December is a good month for you to think about the years ahead

Engineering Development Programmers
Minimum of one year experience with remote terminal devices is especially useful, although not essential. Duties: software to support state-of-the-art remote terminal design, development and testing, and program design for latest technology equipment. Programs will be written in several languages and executed on various computers.

Environmental Engineer for Computer Installations
As a site preparation engineer for computer installations you will have full responsibility for all site work. Travel only during the week. Engineering degree required. A minimum of two years' experience in air conditioning, heating and refrigeration preferred.

EDP Programming Writers
Degree plus 2-3 years' experience in EDP writing. Duties would include the preparation of technical manuals and sales material on new or modified systems, devices, equipment or installations. The material is to be used primarily by Customer Service Technicians and Field Personnel for training, reference, education and maintenance.

Applied Programming Development
These positions are for programmers and systems analysts experienced in on-line, commercial, industrial, financial or retail applications programming. They involve working on third generation equipment. A minimum of one year programming or systems experience is required.

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Your background should include three to six years' experience in marketing, either in sales or systems with a vendor, or experience directly in the evaluation area. Duties would include preparation of reports concerning the capabilities of competitive computer hardware and software; technical sales assistance to the NCR Field Marketing force; analysis of the computer marketplace of the future and development of strategies to take advantage of the market.

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The position is in hardware/software technical support of third generation mixed tape and disc. You shall perform as intermediary in all major software problems from initial presale demonstration through the debugging stages. The position will carry full responsibility for the software support of the new Century Series and 315 Systems. Experience in magnetic file computer most helpful.

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Prefer a BS degree or two years' or more systems software experience with large scale hardware. Work is in the following areas: design and implementation of advanced time sharing, multi-programming, and multi-processor operating systems executives. Design and implementation of on-line languages, file systems and compilers to operate exclusively in a time shared environment.

Management Information Systems
Academic background should include a broad business education with an MBA degree preferred. Experience in MIS and some knowledge of business systems as they can be automated is helpful. The responsibilities will include the determination and co-ordination of user specifications for the development of such an integrated computer-based system.

Planning Analyst
Duties would involve work on high level planning and analysis problems. A technical degree is required. An MBA or some graduate level business training also desirable.

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computer then uses this information to help the scientists decide which mice should be mated to produce the next generation. Through this form of selective breeding it feels that it will be possible to develop many lines of mice, each with a different gene or genes which produce different antibodies. The computer is especially helpful because the combinations of genes that can cause tissue rejection come to an estimated total of at least one trillion.

At the Lowell observatory in Flagstaff, Arizona astronomers are using computer techniques to answer questions about the universe.

Information gathered at the telescopes is electronically coded onto paper tape and sent to an IBM 1130 in the Planetary Research Center. The desk-sized system reduces these seemingly unrelated numbers to tangible results, saving thousands of pencil-and-paper calculations. In the future they would like to set up a microwave link from the telescopes to the computer and display information as it is processed.

Before the recent Mariner fly-by missions, the computer had helped analyze some 10,000 photographic plates of Mars collected since 1900. Every plate was catalogued and analyzed with the aid of the computer. The huge data reduction job was later proved to be quite accurate by the Mariner photographs.

The observatory was founded in 1894 by Dr. Percival Lowell, who predicted the existence of an unknown planet and supervised the calculations of five people who worked seven years to establish its probable position. Sixteen years after Dr. Lowell's death astronomers detected the planet with an improved telescope within 1° of where Dr. Lowell had said it should be.

Kansas City police have announced the successful testing of a computer-based crime analysis program (Law Enforcement—Manpower & Research Allocation System—LEMARAS) that will forecast when and where patrolmen will be needed to combat crime and answer calls for assistance. The Chief of Police in Kansas City has indicated that metropolitan police solve two-
An Information System for Vehicle Scheduling*  

by
R. Noonan
and
A. Whinston

* Research supported in part by the Office of Naval Research and Army Research Office.

Introduction

• Our shipping department is a job sink; once an order has entered it there is no way of determining what has become of the order.
• Our dispatcher is a real genius; sometimes the routes are too long and sometimes too short, but they average out to be just about right.
• You can’t use a computer to schedule trucks. What are you trying to do, tell me how to run my business?

