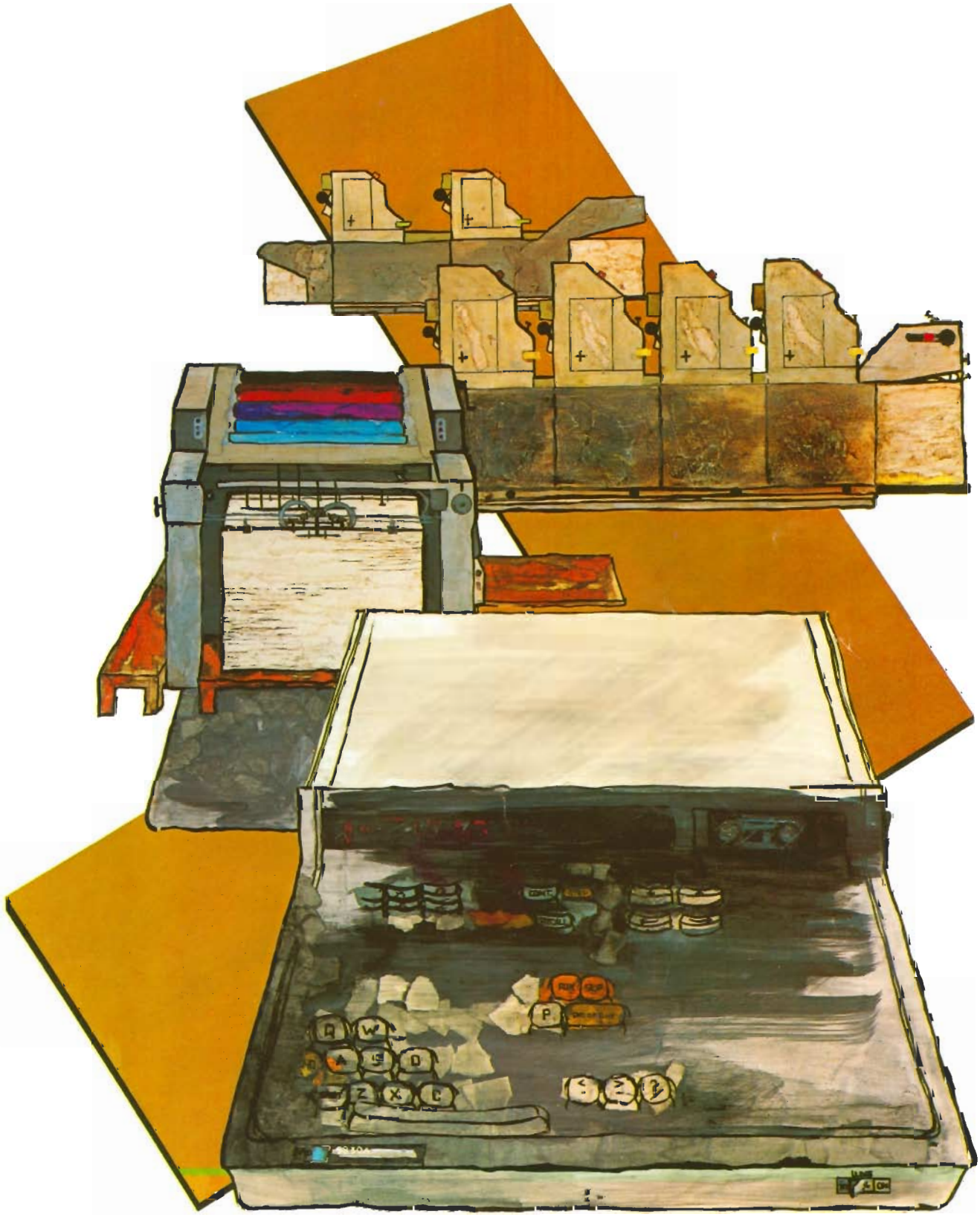
HEWLETT-PACKARD

KEYBOARD

VOL. 5 NO. 4



OVERVIEW

In the business section of this *KEYBOARD* you will find an article describing the many applications an advanced printing company is finding useful for the 9830A Calculator. You may find the descriptions of some of our latest software (Model 20 Payroll Pac) and hardware (Model 81 Calculator) useful in planning your applications for these products.

Two of the features, 'Assignment of Enlisted Marines' and 'π Determined by Monte Carlo Methods,' were submitted in the last 9800 System Application contest. The quality of all entries made it difficult to choose winners; more entries will be published as space permits.

We plan to publish six issues of *KEYBOARD* during 1974 instead of the traditional four, and hope you will enjoy the additional items this will enable us to publish.

All programs, programming tips, and application articles you care to submit will be most welcome; we will give them serious consideration for publication. Send them to the nearest *KEYBOARD* field editor or direct to us at Loveland.

FIRE SPREAD MODEL (9820A)

William H. Frandsen of the Northern Forest Fire Laboratory in Missoula, Montana, has written a new 9820A program, 'Rothermel's Fire Spread Model'. This program, using the 429-register memory and a Math ROM, quickly solves Rothermel's set of parametric equations for obtaining the rate of spread through a porous fuel array. Two fuel categories are accommodated, with up to nine size classes within each category.

This program has been published by the USDA Forest Service, August, 1973 as General Technical Report INT-9. Copies are available from:

Intermountain Forest and Range Experiment Station
Forest Service
U.S. Department of Agriculture
Ogden, Utah 84401
Robert W. Harris, Director

CONTEST: Rationalizing Fractions

G. P. Jenkinson of Louth, Lincolnshire, England recently sent us a challenge to find the fastest program for rationalizing a decimal fraction by expressing it in the form i_1/i_2, where the i's are integers, and obtaining a specified accuracy. We are passing this along to our readers in the form of another contest. *KEYBOARD* will award a small prize for the best answer submitted by anyone not employed by Hewlett-Packard. Entries will be accepted if they are received at our Loveland office by March 20, 1974.

As this issue goes to press, the contest announced in *KEYBOARD* Vol. 5, No. 3 for the best list of uses for the numbers $10^{\pm 99}$ is still open. It closes on December 20, 1973. Send your entry if you have not already done so.

HP Computer Museum
www.hpmuseum.net

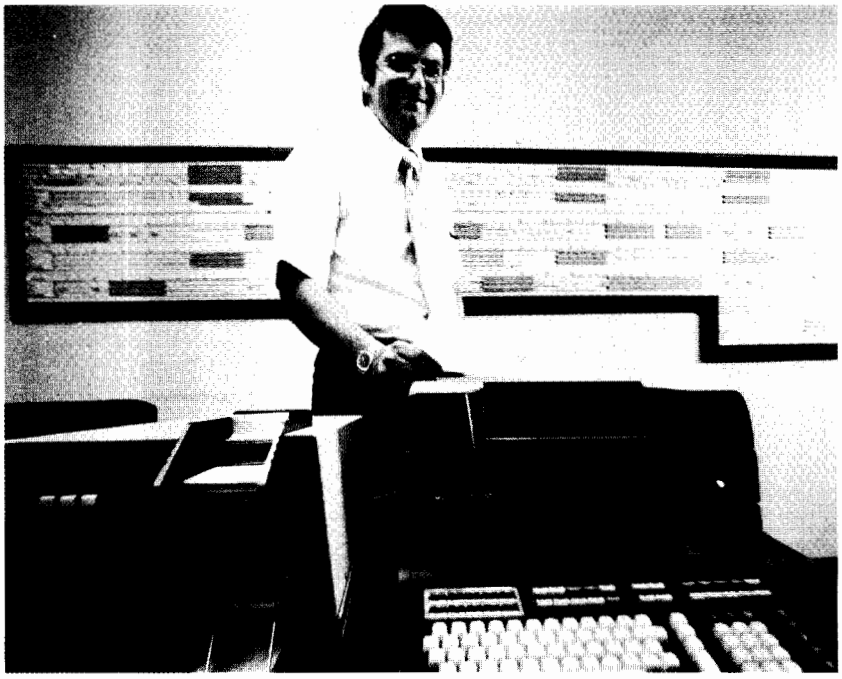
For research and education purposes only.

TABLE OF CONTENTS

APPLICATIONS INFORMATION
FOR HEWLETT-PACKARD CALCULATORS
PUBLISHED AT P.O. BOX 301, LOVELAND, COLORADO 80537

Editor: A.B.Sperry
Art Director: L.E.Braden
Artist/Illustrator: H.V.Andersen

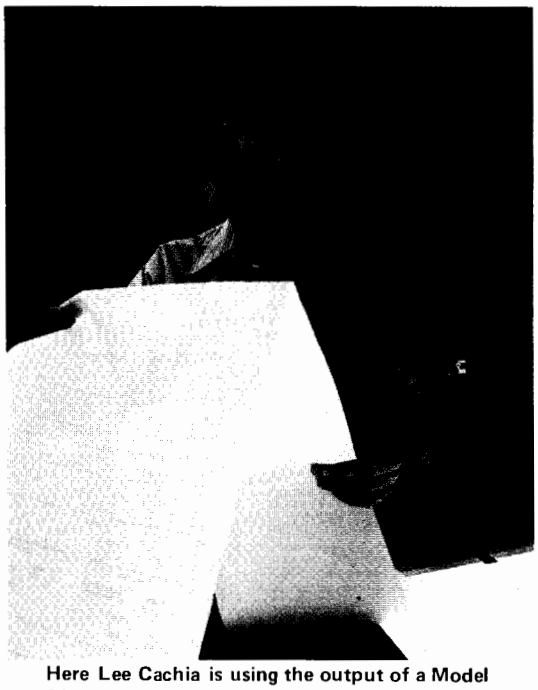
Field Editors: **ASIA**–Jaroslav Byma, Hewlett-Packard Intercontinental, 3200 Hillview Avenue, Palo Alto, California 94304; **AUSTRALASIA**--Bill Thomas, Hewlett-Packard Australia Pty. Ltd., 22-26 Weir Street, Glen Iris, 3146, Victoria; **CANADA**–Larry Gillard, Hewlett-Packard Canada Ltd., 275 Hymus Blvd., Pointe Claire, Quebec; **EUROPE**–Christian Langfelder, Hewlett-Packard GmbH, Herrenberger Strasse 110, 703 Bõblingen, West Germany; **JAPAN**--Akira Saito, Yokogawa-Hewlett-Packard Ltd., 59-1, Yoyogi 1-chrome, Shibuya-ku, Tokyo 151; **LATIN AMERICA**–Ed Jaramillo, Hewlett-Packard Intercontinental, 3200 Hillview Avenue, Palo Alto, California 94304; **SOUTH AFRICA**–Dennis du Buisson, Hewlett-Packard South Africa (Pty.) Ltd., 30 de Beer Street, Braamfontein; **EASTERN U.S.A.**–Stan Kowalewski, Hewlett-Packard Co., W120 Century Road, Paramus, New Jersey 07652; **MIDWESTERN U.S.A.**--Jerry Reinker, Hewlett-Packard Co., 828 Progress Road, Dayton, Ohio 45449; **SOUTHERN U.S.A.**–Bob McCoy, Hewlett-Packard Co., Post Office Box 28234, Atlanta, Georgia 30328; **WESTERN U.S.A.**–Robert C. Reade, Hewlett-Packard Co., 3939 Lankershim Boulevard, North Hollywood, California 91604.



