 pounds in weight, is a parallel, two address machine. It can be tailored to use in ballistic missiles, reentry vehicles, space satellites, or manned vehicles.

Its power supply and oscillator and its logic, memory, and input-output modules are all plug-in type. They are mounted in an interconnection chassis that is wire wrapped to provide highly reliable intermodule connections.

The memory and input-output sections can accommodate one or two memory modules—either braid, core, or alterable plated wire—and interface with a variety of peripheral equipment.

The RAC-230 has a 2 microsecond main memory cycle time with 4096 words in the basic non destructive readout program memory and 2048 words in a "scratch-pad" data memory utilizing coincident current core devices.

For more information, circle No. 67 on the Reader Service Card

S. E. & M. Vernon has introduced a new line of **Atlas EDP form binders.** Utiliizng a spring-loaded clamping bar, the binders can be loaded in seconds. Forms are placed against positioning guides and a lever swung into closed position to securely lock the forms into the binder.

Atlas Binders are available in all popular EDP form sizes to hold burst or unburst sets. Various size sheets can be bound in the same binder with visibility to the binding edge. Covers are available in vivid blue pressboard or cloth-reinforced, simulated leather.

For more information, circle No. 66 on the Reader Service Card

Radiation Incorporated has come up with a machine that removes the crystalline structure build-up on a circuit board, without damaging the board.

Radiation's device applies heat to the raised surfaces or "lands" of a circuit board, concentrating the thermal energy at a precise contact point. The board itself never receives the total heat applied to the crystalline coated surface.

Fully automatic, the machine performs three operations in a span of 48 inches. Total processing time per board is 10 seconds.

For more information, circle No. 65 on the Reader Service Card

Data-link Corporation has introduced a new line of **mylar opaque patches** for repairing and splicing perforated paper tapes.

This self-adhesive patch has a peel-off backing strip and will adhere to all perforated paper tapes. Splices are thin and flexible to allow reliable use in most tape readers without catching in tape guides or drive mechanisms.

For more information, circle No. 64 on the Reader Service Card

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