These statements were representative of comments received from managers of companies which were either partially or wholly in the trucking business. They indicated a lack of awareness for the type of aid that a good management tool could provide.

In this article we will discuss how a modern, computer-based vehicle routing system can be an effective tool in optimally using a vehicle fleet and in providing good management information concerning fleet utilization. We were also interested in combining such a system with customer billing, sales analysis, inventory control, and other systems specific to each user. Although the system was designed specifically for scheduling trucks, it is applicable wherever a routing based principally on time constraints must be determined.

There have been a number of theoretical papers devoted to the so-called scheduling problem. Most of these were unable to solve large problems in a reasonable amount of time. Only one approach has been implemented (as far as was known by the authors) in a practical system for use in solving real-world problems. Thus, although much study has been devoted to these problems, little has been done to develop a system as a good management tool in the area of vehicle routing. As a result, companies were completely dependent on the genius of the traffic manager and his manpower and fleet needs.

This article is intended to bridge the gap between the theoretical work in this area and the practical needs of trucking companies. We will first look at the role of the vehicle routing system as an integral part of a total management information system. Then we will examine the capabilities of the vehicle routing system and the algorithm which underlies it. Finally, we will present an actual example.

As a versatile, management tool

The vehicle routing system should be integrated with other existing computer-based systems, such as customer billing, inventory control, etc. This means that the files involved should be set up so that they can be cross-referenced by the various program modules. In the ultimate system a single entry, the customer order or bill of loading, as entered from an on-line terminal, would generate all the updates necessary to the accounts receivable file, the inventory file, the customer order file, etc. These, in turn, would generate, at the proper time: the customer bills, inventory purchase orders, the vehicle routings, etc.

In addition to the mere day-to-day routing of vehicles to customers, the vehicle routing system automatically provides management control information. First, it generates a written record of what orders were shipped on each truck, when they are scheduled to arrive, and the percent utilization of the fleet. Such information could be used to determine when increases or decreases in vehicles or men are appropriate; it could also be used seasonally to determine good vacation periods. Finally, the information could be used to verify that each vehicle is loaded with the correct amount of goods requested by each customer. This control information provided by the vehicle routing system should be invaluable in allowing higher management to apply good management control to the traffic department.
Multi-dimensional capacity restrictions can be allowed.

An average delay time can be specified for the fleet and/or individually for each customer.

The vehicle fleet can be broken down into types based on capacity and product type.

The system is written in a higher-level computer language and is designed to be computer-independent.

The system is capable of solving relatively large problems on relatively small machines.

<table>
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<tr>
<th>Nr. of Orders</th>
<th>Memory Size (in bytes)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>65 K</td>
</tr>
<tr>
<td>200</td>
<td>65 K</td>
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<td>500</td>
<td>96 K</td>
</tr>
<tr>
<td>1000</td>
<td>131 K</td>
</tr>
</tbody>
</table>

Larger problems can be run on the smaller machines if direct access disk storage is available.

The system allows the suppression of the printing of individual route information, with only summary vehicle utilization information being printed.

As an algorithm

Underlying the vehicle routing system is a classification algorithm. In principle, the problem with the restrictions noted above could be formulated as an integer programming problem. However, the problem formulated would involve too many equations and variables to allow it to be solved. One could solve the problem using the simplex method and simply round to the nearest integer solution, but the formulation would involve millions of variables for even a fairly simple 200 customer problem. This is still too large a problem to solve using present, standard linear programming codes. Finally, one could formu­late the problem as a period-transportation problem, but a 200 customer problem with 50 periods would involve 1 million variables. Although a problem of this size is solvable on a medium-to-large scale computer with disk capacity, it does not allow for the other complexities which we have introduced and would require at least 5 times the amount of computer time.

Basically, we chose to formulate the problem as a classification problem, following earlier work done along these lines by Clarke and Wright. In this way we were able to enlarge the formulation of the problem to allow arbitrary complexities without significantly increasing the size of the problem. One immediate advantage of this type of formulation was that unlike a mathematical programming model, the problem need not have a feasible solution, that is, one in which all orders are delivered in the time period being scheduled.