Bill Crispin, Interweb Customer Service Director, is shown with the Model 30 and and the press loading board it is programmed to update.

The Model 30 in

Interweb President Douglas Laidlaw (left) and Executive Vice President Bill MacDonald stand between the Model 30 and some of the paper inventory it controls.



Here Lee Cachia is using the output of a Model 30 program to reduce layout time from several hours to a matter of minutes.

Modern Printing

Today's printing industry is faced with more problems than ever before. Coping with razor-sharp competition, paper shortages, and a host of other troublesome factors, current printing establishments must have farsighted management and use the most modern equipment and progressive techniques to have satisfied customers and make a profit.

One of the most advanced offset printing companies in the U.S.A. is Interweb, located five minutes from the Los Angeles International Airport. Your editor recently had the opportunity to visit this firm and discuss with its officers some of the factors necessary for success in the printing business.

QUALITY AND EFFICIENCY

Interweb, employing about 60 people, is the only printing company west of the Rocky Mountains which has both a 26-inch and a 36-inch offset web press. The narrower-width press allows printing odd-sized publications such as airline schedules with minimum waste; the 36-inch press handles jobs requiring standard-sized pages. Interweb prints about 40 different specialty magazines for trade and travel, including the Los Angeles Magazine, as well as books, catalogs, and advertising publications.

President Douglas Laidlaw stated that Interweb is built on quality. Top quality plate-making equipment, presses, and techniques used by skilled workers all add up to quality printing and customer satisfaction. Even in the area of transportation, quality was kept in mind in purchasing trucks for the firm. And quality again was a major factor in Interweb's decision earlier this year to purchase an HP 9830A Calculator with printer and hopper-fed marked card reader to perform computations ranging from job estimating to inventory control and plate layout.

Interweb was one of the first printing companies in the U.S.A. to recognize the time- and money-saving capabilities of the 9830A Calculator in its business. It became the second offset printing company in this country to receive a Model 30.

As an example of Interweb's quality equipment, there are the two web presses, which together are worth nearly a million dollars. These presses normally run three shifts, 24 hours a day. The larger unit is a Hantscho 10-color, 36-inch offset press which runs at 800 feet per minute, using up to two and one-half tons of paper per hour. It can produce 25,000 copies of a 32-page signature (16 pages 4-color, the balance one color) per hour. The paper is printed on both sides with all colors in one pass through the press.

As the paper goes through the press, it is under constant tension, ensuring that the color dots are deposited in an accurate position relationship. After printing, the paper goes through a flash heating process to remove the vehicle from the ink. The Offen Flex-air dryer includes an anti-pollution device to burn the released solvents. The paper is next passed over uniformly water-cooled rolls to set the pigment.

The printing quality and efficiency are enhanced by two other devices built into the press equipment. One of these is an automatic roll changer, which maintains 200 feet of slack paper on spring rollers. This allows an operator to splice on the beginning of the next roll of paper when one roll runs out. During the splicing process, the press continues to run at 800 feet per minute, and the paper going through it is maintained at a constant tension.

The other device is a cut-off unit and combination folder to convert the press output into accurately cut and neatly folded signatures before binding.

MODEL 30 APPLICATIONS AT INTERWEB

Streamlined job estimating, job costing, inventory control, and plate layout are among the essential functions which must be performed to allow a high-speed production company such as Interweb to make a profit. Job

estimates must be competitive and versatile; job costs must be updated frequently to check the accuracy of the estimates and to adjust for rapid changes in labor and material costs. These are some of the applications in which the Model 30 is paying its way at Interweb.

The ability to give a customer fast, accurate estimates of cost for his publications and the ability to quickly change the estimate using different parameters are survival factors in the modern printing industry. Bill Crispin, Interweb's Customer Service Director, explained that in addition to quick initial response to job estimate requests, it is essential to be capable of rapidly changing estimates by adjusting a number of parameters. Some of these are the total number of copies required; size, weight, and quality of paper; and the number of colors used. Allowing the customer to choose from various mixes of these variables gives him a publication best meeting his requirements, consistent with lowest possible cost. Mr. Crispin is using the 9830A to allow optimization of job estimates with fast turnover time; Interweb's estimating program currently handles inputs of 146 variables, with a goal of eventually accommodating about 190. This gives the customer the optimum cost/requirements choice with minimum elapsed time.

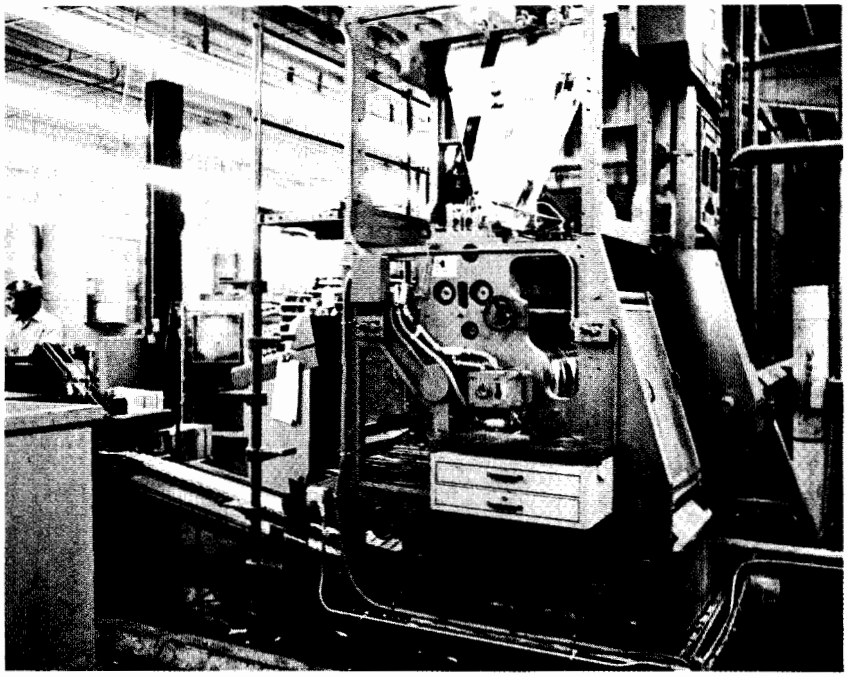
In the job-costing function, records are kept at each printing station showing the vital statistics for each job, including starting and stopping time, job number, operator identification, and other required data. A girl picks up the job cards at each production station once a day for processing. The cards are sorted by starting time, then operation number, then job number to keep a 24-hour operation record for each press. According to Mr. Crispin, Interweb keeps daily, monthly, and annual data including running averages for the various cost factors. As each job is completed, a summary of that job can be requested from the Model 30. This allows comparison of the job cost with the job estimate, as well as fast updating of the overhead factors and other profit-determining variables.

Interweb uses a machine-hour rate to cost jobs, based on the number of productive hours per month, with all overhead being allocated to machine time. This is the system used by the Printing Industries of America Association. At the end of each month, Interweb can quickly recost each job and produce a profit-and-loss statement for that month, as well as calculating the added value per dollar.

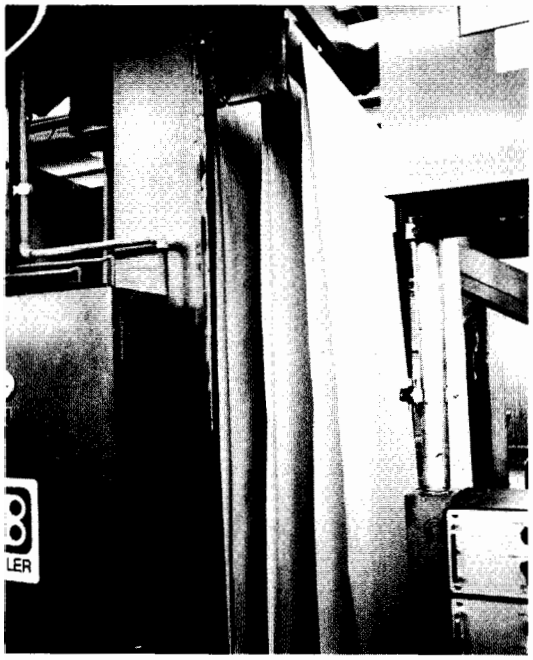
Another important use of the Model 30, according to Mr. Laidlaw, is in solving the complicated inventory control problem. The Model 30 must determine the number of rolls of each kind of paper on hand, the number of pounds included, its location, and whether it is sufficient for the number of copies required by a job. The Model 30 is being used not only to control inventory and allocate paper to jobs, but to order paper for stock and keep track of all paper not allocated to specific jobs.

Magazine page layout is another time-consuming task in the printing business when it is performed manually. Some large magazine publishers have found that by using a computer to do their layout, a five- or six-hour job can be reduced to minutes. One of the latest programs finalized by Mr. Crispin now allows the 9830A Calculator to do Interweb's page layout work, with similarly spectacular savings in time.

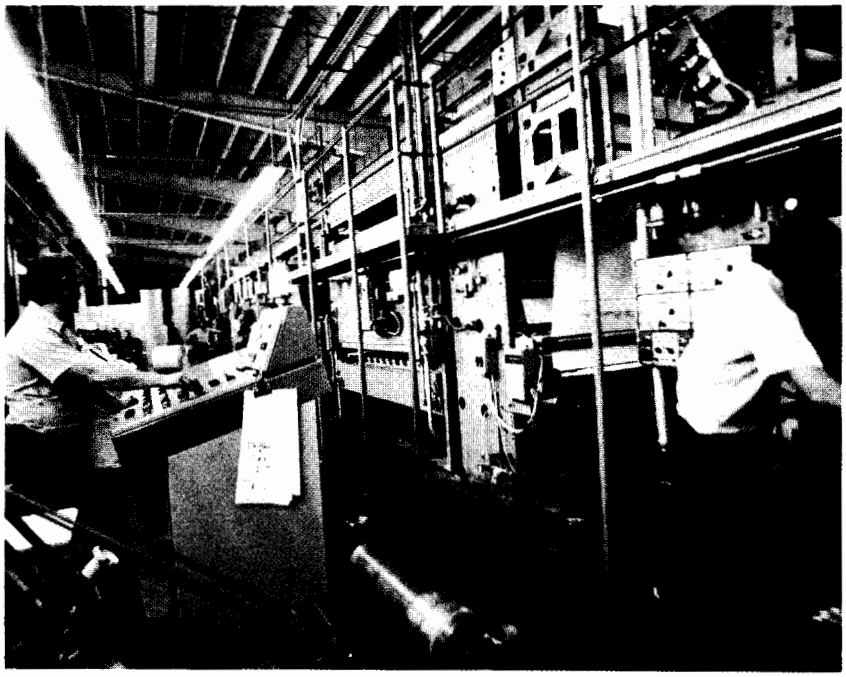
Interweb also uses the Model 30 to load the two web presses for best total output, taking into account all of the material and labor factors involved. Future planned uses of the Model 30 at Interweb include some statistics, vacation time accounting, investment analysis, and letter writing. The total eventual number of applications for the 9830A at Interweb may possibly be limited only by the total number of calculator hours available. ■



Printed pages are automatically cut and folded into signatures at the output of the web press.



The automatic roll changer allows splicing a new roll of paper onto the end of a depleted roll with the press running at normal speed.



Workers adjust controls on the ten color, 36-inch Hantscho web press as a job starts rolling.

Hewlett-Packard Obsoletes Business Tables

by Dennis Procter*

In January of this year Hewlett-Packard introduced one of the most revolutionary products of the century. Since then thousands of businessmen across the nation have proved that the HP-80 is more than an electronic wizard's plaything. It has become an essential tool for making good business decisions. Now Hewlett-Packard gives those "I'd-rather-do-it-myself" business people a choice.

The HP-80, as described in *KEYBOARD* Vol. 5, No. 1 is a quick solution to a large number of business calculations. The Hewlett-Packard Model 81 which was introduced September 19, 1973 is a complete, preprogrammed, printing, desktop business calculator. It does the whole job. If you like the HP-80 but you need a permanent record of the calculations you do--try an HP-81. If you like the HP-80 but you need to save a date or special number for repetitive calculations, or you need a special mode for bond or note calculations, or you need the answers to a few more questions, the HP-81 is what you are looking for.

If you compare key definitions for the HP-80 and HP-81 they are very similar. However, the special financial keys on the left side of the HP-81 need not be used in a special sequence. Furthermore, individual entries can be modified without reentering the entire problem every time. This gives you the flexibility to enter the data as you state the problem and alter the calculation as you wish. The impact printer with special alphanumeric capability gives clear, easy-to-read symbols or abbreviations with all operations you perform. This makes your hard copy a truly valuable permanent record.

PREPROGRAMMED OPTIONS

The HP-81 is preprogrammed in the sense that when you turn it on it is ready to do all the calculations in a standard way. However, you may program or select any of ten modes when calculating bond or note problems. Pre-tax and after-tax, annual or semi-annual coupon, 30-day or actual day month, 360 or 365 day year basis are options available for you to select. Consequently, the HP-81 in another sense is programmable as well as preprogrammed.

The HP-81 not only does everything the HP-80 does but also has ten extended calculations that add extra power and flexibility to an already outstanding array of financial calculations. These extensions are:

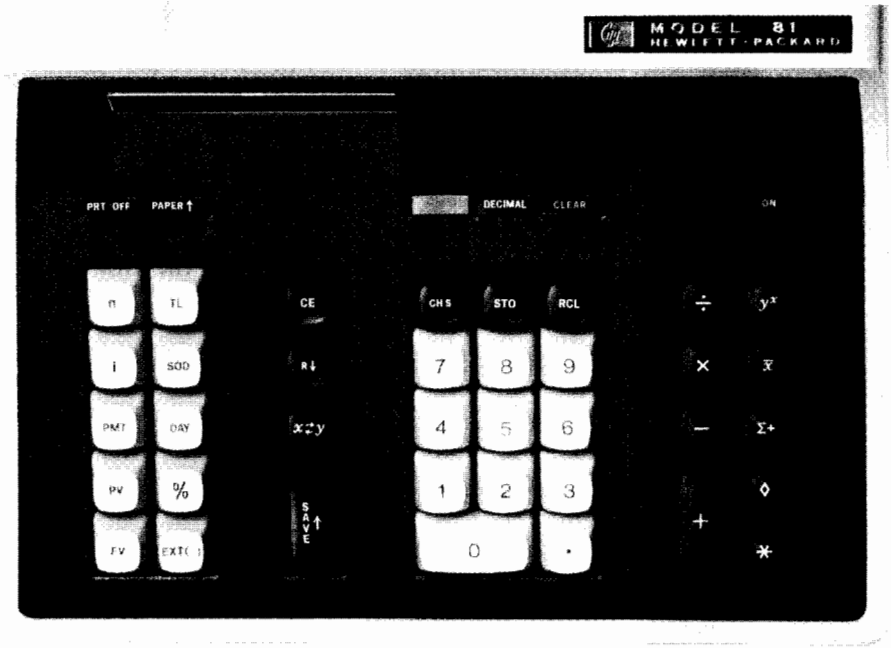
0 - Interest Per Period
1 - Discounted Rate of Return
2 - Declining Balance Depreciation Schedule
3 - Diminishing Balance Depreciation Schedule
4 - Sum-of-the-Digits Depreciation Schedule
5 - Rule-of-78's Prepayment
6 - Amortized Loan Schedule
7 - Odd Days Interest
8 - Coupon Equivalent Yield
9 - Percent of Total

VERSATILE

The HP-81 has something for nearly everyone. Time and money problems directly involve people in business such as accountants, bankers, real estate brokers, and bond traders. But time and money problems also involve people such as engineers, managers, professors, and consultants. The HP-81 does such a wide variety of calculations that if your business directly or indirectly involves time and money the HP-81 will do the work faster and far more accurately than most methods you have used before. Consider the following list of calculation capabilities of the HP-81:

- *Primary:* + - x ÷ ; multiply and divide by any constant; %, Δ%, $Log_{10}X$, Y^X, $\sqrt{X}$; two 200-year calendars, 360/365 days.
- *Investment Analysis:* Discounted Cash Flow; Discounted Rate of Return (for up to 9 uneven cash flows or unlimited even cash flows); Compounded Growth Rate.
- *Depreciation:* Straight Line Calculations; Sum-of-the-Digits Calculations and Schedule; Declining Balance Schedule; Diminishing Balance Schedule.
- *Loans:* Accrued Interest; Present Value, Future Value; Interest per Period; Rule-of-78's Prepayment; Amortized Loan Schedule; APR Odd Days Interest; APR given Add-on Interest; Monthly Payment for Direct Reduction Loan.
- *Annuities:* Future Value of Sinking Fund; Rate of Interest for Sinking Fund; Payment Amount for Sinking Fund.

HP-81 KEYBOARD →



*Calculator Products Division, Hewlett-Packard Company, Loveland, Colorado.

- *Bonds and Notes:* Bond Price and Yield; Callable Bond Price and Yield; Note Price and Yield; Coupon Equivalent Yield; Discounted Note.
- *Statistics:* Linear Regression Trend Line; Expanded Linear Regression with Uneven Periods; Log Trend Line; Correlation Coefficient; Mean and Standard Deviation.
- *Retail:* Markup and Price; Cash Discounts; Proration; Commissions.

EXAMPLES

The following three examples show typical day to day uses of the HP-81.

DISCOUNTED RATE OF RETURN

Let's suppose you are advising a client on which of two investments he should undertake. Both investments have the identical initial cash outlay but the estimated cash flows are not the same. The data he gives you is as follows:

	I	II
Initial Investment	20,000	20,000
Cash Flow 1	3,000	6,000
Cash Flow 2	4,000	2,000
Cash Flow 3	7,000	3,500
Cash Flow 4	17,000	3,500
Cash Flow 5	--	17,000

At first glance it would seem that Investment II would be better since its cash flow is $1,000 higher. However, you know that a good measure of a cash flow problem is its discounted rate of return (DISC ROR). So you quickly key in the data and let the HP-81 do the work.

Investment I

Number of cash flows: 4 [n]

Initial investment: 20,000 [CHS] [PV BND]

Cash flow 1: 3,000 [STO] [1]

Cash flow 2: 4,000 [STO] [2]

Cash flow 3: 7,000 [STO] [3]

Cash flow 4: 17,000 [STO] [4]

Calculate DISC ROR: [EXT( ) M( )] [1]

```
          4.00   → N
-     20000.00   →P
      3000.00   →1
      4000.00   →2
      7000.00   →3
     17000.00   →4
          DISC ROR
         14.92
```

Investment II

Number of cash flows: 5 [n]

Initial investment: same (so you don't have to key it in again)

Cash flow 1: 6,000 [STO] [1]

Cash flow 2: 2,000 [STO] [2]

Cash flow 3: 3,500 [STO] [3]

Cash flow 4: 3,500 [STO] [4]

Cash flow 5: 17,000 [STO] [5]

Calculate DISC ROR: [EXT( ) M( )] [1]

```
          5.00   → N
      6000.00   →1
      2000.00   →2
      3500.00   →3
      3500.00   →4
     17000.00   →5
          DISC ROR
         14.11
```

So what is the conclusion? Investment I has the greatest rate of return and is the best choice. Investment II gives you more dollars but the return is more remote and consequently worth less.

LOAN AMORTIZATION SCHEDULE

Now that you look like a hero as an investment consultant, let's put on another hat--that of a red-blooded American Taxpayer. It's April 14, you are madly making out your tax return and you need to know the accumulated interest for the first four months of the 3rd year of your 30-year, 9½%, $35,000 mortgage that you sold in May. Again you put your HP-81 to work.