After the input phase, the algorithm begins by sorting the customer orders according to priority and amount. A subset of the total number of orders is assigned to individual routes. For each pair of existing routes, a measure of association is calculated as a function of their nearest points, the distance from the warehouse, and the time windows involved (the early and the late delivery times). Two orders are never assigned to the same route if the products involved cannot be shipped on the same type of truck.

The merging of routes is then attempted by order of the greatest association measure; this process continues as long as truck availabilities and size and total route distance permit. Then a new subset of orders is taken and the entire process is repeated (see figure 2).
## TEST PROBLEM NO. 5

### PARAMETERS

- **Fleet Early Start Time**: 8.00
- **Fleet Late Finish Time**: 17.00
- **Average Delay Time/Stop**: .06
- **Speed Modification Factor**: 1.00
- **Number of Warehouses**: 1

### ROUTE NUMBER 5
- **Initial Amount**: 3878
- **Truck Type**: 1
- **Warehouse**: 1
- **Total Time**: 15.36

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**Slack Time**: 0.00

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## ROUTE NUMBER 6
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- **Truck Type**: 1
- **Warehouse**: 1
- **Total Time**: 15.36

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**Slack Time**: 0.00

---

Figure 3

Software Age
An Experimental Approach to Recursive Fortran Subroutine Programming under Operating System 360

by
Herbert C. Kugel

Recursion is the name given to the process of defining a function or relationship in terms of itself. A typical recursive relationship is the factorial function for the positive integer numbers:

Factorial(n) = n*Factorial(n-1), n greater than zero,
Factorial(0) = 1

Recursive programming is an area that has long fascinated many people. Many algorithms have been defined and much thought given to the recursive computer program. Although the results have not always been spectacular, the problem is far from academic since recursion is very much a factor in such diverse areas as operating system generation and compiler writing.

FORTRAN has traditionally been an area where recursive techniques have had only limited success. IBM Operating System 360 FORTRAN, however, does allow the compilation of a recursive subroutine. That is, a subroutine that can call itself in exactly the same manner it might call any other external subroutine. Although the method that will be outlined is quite 'non-standard,' its implementation can lead to a fuller awareness of the fundamental concepts of software development, and, as such, is well worth some thought and consideration.

For the purposes of this article it is feasible to begin with the factorial function itself since certain of its properties are common to all recursive relationships. Each Factorial(n) is defined in terms of Factorial(n-1) and so on back to the initial Factorial(0). The initial Factorial(0) is explicitly defined as one. There is no calculation involved, only a formal definition from which all other values can be derived. There may be more than one explicit definition. The Fibonacci sequence, for example, has two such definitions. It is the series of integers, x1, x2, . . . . . . . x(n), such that every x(n) is the sum of the two preceding values; x1 and x2 are explicitly defined as one:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, . . . .

If the name Fibonacci(n) is arbitrarily assigned to x(n), the process becomes:

Fibonacci(n) = Fibonacci(n-1) + Fibonacci(n-2)
Fibonacci(1) = Fibonacci(2) = 1

The same rules apply to the Fibonacci sequence as the factorial function. There are explicit definitions of the initial arguments and all other values are derived therefrom.

Thus it becomes reasonably apparent that, if the recursive process is to be programmed, the following factors must be carefully considered:

• The initial explicit definitions
• The recursive relationship itself
• The number of times this recursive relationship is to be applied.

The actual programming, obviously, must also be given careful examination. Logically, if a recursive function is defined in terms of itself, then the coding of a recursive subroutine to process that function should involve the creation of a subroutine that has the ability to call itself. For instance, if a subroutine, IFACT, is defined to calculate Factorial(n), the compiler must be able to process a structure of the form:

SUBROUTINE IFACT (IY,N)
CALL IFACT (IY,K)
RETURN
END

If the name Fibonacci(n) is arbitrarily assigned to x(n), the process becomes:

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Fibonacci(1) = Fibonacci(2) = 1

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• The recursive relationship itself
• The number of times this recursive relationship is to be applied.

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RETURN
END

IZ(n), are defined as data constants, their location within the subroutine is completely unrelated to the condition of the general registers at any given time. Hence, they are also independent of the number of times the subroutine calls itself. Now, since the logic of the recursive function is such that the dependent variables replace the independent variables, it can be seen that this is quite easily accomplished by having all recursive calculation input and output go to and from these IZ(i). Thus, when the recursion is complete, the desired results are in IZ(i). They can be transferred to the calling program and the IZ(i) are then reset to their initial explicit definitions if the subroutine is to be used again.

This is all relatively simple, as will be seen from the following example. For the moment assume the existence of two assembly language subroutines, SET and RESET, that deal with the problem of saving and restoring the initial contents of the general registers. Now consider the following subroutine IF ACT. The purpose of this routine is to set the value 1Y equal to the Factorial of integer (n).

SUBROUTINE IF ACT (IY,N)
INTEGER IZ1/1/
CALL SET
K = N
IF (K) 4,4,3
3 IZ1 = IZ1*K
K = K - 1
CALL IF ACT (IY,K)
4 IY = IZ1
IZ1 = 1
CALL RESET
RETURN
END

In IF ACT, the INTEGER statement is used to define IZ1 as the explicit Factorial (0) value of one. The K = N statement takes, during the first call to the subroutine, the externally supplied N and initializes it as an internal counter, and, in this case, operand, K. This K is compared to zero. If it is not zero, a recursive calculation is performed and IZ1 is set equal to IZ1*K. The value K is then decremented and IF ACT is called recursively, this time with K as an argument instead of N. This is done with all recursive FORTRAN subroutines. In fact, if each recursive call is thought of as being made to an external subroutine, say IFACT2, the above logic would reduce to the quite familiar:

SUBROUTINE IF ACT (IY,N)

.

K = N
.

K = K - 1
CALL IFACT2 (IY,K)
.

The only difference is the call. Any recursive subroutine is called once with an externally supplied N. The subroutine then calls itself (n - 1) times using an internally generated counter K. Each call results in exactly one iteration. After N such calculations the process is complete, and, in the case of IF ACT, IY is set equal to IZ1, which now contains the Factorial (n). It is quite important to stress that this logic is completely independent of whether N or K is involved in the arithmetic calculations. It need not have been, as is shown in the next examples.

It is simple to extend this approach to several variables. All that is required is that a unique IZ(i) be associated with each variable. Consider, for example, the Fibonacci number sequence defined above. It is possible to create a subroutine, FIBNCI, which, for any integer n, determines the three values Fibonacci (n), Fibonacci (n + 1) and Fibonacci (n + 2). The coding for this is straightforward:

SUBROUTINE FIBNCI(IYN,IYN1,IYN2,N)
INTEGER IZ1/0/,IZ2/1/,IZ3/1/
CALL SET
K = N
IF (K) 3,3,4
3 IYN = IZ1
IYN1 = IZ2
IYN2 = IZ3
IZ1 = 0
IZ2 = 1
IZ3 = 1
CALL RESET
RETURN
4 IZ1 = IZ2
IZ2 = IZ3
IZ3 = IZ2 + IZ1
K = K - 1
CALL FIBNCI (IYN,IYN1,IYN2,K)
END

This logic is exactly the same as in IF ACT. The only difference involves the initial explicit definitions and the arithmetic calculations. The integer values at IZ2 and IZ3 are the initial explicit definitions for Fibonacci (1) and Fibonacci (2) respectively. When FIBNCI is first entered, IZ1 is set equal to IZ2, which, in turn is set equal to IZ3. IZ3 is then defined as IZ1 + IZ2. These values, after the first call, are Fibonacci (1), Fibonacci (2), and Fibonacci (3) respectively. This process is then repeated recursively (n - 1) times. During each such call Fibonacci (j + 1) and Fibonacci (j + 2) are moved down to Fibonacci (j) and Fibonacci (j + 1) respectively. A new Fibonacci (j + 2) is calculated and placed in IZ3. After this process has been repeated n times, IZ1, IZ2, and IZ3 contain Fibonacci (n), Fibonacci (n + 1), and Fibonacci (n + 2) respectively. These values are delivered to the calling program and the IZ(i) are reinitialized, as was IZ1 in IF ACT.