Mortgage Amount: 35,000 [PV BND]

Number of Payments: 360 [n]

Interest per Period: 9.5 [SAVE ↑]

12 [÷ ÷K] [i YTM]

Calculate PMT: [PMT INT]

Store PMT: [STO] [PMT INT]

Starting Amortization Payment:

25 [STO] [1]

Ending Amortization Payment:

28 [STO] [2]

Calculate Loan Amortization Schedule:

[EXT( ) M( )] [6]

```
                CLEAR
       35000.00   →P
         360.00   → N
           9.50     ↑
          12.00     ÷
            .79   ◇
                  → I
                  PMT
         294.30
                  →7*
          25.00   →1
          28.00   →2
  25
         273.50
          20.80
       34526.11
  26
         273.33
          20.97
       34505.14
  27
         273.17
          21.13
       34484.01
  28
         273.00
          21.30
       34462.71
  I  N  T
        1093.00
```

The output for each period is interest paid, principle paid, and balance. The total interest paid in that interval is printed at the end. So your interest tax deduction for this year is $1093.00.

PERCENTAGE DISTRIBUTION

As a final example of the HP-81's flexibility and day-to-day usefulness, let's suppose you are analyzing last month's sales data. You have the number of units sold in each of your sales offices and would like to know their percentage distribution.

A. 152	E. 120	I. 111
B. 94	F. 74	J. 206
C. 210	G. 200	K. 58
D. 35	H. 185	L. 40

The data would be entered as follows:

Number in sample: 12 [n]

Data: 152 [STO] [1]

94 [STO] [2]

⋮

40 [STO] [.]

[2]

Calculate Percentage Distribution:

[EXT( )] [9]
M( )

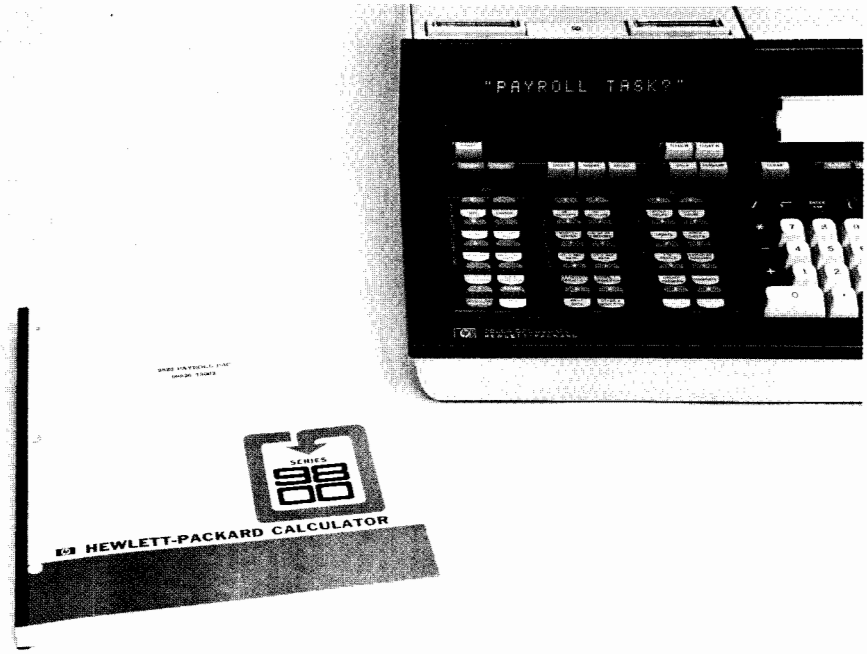
```
                CLEAR

          12.00    → N
         152.00    →1
          94.00    →2
         210.00    →3
          35.00    →4
         120.00    →5
          74.00    →6
         200.00    →7
         185.00    →8
         111.00    →9
         206.00    →0*
          58.00    →1*
          40.00    →2*
1
         152.00
          10.24       %
2
          94.00
           6.33       %
3
         210.00
          14.14       %
4
          35.00
           2.36       %
5
         120.00
           8.08       %
6
          74.00
           4.98       %
7
         200.00
          13.47       %
8
         185.00
          12.46       %
9
         111.00
           7.47       %
10
         206.00
          13.87       %
11
          58.00
           3.91       %
12
          40.00
           2.69       %
Σ
        1485.00       *
         100.00       %
```

ORDER YOUR CHOICE

The HP-80 and HP-81 give you a real choice in calculating capability. The HP-81 is not just a printing version of the HP-80. You can choose a pocket-sized, use-it-anywhere, extremely powerful mini-calculator or a highly flexible, printing, do-it-all, desk-top calculator. The choice is yours. Orders for the HP-81 may be placed or further information obtained by contacting your local Hewlett-Packard sales office, or by filling out and mailing the postpaid card in this *KEYBOARD.* ■

9820A Payroll Pac



by Jeff Osborne*

All businesses, whether large, medium, or small, have the common problem of calculating payroll. Employers need an accurate and reliable method for keeping payroll records up to date. Not only must current paychecks be issued showing the correct gross and net pay after taxes, the amount of taxes and other deductions; these records must also be kept updated to allow easy issuance of W-2 forms at the end of the year.

The HP Model 20 Calculator can provide the solution to these problems with the introduction of the new 9820A Payroll Pac.

Businesses having from 25 to 150 employees can generally make good use of the payroll system. Each Payroll Pac includes one tape cassette containing programs and 100 employee data files. Additional cassettes are available. When the system is first installed, it is usually advantageous to use less than 75 or 85 employee data files per tape. Leaving some empty files on the tapes provides room on them to add new employees as the need arises.

RECORDS MAINTAINED

The Model 20 Payroll Pac will keep year-to-date totals as well as current figures for the following items:

- Gross pay
- Federal withholding tax
- FICA (Social Security taxes)
- State and local taxes (the calculator must be instructed how to compute them)
- Five voluntary deductions
- Net pay

In addition to these quantities, the system also stores for each employee:

- Name
- Social Security number
- Marital status
- Number of exemptions claimed
- Department number
- Pay rates
- Amounts of the voluntary deductions

PAYROLL SYSTEM ADVANTAGES

The payroll system is easy to use. To start it in operation, the user loads two files from the tape cassette. When these files are loaded according to the procedure described in the manual, a 'supervisor' program takes over. After that, the user can select programs to perform the various required functions simply by pressing a key corresponding to the particular program desired (Fig. 1).

One of the prime advantages offered by the payroll system is that it relieves you of the error-prone task of performing hand calculations and table lookups otherwise involved in computing payroll. The system automatically computes Federal withholding tax, using the percentage method. It also computes FICA for each employee. If the calculator is told how to compute state and local taxes, it also withholds them automatically. When you are ready to start your payroll calculations, you simply tell the calculator which voluntary deductions to take out of each employee's paycheck, the

*Calculator Products Division, Hewlett-Packard Company, Loveland, Colorado.

number of hours worked by each employee, and the amount of any miscellaneous pay; the calculator does the rest.

The system will provide you with typed reports, showing the actual information entered for each employee each payroll period, the results of the calculations, and year-to-date totals for all employees. When you are satisfied that the information entered for each employee is correct, you tell the calculator to type the checks, automatically.

At the end of the year, the W-2 forms can also be typed for all employees.

If an employee leaves the company, the payroll system allows entering his hours and getting his check immediately. After his last check has been issued, the system can be instructed to deactivate his file. His data file with its year-to-date totals will be retained on the tape cassette, but it will be ignored until the end of the year, when W-2 forms are typed. Once the W-2 has been issued to the terminated person, his data file can be erased to make room on the tape for another employee.

EXPANSION AND MODIFICATION

The payroll system is expandable. If you have a special payroll need that is not covered in the general manual and want to do your own programming, you can easily interface added programs to the payroll system by using the Utility program key (Fig. 1). This key causes a program on a magnetic card to be loaded into the system and used as if it were on the tape cassette. Enough information is supplied in the manual to allow the user to write these programs.

The system can be modified to some extent. Names of the variables (voluntary deductions, for example) can be changed, but since the programs are all interrelated there are few other permissible modifications.

SYSTEM STRUCTURE

The equipment required to use the 9820A Payroll Pac is:

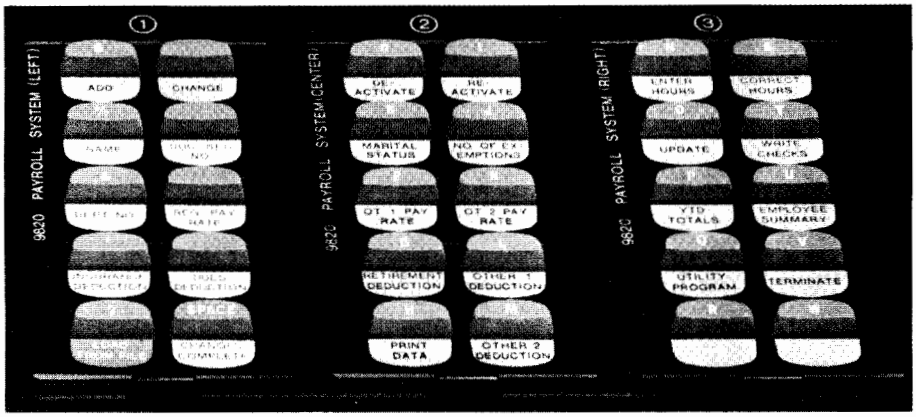


Fig. 1 Payroll Functions Available

9820A Calculator with Option 1 - 429 total data registers
11223A Cassette Memory ROM
11224A Peripheral Control II ROM
9861A Typewriter
9865A Cassette Memory

The materials provided with each Payroll Pac include:

One tape cassette containing programs and 100 employee data files
Three key overlays for the payroll system
A set of utility programs recorded on magnetic cards
A manual describing the operation of all programs

Orders for the 9820A Payroll Pac or questions related to it should be placed through your local Hewlett-Packard sales office. ●

Assignment of Enlisted Marines

(A Systems Evaluation)

by John D. Lanigan and Kent Kreamer

The optimal classification and assignment of enlisted personnel is one of the primary missions of the Personnel Department at Headquarters Marine Corps. To this end, a number of sophisticated, computer based models are utilized in the a priori determination of structure space allocation and classification of Marines. However, a need existed for a tool to measure the results of these manpower management actions. For this purpose, the Hewlett-Packard 9820A Calculator with expanded memory coupled with the 9862A Plotter and 9861A Output Typewriter has been utilized to calculate and display requisite performance measures.