The only programming constraint in this method is in the inherent nature of any subroutine generated by the FORTRAN compiler. These modules are designed to obtain all the arguments supplied to them by the calling program, modify some as called for by their coding logic, and then return all these arguments, both modified and unmodified, to the calling program. Since the recursive subroutine repeatedly calls itself with a decreasing variable, K, it replaces the previous K during each recursive call. Finally, at K = 0, when all arguments are returned to the calling program before final exit, this zero value replaces the initial value of N. Because of this, N must be saved if it is to be used again. This is the only major constraint that must be defined in recursive usage.

There is no problem with unmodified arguments. The recursive subroutine passes unmodified arguments to itself in exactly the same way it would pass them to any external subroutine. Consider, for instance, a subroutine, SQRT!, that uses Newton's Method to set Y equal to the square root of X. Newton's Method is defined in almost any text on numerical analysis, but for the purpose of this discussion it is sufficient to state that the method uses the recursive relationship:

\[ Z(n+1) = Z(n) - \left( \frac{(Z(n))^2 - X}{2\times Z(n)} \right) \]

where each \( Z(n) \) is normally the same or a closer approximation of the square root of \( X \). (\( Z(n) \) and \( Z(n+1) \) should eventually be the same if \( X \) were a perfect square.)
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Suggestions for SOFTWARE AGE

________________________________________________________________________
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b) Provide rapid responses to agent inquiries regardless of their geographical location.

c) Perform the varied accounting functions necessary in a reservation system.

It is extremely important to distinguish problem symptoms from the real needs. In order to design a good system, the problems must first be clearly defined. In many cases, the stated problems are only symptoms of an underlying problem of gathering, analyzing, classifying and disseminating information. The system must be designed around the problem instead of around the symptoms of a problem.

Determination of the Problem

Problems which require an on-line real-time system solution usually involve many information senders and receivers. A list must be compiled of all senders and receivers of information and their geographical locations. The amount of data being received and transmitted from each location must be determined. This data should be in the form of messages per minute, hour, or day, the peak number of messages per unit time, message length, and the duration of the peak data transmission or traffic period. One example of data senders and receivers is in an airline reservations system. Here, the data is sent and received by a number of persons at different locations. There may be several agents at city A, transmitting hundreds of transactions per peak hour. There may be many agents at city B, transmitting dozens of transactions per peak hour, etc.

System Cost

The system is normally designed to handle the peak traffic projected several years hence, rather than projections of the current average traffic. One factor which may lead to a decreased system cost is that traffic peaks may occur at different times in different portions of the system. This information should be used in designing the system. Neglect of this factor may require more equipment than necessary, causing a substantial increase in the price of the proposed system. There is little difficulty in defining a real-time system which will work. However, the problem is defining one which will operate efficiently and is optimized for minimum cost in the particular application.

Response Time

The response time delays which can be tolerated by each user should be documented. Usually the delay which can be tolerated determines the speed and type of communications network required. If the messages are short and the response time is short, a low speed communications network may be used. If the messages are long and short response times are desired, a high speed communications link may be desirable. Transmitting a message from a remote terminal to another point in the system can account for an appreciable part of the response time.

Data Transmission Characteristics

The nature of the transmitted data must be defined before designing and predicting performance of a system. For example, it may be numbers, letters of alphabet, punched card data, or other types of inputs, such as signals from counters or digital converters. In a traffic control system, for example, the data is essentially a car or no car signal between the traffic system and the computer system. On the other hand, for an airline reservations system, the transmitted data consists of alphanumeric character input and output messages called transactions. Fifty percent of the transactions may have a 40 character input message and a 120 character reply; 30% of the transactions may have an input message of 75 characters and have an average reply of 50 characters with a range between 25 and 300 characters. Ten percent of the transactions may be input messages of only 100 characters. Ten percent of the transactions may be output messages of 100 characters average, ranging from 50 to 500. It is in this manner that transactions or types of messages must be described for each geographical location.

Communications

In many systems, the communications network may already be in operation. In these cases, it may not be possible to change the network drastically. An example might be an inventory/order entry and reply system using a full-duplex communications network with over 200 cities involved. It would be impractical from a cost standpoint to alter the existing communications network. In this case, additions to the system would have to be designed around the existing remote communications facilities.

Multi-Programming

Sometimes, along with the real-time requirements, there is a requirement for concurrent batch (background) processing. This may be defined in terms of the characters or computer words of input and output and the type of processing involved. For example, 3,000 cards per hour input and 4,500 lines per hour of high speed printing may be desired as a card-to-printer conversion action to occur concurrently with the real-time activities.

At this point in the design process, the data necessary to determine the problem scope has been gathered. The next step in the process of designing the system and understanding the problem is to construct a trial system block diagram.
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Class C programs are all other programs. These might be programs contributed by users of IBM hardware, and by IBM employees. Most of the reclassified old Type III and IV programs will be assigned here, as well as many new programs.

All new system control programs will continue to be provided and installed free of charge, but only once for each computer for each user. Maintenance (including updates), debugging, and temporary patches will also be provided free of charge as long as the user keeps up to date. These provisions will also apply to any old Type I, II, and III programs reclassified as system control programs.

For program products (programs in classes A, B, and C), the picture is quite different (see Table I). To obtain these programs, the user must make a monthly payment for each computer on which he is licensed to use the program. Installation and maintenance will sometimes be included in the license price for classes A and B. For class A programs some debugging and temporary patches will also be provided, but not for classes B and C. Also debugging on live data will probably not be provided for any program products. Class C programs will usually be eligible for no free service.

Eligibility for free service will also depend on the up-to-dateness of the software. A program otherwise eligible for free service will apparently not be eligible if it is not the most recent version, if it does not include all updates and modifications, or if these updates or modifications were not performed by IBM personnel for the user promptly after their official release. The user must permit IBM to keep his software current, to keep it qualifying for any free services for which it might be eligible.

This same concept applies also to the installation of new programs. Assuming the program is eligible for IBM-provided installation service (a system generation for an operating system, for example) then the work must be done by IBM and the result must conform to IBM's normally established practices. The user will not be able to have IBM customize a program for him and expect it free of charge. Further, if the user does have a piece of IBM software customized, then it may fail to qualify for some subsequent free services.

Starting in 1970, the existing Type I, II, III, and IV programs will be subject to the same installation, maintenance, debugging, and temporary patch policies as the new programs under the new classifications. The eligibility for free service will depend upon the service classification assigned to each of the old programs, even though IBM will continue to provide the programs free of charge.

Software License Agreement

IBM is taking a number of steps to protect its software and its revenues. One basic step is the copyrighting of the programs to establish IBM's legal right to try to control the terms on which anyone can use the software. The copyrights give IBM access to the courts, if necessary, to enforce its ownership claim on its software, and they help demonstrate IBM's interest in its software.

IBM is taking a second step. To gain revenue from the software, and to protect IBM from unauthorized use of the software, IBM has drawn up a "License Agreement for IBM Program Products." IBM assumes all who use program products agree to the terms IBM sets forth acceptance of a program is equivalent to signing the License Agreement. In brief summary, the major provisions of the License Agreement are these:

1—Use is limited to a single specified CPU.
2—The user may make no more than five copies of the program or documentation.
3—The user must not make copies available to any one, of either the program or the documentation.
4—The user is to pay a monthly charge.
5—The user may also have to pay an initial charge.
6—IBM may change the monthly charge at any time, with notice.
7—If the user modifies a program, he forfeits the right to free debugging service from IBM, a consequence of the modification.
8—Use of the program is entirely the users responsibility.
9—IBM does not guarantee the results of using a program.
10—IBM may discontinue the license upon six months' notice.
11—The user may discontinue a license with one month's notice, after the first two months.
12—When either IBM or the user discontinues the license for a program, the user must destroy all copies of the program and documentation.
13—IBM may modify the Agreement but the user may not (the user may discontinue all licenses).

System Engineering Agreement

IBM is taking a third step. As a result of its unbundling, IBM will cut off, as of January 1970, all free systems engineering services which it deems nonessential for the support of its own sales force. It is thus putting systems engineering onto a pay-for-service basis. IBM customers who wish assistance in the installation and use of data processing products can now purchase it from IBM.