Input to the program are magnetic data cards that contain twelve months of performance data for each Military Occupational Specialty (MOS) or Occupational Field (OF), as follows:

a. Grade Adjusted Recapitulation (GAR) - the total number of Marines authorized for all grades in an MOS or OF.
b. Authorized Strength - the total billet authorization for Marines carrying the specified MOS or OF.
c. 'B' Billet Allocation - the total billet authorization for Marines in the specified MOS or OF allocated to generalized billets; i.e., billets that can be filled by Marines from any MOS.
d. 100% Billet Requirement - the total number of billets that must be staffed. (This element is not used in the subject program but is included so that the same data card can be used in separate programs that calculate and plot availability information.)
e. Overseas Unaccompanied - the total number of billets at locations where dependents are not authorized.
f. Actuals - the total number of Marines that are serving in a specified MOS or OF.
g. Chargeables - the total number of Marines that are serving in a specified MOS or OF and who are not in a training, transient, patient or prisoner status. [The not chargeable population (Actuals - Chargeables) is the personnel overhead and is referred to collectively as 'Individuals'.]
h. 'B' Billet Fill - the total number of Marines from an MOS or OF who are serving in 'B' billets.

Each month, the data cards for each MOS or OF are updated by adding the new month's data and dropping the oldest month's data from the card, using the Data Construct program. The ability to group occupational fields or military occupational specialities is given by the Grouping Data program.

The program has been written to type twelve months of performance data as shown (Fig. 1) and to graph the three primary performance measures; Actual Population versus GAR Authorization; Chargeable Population versus Total Authorized Billets, and 'B' Billet Fill versus 'B' Billet Allocation (Fig. 2). The turnaround times refer to expected time between overseas unaccompanied tours. (The only stop in program operation is at the outset when operator indicates whether data for an MOS or OF is being calculated.)

The example shown is for Occupational Field 70, Aviation Operations.

The manpower managers for each of the 39 occupational fields comprised of 488 military occupational specialities use the results of this program to determine the sufficiency of both manpower goals and actions, such as:

a. The ability of the training line to support the GAR.
b. The appropriateness of the allocation for nonchargeable assets.
c. The adequacy of the 'B' billet allocation.

Editor's Note: This article was an entry in the *KEYBOARD* 9800 System Application Contest.

START JAN. 72

70	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
GAR	2338	2338	2338	2338	2553	2567	2567	2567	2567	2567	2567	2567
ACTUALS	2454	2411	2394	2354	2324	2280	2290	2290	2364	2360	2410	2419
DELTA	116	73	56	16	-229	-287	-277	-277	-203	-207	-157	-148
%	105	103	102	101	91	89	89	89	92	92	94	94
TURNAROUND (GAR)	5.5	5.5	5.5	6.1	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7
TURNAROUND (ACT)	5.8	5.7	5.6	6.2	6.1	5.9	5.9	5.9	6.1	6.1	6.3	6.3
AUTH (A+B)	2081	1877	1932	1962	2072	2138	2138	2138	2133	2133	2133	2133
CHAR	2031	1994	2020	2020	2052	2058	2021	2021	2049	1997	2067	2084
DELTA	-50	117	88	58	-20	-80	-117	-117	-84	-136	-66	-49
%	98	106	105	103.	99	96	95	95	96	94	97	98
B ALL	130	130	130	130	209	226	226	226	226	226	226	226
B FILL	199	232	244	264	263	250	245	245	242	240	238	235
DELTA	69	102	114	134	54	24	19	19	16	14	12	9
%	153	178	188	203	126	111	108	108	107	106	105	104

Fig. 1 Table of Performance

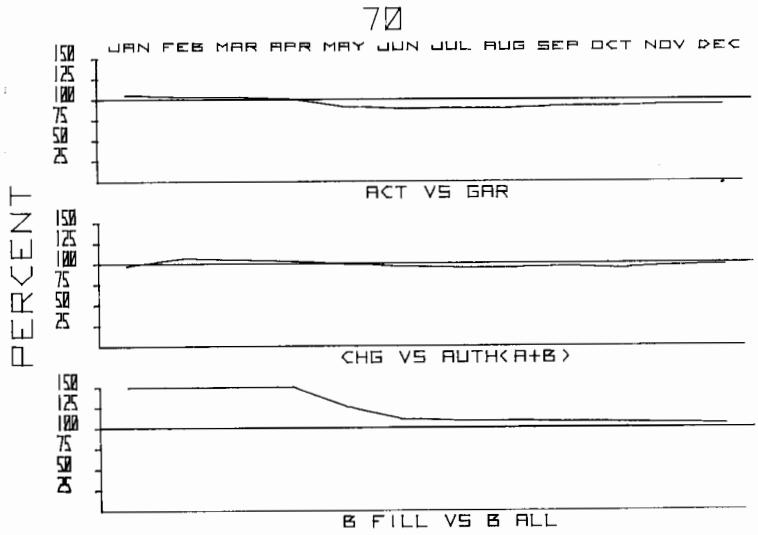


Fig. 2 Primary Performance Measures

Lance Corporal Kreamer

Major Lanigan

CURRICULUM VITAE

Major John D. Lanigan was the Operations Analysis Officer for the Analysis, Statistics and Plans Unit of the Enlisted Assignment Section, Personnel Department, Headquarters U.S. Marine Corps from September 1970 to July 1973. He is currently a research analyst with the Operations Analysis Division of the General Research Corporation. He is a graduate of the U.S. Naval Academy and the U.S. Naval Postgraduate School where he received his M.S. in Operations Research. Lance Corporal Kent W. Kreamer is a Statistician with the same Section in the U.S.M.C. He received his B.S. as a Mathematics major from Millersville State College, Millersville, Pennsylvania. ●

Computer-aided Intuition in Walsh Functions Research

by Claude Cardot

At the fall of 1971, I was engaged in a contract about the feasibility of telephone multiplex systems using Walsh carriers.

Existing definitions of Walsh functions were, at that time, mainly recursive: from an even function one obtains the following odd function by changing the sign of the left half, and from an odd function, one obtains the following even one by an appropriate cyclical shift.

This procedure needs a sufficient storage to store at least one complete Walsh function in memory in order to generate the following one.

One basic point in my contract was to study the crosstalk resulting from the limited passband of a transmission line; it was then necessary to generate easily as many Walsh functions as possible (at least the first 32) in order to try to compute their Fourier series and the cross-products of them.

My computing facilities were limited to a 9100B and 9125A Plotter. I had the alternative of either finding another computer or finding another definition for Walsh functions; the storage of a full Walsh function exceeds, at first glance, the capacity of a 9100B.

Then came the idea to use existing trigonometric facilities in the computer and, after some work, I arrived at the following direct analytic definition of Walsh Functions:

If the rank is written in standard binary notation, for instance: 43 = 101011, for the 43rd Walsh function, this function is expressed by:

$$W_{43}(x) = \text{sgn.}\ (\cos 16x\ \cos 4x\ \cos x\ \sin x)$$

when the orthogonality interval is taken as: $(-\pi, +\pi)$.

The rule is that the bit at the right, if '1', induces a (sin x) term in the trigonometrical product and any bit '1', k places from right, a $(\cos 2^{k-1} x)$ term. '0' bits are simply ignored.

That definition allows one to plot easily 32 Walsh functions with the 9100B (Fig. 1) and, if it were not for the difficulties due to the plotting scale and computing time, one could obtain up to 1024 Walsh functions from the same configuration.

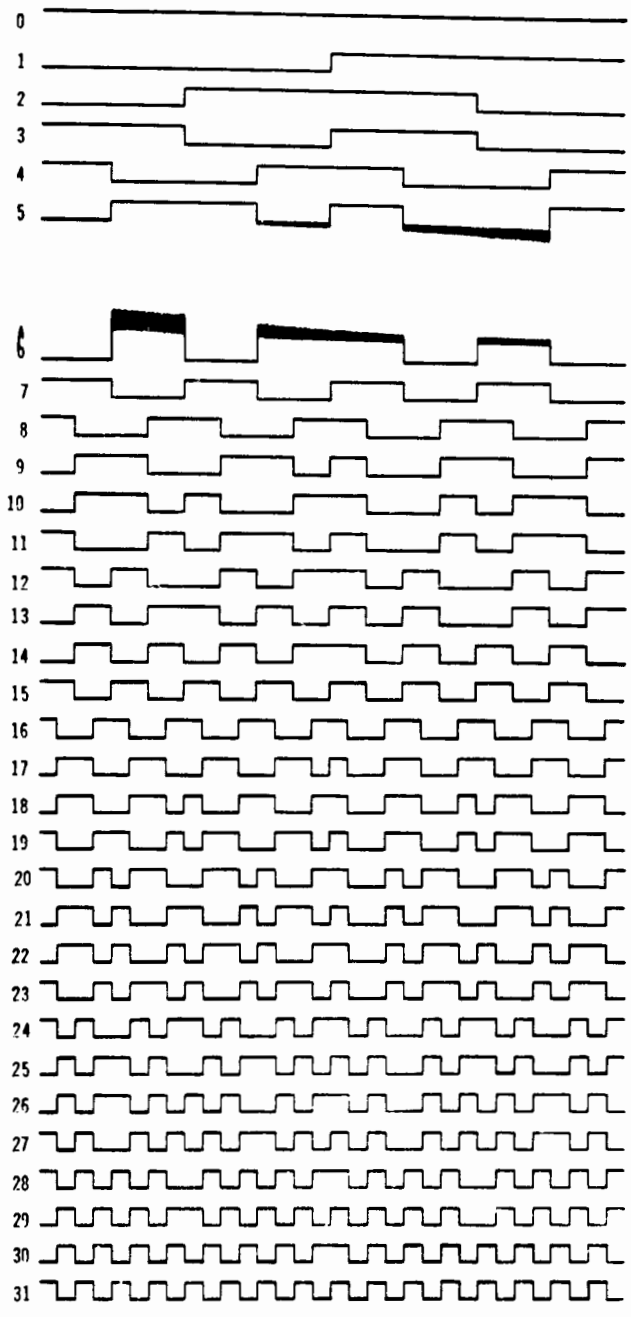


Fig. 1 The 32 first Walsh functions.