To facilitate this, IBM has drawn up and expects its customers to sign an "Agreement for IBM System Engineering Services". Some of its provisions, in summary, are:

1—The price is based on time and materials. It is never a fixed price, even if a "quotation" has been made.
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3—IBM invoices at its current rates, and may change them after notice (see Table II).
4—IBM determines which personnel to assign.
5—The user assumes responsibility for the supervision, management, and control of the work of the personnel IBM assigns.
6—IBM does not warrant the fitness of the work of its personnel in meeting the user's need.
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Tracor Computing Corporation (TCC) Austin, Texas and Insurance Information Exchange, Inc. of Dallas have announced that the two companies have reached an agreement in principle under which TCC will acquire the Dallas Computer software company. Insurance Information Exchange provides consulting, programming assistance, training and "software packages" to insurance companies while Tracor Computing Corporation offers a full range of computing capabilities, including hardware product development. TCC specializes in systems and facilities management services. under which they take total responsibility for a customer's computing requirements.

University Computing Company, a multi-national computer service organization headquartered in Dallas, has acquired Computer Data Sciences Inc. of Cleveland, a affiliate of Curtis Noll Corporation. Computer Data Sciences was formed in Cleveland in late 1967 and has specialized in computer programs and operating systems, and the development of a cathode ray tube type-setting service for the printing and publishing industries. CDS will remain intact as a wholly-owned division of UCC's Applied Science Group. UCC International, Inc. has also organized a new subsidiary, University Computing Canada, Ltd., headquartered in Toronto. UCC operates a nationwide computer Utility Network, powered by computing centers of varying capacity in some 15 cities, and a similar network in Great Britain and western Europe.
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I.A.C.P.

A professional organization to represent the interests of programmers throughout the world has recently been formed. The International Association of Computer Programmers, Inc., or I.A.C.P., a non-profit organization is presently encouraging the formation of local chapters by active, affiliate and student members throughout the United States.

The schedule of the new association calls for:

- A monthly magazine containing articles and departments of interest to the computer programmer
- State, regional, national and international meetings of the membership
- Educational seminars, lectures and exhibits
- Publication of educational materials
- And many more programs of interest to the members of the programming community.

If you are interested in further information on how you may form or join a local chapter in your community please write to Richard Lynch, % Software Age Magazine, Box 2076, Madison, Wisconsin, 53701.

data names and procedure names giving all page and line references used by data and procedure division names. The Cross-Reference list indicates any fields which are used as subscripts, list indicates any fields which are used as subscripts, qualifiers, or data files.

Previous to the introduction of this unique mini-program it was impossible to generate a Cross-Reference list from an IBM Cobol compilation.

For more information, circle No. 14 on the Reader Service Card

... ...

MIRACL/CPG, a computer software product directed toward reducing turnaround time for writing and testing programs has been announced by Republic Software Products, Inc., a subsidiary of Republic Systems, Inc. of East Orange, N.J.

MIRACL/CPG (Cobol Program Generator) generates complete, debugged Cobol programs with far less effort than through the use of Cobol. The MIRACL system improves on the efficiency of programming languages by eliminating the repetitive and time-consuming aspects of detailed coding. As many as 30 or more Cobol statements are replaced by one MIRACL statement. This allows programmers to spend a higher proportion of their time on program and systems logic instead of clerical details. An additional feature makes it possible for non-programmers to use MIRACL and generate reports.

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... ...

Information Science Incorporated of New York City, New York has developed a new programming tool for the creation and maintenance of computer files that includes complete edit and update capabilities. Termed the General Maintenance System (GMS) the new concept is a general purpose system that creates a complete range of edit and update programs, including file creation, transaction editing, file maintenance and optional audit-trail, and/or error routines. The programs are created for each file by the GMS "generator" and all are written in COBOL, with provision for incorporation of unique individual user routines. Minimum machine configuration specifications for installation are: System/360—32K DOS or OS; Reader Punch; Printer; Disk Drive for system residence and one additional direct access device or four tape drives; or equivalent COBOL support configuration.

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Good documentation is usually one of the biggest headaches for programming managers since most programmers feel documentation to be an insult to their intelligence. This aversion towards documenting quite often just covers up the fact that program documentation is difficult, time consuming, and not as thrilling as actual programming.

Aside from providing the programmer with clerical and typing help, the manager who wants good documentation should also provide a documentation guide. That's where this book can be useful; it offers the busy manager a chance to adopt a standard guide at little expense and effort on his part.