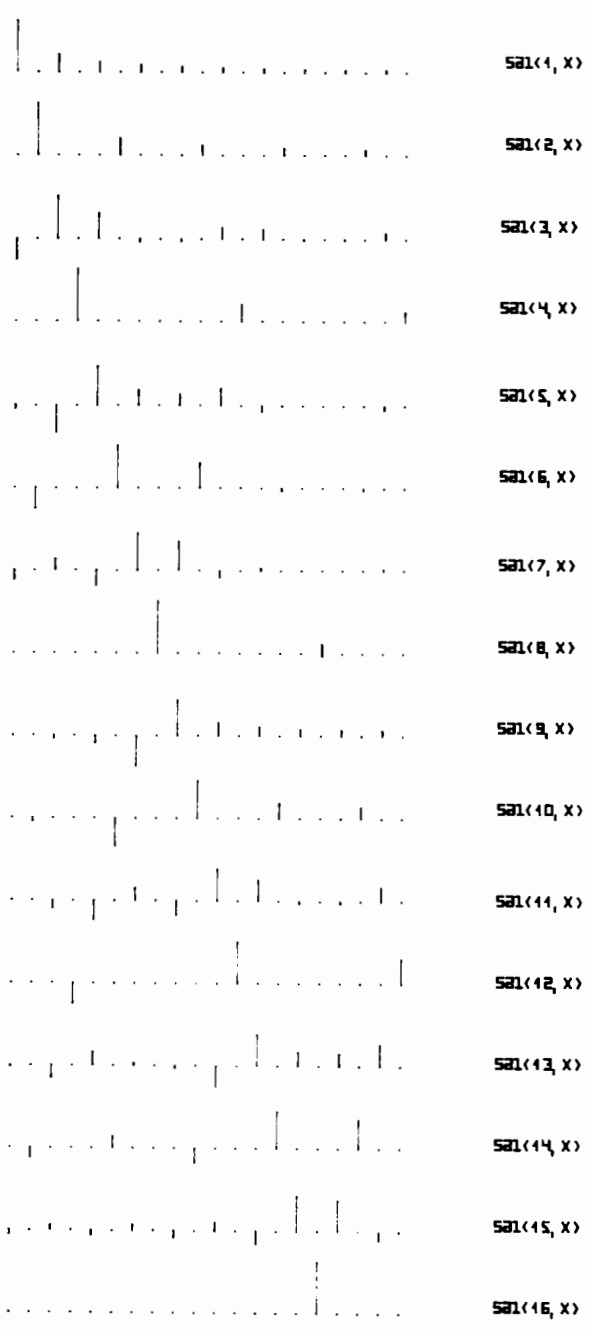


Fig. 2 Spectra of the 16 first odd Walsh functions.

This definition gives an easy derivation of the Fourier series for a Walsh carrier (continuously repeated Walsh function) and, also, of the crosstalk between any two Walsh carriers, as a function of the line cutoff frequency.

Having hung on my office's walls the spectra (Fig. 2) and also the crosstalk curves obtained from my 9100, two facts impressed my mind, when looking at these plots for a while.

The first one is that the spectra have lines on separate sets of frequencies, so that the Walsh carriers can be classified into equivalence classes such that two carriers in distinct classes remain orthogonal without crosstalk, whatever the cutoff frequency of the transmission line may be. Some algebraic manipulations allowed me to obtain the equivalence class of a function directly from its rank, and to show that all these semi-infinite equivalence classes are isomorphic: they differ only by the frequency scale.

The second observation was that some crosstalk curves did repeat, instead of being all different. Relying on the convolution theorem, I found, of course, the same particularity in the convolution products. When I could program my 9100 to plot them for an 8-function equivalence class (at the price of about 8 hours operation), I obtained Fig. 3.

A surprising fact appeared: to within sign, the number of distinct convolution products was always a power of 3, as far as I could plot the matter. With great excitement, I tried to justify and generalize this intrusion of the number 3 in an apparently pure binary problem.

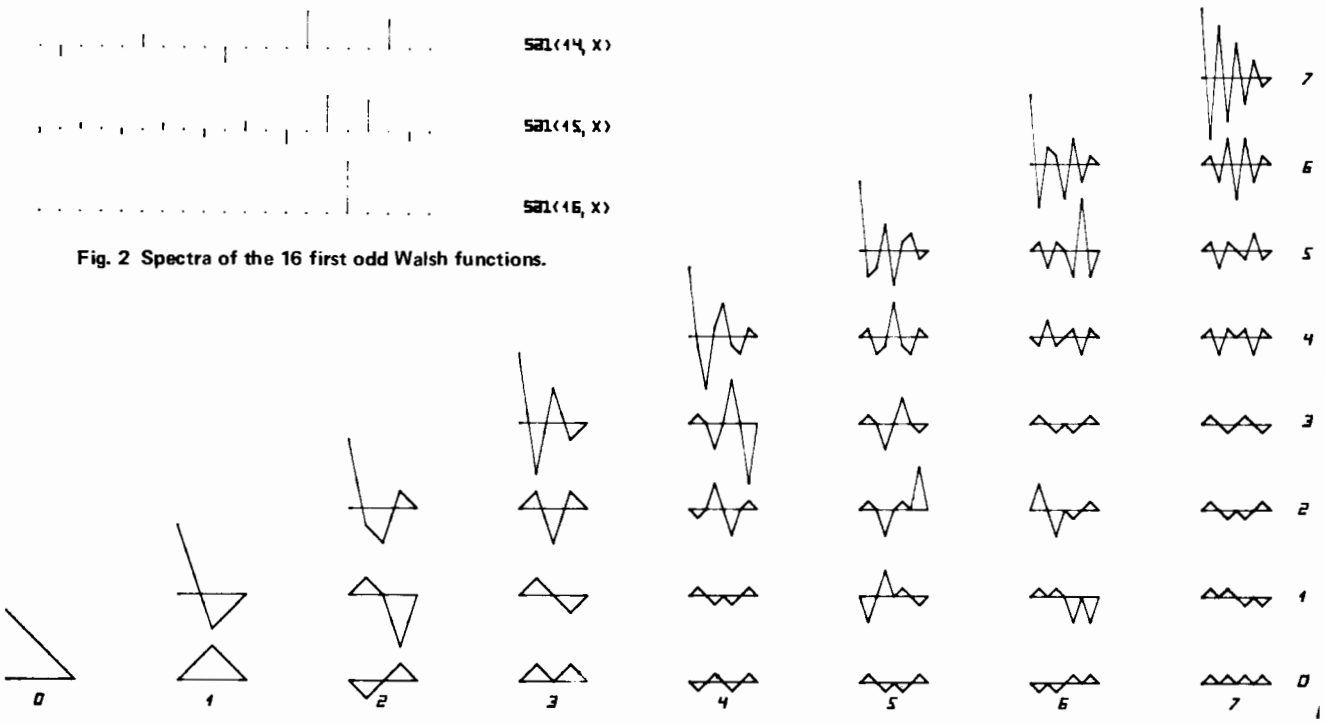


Fig. 3 Convolution products between the 8 first Walsh functions in the same equivalence class. Note that there are only 27 different products instead of 36, to within sign. (One quarter of the period is plotted: each plot must be completed by symmetry around its left end and by antisymmetry around its right end.)

The key is as follows: a Walsh function can be represented also under a polynomial form as: $(1 \pm y)$ $(1 \pm y^2)$ $(1 \pm y^4)$ $(1 \pm y^8)$ ... and so on, y being a positional variable, as used in error-correcting codes theory, the maximal degree in y being k-1 for the group of the 2^k first Walsh functions, which correspond to the possible choices between + and – signs in the brackets. Now, the product of two brackets with the same degree has only *three* possible forms and not *four*: $(1 \pm y^4) \cdot (1 \pm y^4)$ can be only: $(1 + y^4)^2$; $(1 - y^4)^2$; or $(1 - y^8)$, and nothing else.

I soon derived from this an exact characterization of the convolution products between Walsh functions with, in return, the practical benefit of obtaining formulas giving the crosstalk induced by an eventual synchronization lag between the multiplex terminals.

All theoretical results I just briefly mentioned here can be found with their full justifications in the bibliography below.

When I remember these six months of hard research, I cannot but think that if I had any easy access to a bigger computer, I should probably not have contributed in the progress of Walsh functions theory. The same would have been true if I had possessed no computer at all.

M. Claude Cardot was born in Paris, France in 1919. He was graduated from the Ecole Polytechnique, Paris, in 1939 and from the Ecole Nationale Supérieure des Télécommunications, Paris, in 1942. He holds a Licence-ès-Sciences.

Basically a communication engineer, M. Cardot worked with the French Post Office from 1943 to 1955. He joined Compagnie Générale d'Electricité in 1960 and has been engaged in research and development work on satellite communication systems. He is presently in charge of a Group of Applied Mathematics at CIT-ALCATEL, a Society in the C.G.E. group.

M. Cardot has always had a keen interest in engineering applications of mathematical concepts. He published in 1952 one of the first papers in France about switching algebra and, later on, several applications of lattice theory to streetlight remote control and other automation problems. He also published two textbooks in the fields of mathematics and communication.

He is a member of Société Francaise des Electriciens, des Electroniciens et des Radioélectriciens.

BIBLIOGRAPHY

(1) Henning F. Harmuth Second Edition — *Transmission of Information by Orthogonal Functions* - Springer Verlag, 1972.

(2) Claude Cardot (in French) — *Définition analytique simple des fonctions de Walsh et application à la détermination exacte de leurs propriétés spectrales.* Annales des Télécommunications, 1972, n° 1-2.

(3) Claude Cardot (in French) — *Etude de l'influence de l'erreur de synchronisation sur le fonctionnement d'un multiplex à posteuses Walsh.* Annales des Télécommunications, 1972, 27, n° 3-4.

(4) Claude Cardot (in English) — *A New Eye on Walsh Functions.* Proceedings of the third (1972) Symposium on Applications of Walsh Functions, Washington, D.C., March, 1972. ■

Teachers Corner

THE NUMBER π DETERMINED BY MONTE CARLO METHODS

Part No. 09810-75901

by Dr. Kurt Tanner

THEORY

This program consists of three different parts, each of which may be used separately to calculate the number π, using pseudo-random numbers (Monte Carlo Method).

Part 1: The Buffon Needle Problem

On a large sheet of paper a number of equidistant lines are drawn (d: distance between two lines). If a needle of length a ($a \leqslant d$) is thrown onto the paper, the probability that it will cut one of the lines is $P = \frac{2a}{\pi d}$.

The position (x/ϕ) of the needle (see Fig. 1) will be simulated by two random numbers (r_1/r_2), $x = d \cdot r_1$ and $\phi = \pi \cdot r_2$. The condition for cutting is:

$$x \leqslant a \cdot \cos \phi \quad \text{or} \quad x \geqslant d + a \cdot \cos \phi.$$

In each experiment the program generates n pairs of random numbers (the needle is 'thrown' n times) and examines how often (i times) the condition of cutting is met. If n is large enough, the relative frequency $\frac{i}{n}$ is a good experimental value of the probability P: $P \approx \frac{i}{n}$. It follows $\pi \approx \frac{2an}{di}$. For convenience the program uses a = d = 1.

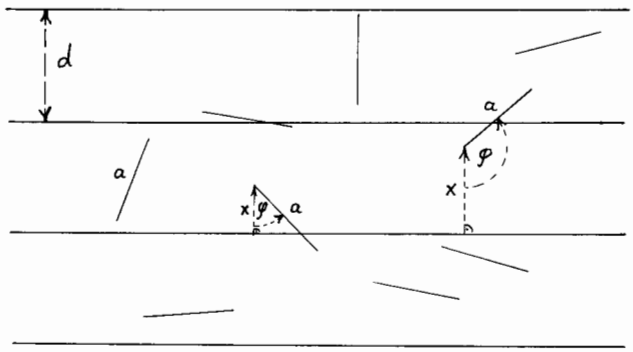


Figure 1

Part 2: Number Theory

If n is the number of pairs of any two positive integer numbers and if i is the number of those pairs of integers which have no common divisor, the number theory shows: $\lim_{n \to \infty} \frac{i}{n} = \frac{6}{\pi^2}$. This leads to $\pi \approx \sqrt{\frac{6h}{i}}$ if n is large.

The program calculates at random n pairs of positive integers ($< 10^5$) again using the Monte Carlo Method. The Euclidean algorithm is used to find the largest common divisor of the two integers. If this divisor is 1, the two integers are said to have no common divisor.

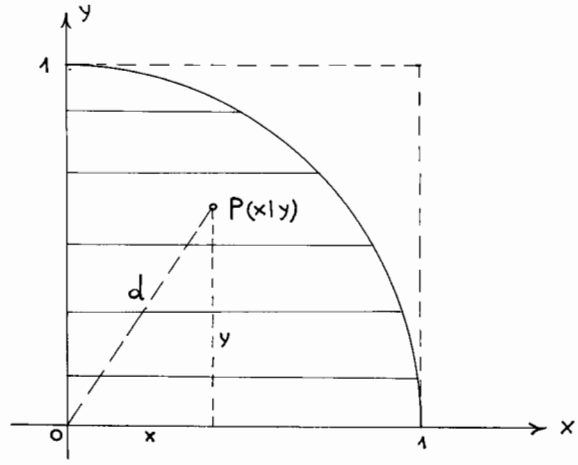


Figure 2

Part 3: Area of a Circle

Calculus shows that $\frac{\pi}{4} = {}_0\int^1 \sqrt{1 - x^2} \cdot dx$ (see Fig. 2). The program calculates the definite integral by the Monte Carlo Method. Two random numbers (r_1/r_2) are the coordinates (x/y) of a point within the unit square. n such points are generated and the program examines how many of them (i) lie within the circle (radius: 1). The quotient $\frac{i}{n}$ is an experimental value of the shaded area and therefore also of the definite integral. It follows $\pi \approx \frac{4i}{n}$ if n is large.

GENERATOR OF PSEUDO-RANDOM NUMBERS

The method used is a congruential method, namely $z_{i+1} \equiv \lambda \cdot z_i \pmod a$. Given an initial starting value z_0, a constant multiplier λ, the relationship just mentioned yields a sequence of integer numbers $z_1, z_2, \ldots, z_i, \ldots$, $z_i < a$ for all z_i. Then $r_i = \frac{z_i}{a}$ is a pseudo-random number in the unit interval: $0 < r_i < 1$.

After many trials I have found that $a = 2^{20} = 1{,}048{,}576$ and $\lambda = 7^7 = 823{,}543$ makes a good selection. z_0 can be any positive odd integer number less than 1,048,576. This choice of a and λ yields 4 different series of pseudo-random numbers. Each series has a period of 131,072 random numbers (for example, $z_0 = 1$ will produce the first, $z_0 = 3$ the second, $z_0 = 9$ the third, and $z_0 = 11$ the fourth series). The program uses $z_0 = 1$.

Editor's Note: This article was an entry in the KEYBOARD 9800 System Application Contest. The complete program is available through the Calculator Program Catalog.

really satisfactory. Several distribution tests (including χ^2-tests) have shown the superiority of the algorithm used in this program.

A 20-step subroutine is used to generate the random number r_i.

See textbooks for the general theories. Pseudo-random number generator: R. R. Coveyou and R. D. MacPherson, Fourier Analysis of Uniform Random Number Generators, J.ACM, XIV (1967), p. 100-119.

STATISTICAL ANALYSIS

Each experiment consisting of n trials (n pairs of pseudo-random numbers) is repeated m times, always starting from a different z_0-value. From the m experimental values of π_j the arithmetic mean and the mean deviation are calculated:

$$\bar{\pi} = \frac{1}{m} \sum_{j=1}^{m} \pi_j \quad , \quad \Delta\bar{\pi} = \sqrt{\frac{\Sigma\pi_j^2 - m\bar{\pi}^2}{m(m-1)}} \; .$$

The arithmetic mean $\bar{\pi}$ represents the result of m·n trials. The program uses m = 10. This calculation is done in a subroutine.

TEACHING POINTS

The program illustrates a number of important subjects that turn up in mathematics: the modern definition of probability (the relative frequency is a measure of the mathematical probability), the law of large numbers, the usefulness of the Monte Carlo Method, the calculation of a definite integral by this method, and topics from number theory. Students have been astonished that the important number π can be calculated by these and similar methods. It gives them a feeling for stochastic processes. Hopefully, these students will be led to a deeper understanding and a more zealous investigation of the fascinating world of mathematics.

Kurt Tanner was born March 20, 1927, in Schaffhausen, Switzerland. Having completed all the preliminary studies in Switzerland, including a 6-year course in philosophy and theology, he went on to study mathematics and physics in New York (Fordham University, Bronx). He received his M.S. degree in physics in 1959 and his Ph.D. degree in physics in 1963. Ever since September 1962 he has been teaching mathematics and physics at a private gymnasium (a sort of junior college) in Immensee, Switzerland, a place near Lucerne. He enjoys playing chess, as well as hiking through the mountains.

EXAMPLES

Program Part Nr.	Buffon		Number Theory		Area of a Circle	
Number of Trials Per Experiment	1.2002 1000.0000	1.0000 10000.0000	2.0000 1000.0000	2.0000 10000.0000	3.0000 1000.0000	3.0000 10000.0000
Absolute Frequencies and Experimental Values of π	650.0000 3.0769	6327.0000 3.1611	601.0000 3.1564	6384.0000 3.1383	[illegible]	7527.0000 3.1930
	634.0000 3.1467	6388.0000 3.1309	605.0000 3.1620	6262.0000 3.1961	[illegible]	7916.0000 3.1664
	[illegible]	6351.0000 3.1526	[illegible]	6450.2000 3.1491	[illegible]	7853.0000 3.1332
	635.2002 3.0965	6350.0000 3.1535	607.0000 3.2456	6127.0000 3.1258	[illegible]	7796.0000 3.1534
	604.0300 3.3113	6345.0000 3.1501	627.0000 3.2954	6277.0000 3.1422	[illegible]	7845.0000 3.1380
	648.0000 3.0864	6332.0000 3.1568	639.0000 3.0643	6359.0000 3.1521	[illegible]	7868.0000 3.1592
	634.0000 3.1546	6427.0000 3.1119	594.2002 3.1785	6135.0000 3.1273	[illegible]	7818.0000 3.1264
	627.0000 3.1898	6322.0000 3.1631	608.0000 3.1414	6254.0000 3.1478	[illegible]	7837.0000 3.1348
	611.0000 3.2733	6415.0000 3.1177	589.0000 3.1917	6040.0000 3.1582	[illegible]	7883.0000 3.1552
	623.0000 3.2103	6354.0000 3.1476	620.0000 3.1103	6209.0000 3.1559	[illegible]	7853.0000 3.1412
Total Number of Trials	10000.0000	100000.0000	10000.0000	100000.0000	10000.0000	100000.0000
Arithmetic Mean and Mean Deviation of π	3.1630 .0261	3.1485 .0058	3.1359 .0121	3.1457 .0034	[illegible]	3.1424 .0042
Time	38 min.	6.35h	49 min.	8.2h	40 min.	6.65h

Programming Tips

ERRATA

The Economical "IF Y = 0" Test - Model 10 programming tip on the back cover of *KEYBOARD* Vol. 5, No. 3 had some typographical errors. The second and third paragraphs of Professor L. Glasser's tip should read:

The test "if y = 0" may be economically applied on the Model 10 Calculator by adding the contents of x- and y-registers into the y-register, and testing the resulting x- and y-register contents for equality.

Thus, with y containing the quantity to be tested, and any quantity to be operated on in x, include in the program:

9100A/B PRINTOUT IDENTIFICATION

Our thanks for the following programming tip for alphanumeric identification of 9100A/B-9120A printouts go to N. H. Wooding, Jr. Mr. Wooding is a graduate research assistant working with the Southeastern Cooperative Fish and Game Statistics Project, North Carolina State University at Raleigh, Raleigh, North Carolina.

In using the 9100A/B Calculator with the 9120A Printer, you may have wanted a means of alphanumerically labeling similar sets of data and output. The calculator uses the letters a-d in storage addresses. A simple technique allows storing this alphabetic information with numerical information in an available register. From there, it can be recalled by the program and used with or without incrementing to label outputs.

As an example, the following sequence will store the alphanumeric d 00 in the d register:

SWITCH RUN
PRESS GOTO d 0
SWITCH PROGRAM
PRESS 2
SWITCH RUN
PRESS XTO d.

To recall this and increment it, the program steps:

d
↑
1
+
YTO
d
⋮
PRINT

will cause the y-register printout to show d 01, d 02, . . . d 99 as needed. Either fixed point or floating point may be used.

Other similar storage-recall label arrangements can be used. By addressing a0 and entering 0, the recalled display/printout would be a.0; adding sequential 1's would then give b.0, ..! .0(f.0), c.0, d.0.

The use of this type of labels for printout increases the legibility of some tapes, justifying their use of storage registers except in programs using all of the calculator's memory.

One caution: while the alphanumeric labels can be incremented, decrementing immediately destroys their alphabetic portion, and the resulting number is not readily identified.