Fourteen guides are provided for almost all types of programming situations including conversational and non-conversational, internal logic, library users, operations, and operating system guides. The book provides the guides, with little discussion on their use, but the information seems sufficient for successful documentation. The book does suffer from the lack of any completed examples, but the material is clear enough that this omission is not fatal. Rather than each computer installation researching and designing its own software guide it will probably be more efficient for the installations to start with a guide, like this one, and proceed to modify, add, and delete sections as needed.


John Diebold obviously belongs to the optimisti c school of technology—that is, technology can solve all man's problems. Such a philosophy becomes evident as one reads through the book because such statements appear as: "We today possess the means for achieving virtually any ends we wish, whether it be to travel the galaxy, mine the ocean, replace the human body, or educate, house, and care for the world's population." Unfortunately these optimistic promises do not state explicitly how we are to solve the political problems of population control, resource distribution, or how we are to prevent atomic, biological, or environmental destruction.

Since John Diebold is a very successful manager (president and founder of the Diebold Group, Inc., an international management consulting company, and chairman of John Diebold Inc., a management and investment company) one would rather expect him to take a manager's point of view, and he does in this collection of speeches. Diebold rightly condemns organized labor for demanding higher wages and supporting featherbedding jobs, but he completely ignores industry's disinterest in employee obsolescence. He also states that labor should be demanding educational facilities for workers caught in a technological squeeze of old work skills and new methods, and while this is a pertinent point, both labor and industry have not been too eager to help with the difficult task of retraining workers. Rather, industry usually prefers to simply lay off obsolete workers with obsolete skills and contribute to unemployment compensation.

Diebold goes on to suggest that a computerized job bank which matches employee qualifications to employer requests will help alleviate unemployment, but this suggestion ignores that fact that an uneducated laborer can not be matched to any available technological position.

While this book will make many highly placed technocrats pleased with their future (Diebold does a good job of describing technological possibilities), the book does not give the answers to the political problems of implementing the solution. By far the best chapter is on Education. Diebold concludes that both the population and information explosion combined with a rapidly changing technology will force major changes in education. Diebold sees all this as an impetus to study how people learn and the introduction of new teaching devices such as computers. Diebold perceptively notes that because of the rapid change in technology future education of a child must address itself to imparting an ability to learn and concern itself less with the content of learning.

Other topics covered are the impact of science and technology, international disparities (European only), and the training of managers. The subtitle of the book more correctly describes the content of this book than the title.
The recent expansion of our hybrid organization and the creation of two new software organizations at Lockheed have generated a number of important positions for software and analytical programmers in the fields of hybrid, airborne and test data processing.

The positions represent senior technical staffing requirements to fulfill prime contractor responsibilities for total ASW systems software design and integration activities on such programs as the Navy's new S-3A and P-3C as well as a number of advanced R&D projects.

Immediate requirements are in the following areas:

**HYBRID APPLICATIONS**
To perform continuous system simulation and dynamic analysis problems in support of engineering projects. Requires hybrid, analog or digital computer experience, especially hybrid.

**TEST DATA PROCESSING**
Will plan, flow chart, write, debug, check-out, and monitor production running of FORTRAN IV language telemetry data processing programs. Requires scientific programming experience in retrieval, calibration and processing of airborne recorded PCM and FM telemetry data.

Or will devise subroutines to be assembled with systems software in conjunction with real-time applications in the area of scientific test data acquisition and processing. Requires experience in systems software used in real-time or on-line computer systems and systems software maintenance.

**ASW SOFTWARE**
To provide major technical contributions and conceive advanced systems for S-3A software programs; technical direction of subcontractors engaged in program development, test and evaluation. Specialty areas include: control program design for real-time, multiprocessor configuration; tactical mission application programs; and functional and diagnostic test programs.

**COMPUTER DESIGN**
Design and configure special and general purpose computers. Logic design experience required.

**DIGITAL RESEARCH**
Digital circuit design of interface units for general purpose digital computers to peripheral equipment (displays, controls, drums, etc.). Provide systems design, circuit design of systems, implementation to breadboards and test of interface and control units to be used in lab environment.

For more information or to submit your résumé, please write C. R. Alexander, Employment Manager, Dept. 3912, 3459 Empire Ave., Burbank, California 91503. An equal opportunity employer.
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