Sample Printout

```
0.
1.002
d01.
1.001

d02.
1.000

d03.
1.000249781  00

d.04         02
1.000124883  00

d.05         02
1.000062439  00

d.06         02
1.000031219  00

d.07         02
1.000015609  00
```

EXTENDING DEFINABLE FUNCTION KEY TO ANY NUMBER OF FUNCTIONS - 9810A

Here is a programming tip for the 9810A submitted by Professor A. S. Gladwin, McMaster University, Hamilton, Ontario, Canada.

This tip points out the fact that the Model 9810A Math Block Definable Function key can be programmed to call any number of user-defined functions. The general concept is to store various functions as subroutines and then by a stored code call them from the f( ) program. In other words, given the function $f_n(y)$, y is a number stored in the y-register and n is a number identifying the function stored in say the x-register. The flow of the program would be to check the code in the x-register for the designated function and then make the computation on the value in the y-register. A sample program might be coded as follows:

```
LBL
 F
RUP
 1
X=Y
CNT
GTO        } Check for f1(y)
LBL
 A
 2
X=Y
CNT
GTO        } Check for f2(y)
LBL
 B
 3
X=Y
 .
 .
 .
LBL
 A
 DN
Calculate  } Subroutine to
 f1(y)     } calculate f1(y)
 S/R
LBL
 B
 DN
Calculate  } Subroutine to
 f2(y)     } calculate f2(y)
 S/R
 .
 .
 .
```

TERMINATING DATA ENTRY - 9810A

Mr. Oliver H. McKagen, III, Joseph C. Draper & Associates, Blacksburg, Virginia, submitted this time-saving programming tip for the 9810.

Many programs call for entering a series of data values into a summation or repetitive routine as a first or intermediate step in computing a final answer. Very often the series is terminated by a SET FLAG by the operator. This often results in entering an incorrect or zero value if he forgets to set the flag before pressing CONTINUE. A possible solution to this problem is to test the entered value for zero and when this condition is met have the program branch to the appropriate routine. Thus the task of the operator is simplified to entering a zero and pressing CONTINUE once all the data has been entered.

CHANGE 9820A SETTINGS DURING PROGRAM EXECUTION

Mr. Steven W. Weeks, Division of Environmental Health, Kansas State Department of Health, Topeka, Kansas recently sent us this helpful tip in using the Model 20.

Changes in the fixed/float and flag settings other than restoring the previous condition or setting flag 0 are often desirable while running a program. Such changes may be made when the calculator pauses for an ENT statement. If the response to

```
ENT "NEXT X?", X
```

is . . . FXD 2; SFG 8; 25 RUN PROGRAM

the first two actions will be taken before 25 is stored in X. The value to be stored must always come last. For example, if the response to the above ENT statement was

25; FXD 3 RUN PROGRAM

3 would have been stored in X. Also, arithmetic expressions may be executed at such a pause. In the above example, if the response was 10 → B; SIN (π/8) RUN PROGRAM, 10 would have been stored in B and the result of the expression in X.

ONE-LINE AVERAGING - 9820A

The following one-line program for the Model 20 averages N numbers. Our thanks go to Philip A. Dawdy, Lansing, Michigan for submitting it. END RUN PROGRAM should be pressed before each series of numbers is entered. This causes printing 0.0000, which can be ignored.

```
0:
FXD 4;PRT A;B+A→
B;C+1→C;ENT "N",
A;GTO 0;IF FLG 1
3;PRT "TOT:",B,"
AV:",B/(C-1);
SPC 8;TBL 5⊢
R394
```

RECT/POLAR AND POLAR/RECT SUBROUTINES 9820A

D. L. Schacher, Vice-President of Tel-Instrument Electronics Corp., Carlstadt, New Jersey submitted the following programming tip.

If you have a UDF ROM for your 9820A, two very handy subroutines to have are 'R/P' (Rectangular to Polar) and 'P/R' (Polar to Rectangular), as shown in Figs. 1 & 2. The power of these subroutines is nicely shown in Fig. 3, which is the complete program for calculating Δ = S11*S22 - S12*S21 (from Pages 5-6 of HP Application Note 95 on S-Parameters), if we assume S11, S12, S21, and S22 are stored in register R1-R8, as shown in Fig. 4. Line Ø, in one call, takes the product of S11 and S22 magnitudes, the sum of their angles, converts the resultant vector to rectangular coordinates, and stores in A & B. Line 1 does the same for S12 and S21, storing in X and Y. Line 2 subtracts the real components (A-X), the imaginary components (B-Y), and converts the answer to polar coordinates. This procedure is so simple that programs can be written directly from the vector equations.

Example

```
S11 MAG
              .277
ANG
          -59.000
S12 MAG
              .078
ANG
           93.000
S21 MAG
             1.920
ANG
           64.000
S22 MAG
              .848
ANG
          -31.000
DELTA
              .324
          -64.834
```

```
0:
"R/P "; (P1P1+P2
P2)→P3; SFG 14⊢
1:
ATN (P2/P1)(P3≠0
)+180(0>P1)(2(0≤
P2)-1)→P4⊢
2:
CFG 14; END ⊢
R373
```

Fig. 1

```
0:
"P/R "; P1COS P2→
P3⊢
1:
P1SIN P2→P4⊢
2:
END ⊢
R373
```

Fig. 2

```
0:
CLL P/R R1R7, R2+
R8, A, B⊢
1:
CLL P/R R3R5, R4+
R6, X, Y⊢
2:
CLL R/P A-X, B-Y,
R9, R10⊢
3:
PRT "DELTA ", R9,
R10⊢
4:
END ⊢
R373
```

Fig. 3

	MAG	ANG
S11	R1	R2
S12	R3	R4
S21	R5	R6
S22	R7	R8

Fig. 4

AVAILABLE 9830A MEMORY

Our thanks go to Bob McCoy of the HP sales office in Atlanta, Georgia, for the following tip.

When the Model 30 memory has information in it and you need to know how many words of memory are still available, the Model 30 Operating and Programming Manual gives a key sequence LIST 9 9 9 9 EXECUTE to display this. A shorter and faster routine to get the same result is LIST followed by pressing any Special Function key.

9820A ENTRY SPACE SAVING

This programming tip was submitted by D. J. Hartley, John Wilson and Partners, Brisbane, Australia.

Frequently it is desired to print input data as it is entered. This often results in the duplication of alpha-numeric strings in DISPLAY and PRINT statements. Trials to find ways of eliminating this duplication led to the following:

When a STOP instruction is executed following a PRINT statement the printed information also appears in the display thus serving as the alpha part of an enter statement. Data may then be entered in the normal way and the implied Z store operates so that the input value enters the Z-register, i.e.,

CONVENTIONAL

```
BREADTH (INS) =
              1.10
LENGTH (INS) =
              2.20
DEPTH (INS) =
              3.30
```

```
0:
FXD 2;ENT "BREAD
TH (INS) =",A,"L
ENGTH (INS) =",B
,"DEPTH (INS) ="
,Z⊢
1:
PRT "BREADTH (IN
S) =",A,"LENGTH
(INS) =",B,"DEPT
H (INS) =",Z⊢
R408
```

MODIFIED METHOD

```
BREADTH (INS) =
              1.10
LENGTH (INS) =
              2.20
DEPTH (INS) =
              3.30
```

```
0:
FXD 2;PRT "BREAD
TH (INS) =";STP
⊢
1:
PRT Z→A;"LENGTH
(INS) =";STP ⊢
2:
PRT Z→B;"DEPTH (
INS) =";STP ⊢
3:
PRT ⊢
R414
```

Note:

(a) A saving of 6 registers.
(b) The 'PRT' in line 3 of the modified method. It is not necessary to say PRT Z. This applies with a normal input statement too, i.e., ENT "X-", X; PRT; ... will cause the entered value to be printed.

A similar technique may be applied using DISPLAY statements where it is not desired to print everything as in array input or with questions. The following example illustrates this for a series of questions (options) where the code is: RUN PROGRAM to say 'no': *Any number* RUN PROGRAM to say 'yes', i.e., to select the option. Repeated pressing of RUN PROGRAM will cause a cycle through the options available.

CONVENTIONAL

```
0:
CFG 13;ENT "NEW
CIRCLE?";Z;IF
FLG 13=0;JMP 50⊢
1:
CFG 13;ENT "NEW
SLICE WIDTH?";Z;
IF FLG 13=0;JMP
10⊢
2:
CFG 13;ENT "NEW
SOIL PROPS?";Z;
IF FLG 13=0;JMP
20⊢
3:
CFG 13;ENT "NEW
RUN?";Z;IF FLG 1
3;JMP -3⊢
R389
```

MODIFIED METHOD

```
0:
0→Z;DSP "NEW CIR
CLE?";STP ⊢
1:
IF Z≠0;JMP 53⊢
2:
DSP "NEW SLICE W
IDTH?";STP ⊢
3:
IF Z≠0;JMP 12⊢
4:
DSP "NEW SOIL PR
OPS?";STP ⊢
5:
IF Z≠0;JMP 21⊢
6:
DSP "NEW RUN?";
STP ⊢
7:
IF Z=0;JMP -7⊢
R392
```

Note the saving of 3 registers.

Editor's Note: Our thanks go also to D. L. Schacher, Carlstadt, New Jersey, who sent us a similar programming tip after this one was received.

ARCTAN BETWEEN ± 180 DEGREES - 9820A

Once again Dr. Anthony F. Gangi, Professor of Geophysics, and L. David Jones, graduate student, both of Texas A&M University, College Station, Texas have given us an interesting programming tip for the 9820A Calculator.

Their tip involves calculating the phase angle of a complex number (i.e., taking the inverse tangent of a ratio) so that it lies between ± 180 degrees. The inverse tangent routine on the 9820A Math ROM gives an answer between ± 90 degrees. This is because the inverse tangent is multivalued. However, when the signs of the numerator and the denominator are individually known, as in the case of complex numbers, the proper quadrant can be determined for the inverse tangent. The algorithm is based on the following:

given (1) a complex number

$$z = x + iy$$

and (2) the phase of the complex number

$$\theta = \text{TAN}^{-1}\ (y/x),$$

then the phase angle in degrees, radians, or grads can be found by using the following one line of code (Table 1, Table 2, or Table 3, respectively, must be set; assume X in x and Y in y, then θ will be in A):

0: SFG 14; ATAN (Y/X) - 2 ATN 1E99

(0 > X) [(0 > Y) - (0 ≤ Y)] → A ⊢

The need for SFG 14 is to avoid NOTE 10 for 90°, x = 0, y > 0 and -90°, x = 0, y < 0.