CIVIL ENGINEERS
POCKET COMPUTER MONTHLY

Premier Issue

EDITORIAL

Our purpose is to serve the civil engineer. We seek to aid the person who is less concerned with computers than with civil engineering. All issues of this publication will deal with a review of one or more civil engineering problems.

Our goal is to expand your capability in the practice of civil engineering.

Although this new publication is intended for the civil engineer, other disciplines might benefit as well.

Our "slide rule-type" calculator replaced the slide rule about 1973; later, the programmable calculator. These hand-held tools are still dominant in civil engineering. But about two years ago, Radio Shack's PC-1 (Sharp PC 1211) battery-powered hand-held computer became available. We found it suitable for many of our computation problems. Still do. Then about eight months ago the powerful PC-2 (Sharp PC 1500) became available and, eventually, the printer-plotter. Then the 8K memory expansion.

The computer picture seems to be changing for the better at an exponential rate.

For most of us, the cost of hardware is a primary factor. A top quality K&E slide rule cost about $25 back in the '50's. A PC 1211 can be bought today for about $115. Not too bad, in comparison, considering what has happened to the dollar.

The civil engineer may rarely need the great power of a costly non-portable computer. But we frequently need a hand-held unit, a powerful battery-operated computer that can be put in a drawer or a brief case. We need portable computation capability in our office, at the client's office, at a branch office, and in the field.

We have the hardware. We are getting the software. In the .....

NEXT ISSUE

we will show how to solve a multitude of engineering problems with GCP, the General Computation Program.

GCP is a formula solver. It can solve a set of inter-related formulas. The formulas are merely written into the computer (A few easy-to-learn rules must be followed). Then the data are entered and the solutions are displayed.

If your experience is like ours you have been inhibited in writing programs where only a few solutions are required. Now, with GCP, the answers can come as quickly as the formulas and input data can be typed in - a matter of minutes - a real time saver.

The use of GCP will greatly enhance the usability of your PC. We know because it has enhanced ours. GCP is "resident" in our PC-ready to go at a moment's notice.

The pocket computer is a powerful device and in future issues, we will be exploring its many capabilities.

Cliff Hall, PE, Editor

INPUT WANTED

Write to us. We want to know what you are interested in, and what you are doing with your PC (practical applications, tips, news). Perhaps you have a useful program to contribute. We reserve the right to edit your text. (Type double-spaced). However, we will not change your program listing, should we decide to publish it. A modest fee will be paid for all programs published. No mailings will be returned to sender. Send to CECOM P.O. Box 6 Hart, MI 49420.

STATISTICS

Most every civil engineer has to deal with DATA - usually test data - and must reach reasonable conclusions from the data.

This Premier Issue will attempt to provide some help with this type of problem, using statistics.

This program does the work - no need to look up numbers in tables.

Mean

As soon as the data are in hand, our first instinct is to average it. When we perform an average, we are "investigating the central tendency of the data." A good beginning.

Suppose we calculate the average or mean value for a set of test samples we obtained from a soil layer. At this point, we only know the test results, and their average, for these soil samples. For example: "The average unconfined compressive test strength for this soil layer is 3000 psf."

Standard Deviation

We can do more. We can readily calculate the standard deviation from the test data.

The standard deviation, along with the mean and the sample size (number of tests), are specified by ASTM as the minimum information to be provided in analysis and presentation of data. The standard deviation is a measure of the "spread" of the data - a lower (lesser) value of standard deviation indicates higher quality data. These three parameters describe the test results much more fully than the parameter, "mean", alone.

Sample Size

Lets take up the matter of sample size. We will consider a soil layer, and 12 year old boys.

For the soil layer, let's consider unconfined compressive strength; for the boys, height in inches.

If we wish to know something meaningful about the average height of the 12 year old male population, we should measure some boys. Common sense says we should not measure just one or two. Go to one or more schools, and measure a few hundred boys who are 12 years old. The average will give us some kind of indication of the mean height of the U.S. population of 12 year old males.

Our data will acquire more meaning if we can gain some statistical assurance that the number of data points, called the sample size, is large enough.

In engineering terms, we should ideally not start a costly program of evaluation until we acquire some idea of the size of sample we will need in order to have reasonable assurance that the data will truly represent the population.

The enclosed program will allow the user to enter with a defined confidence level, and estimated values of mean and standard deviation; then, by successive trials, compute the minimum sample size. This will allow the user to, for example, estimate the desirable minimum number of samples in a soil testing program - to avoid too few which could falsely estimate the soil strength, or too many, wasteful of money. Your ability to accurately estimate minimum sample size will improve with use of this program.

Confidence

We can estimate the range within which the actual mean value of the population will lie, based on a specified degree of confidence. After appropriate analysis, we may say, for example: "With 95 percent confidence, the mean unconfined compressive strength of the actual soil layer, in-situ, lies between 2650 and 3350

psf." Obviously, if the specified confidence (or "certainty") is greater, (say, 99% instead of 95%) the resulting range is wider. Also, if the sample size is less, the range is wider. When it comes to data, the more the better. But data gathering can be costly.

You may be only interested in one end (or "side") of the range ("What is the lower limit of the mean unconfined compressive strength of the actual soil layer, with 95 percent certainty."). If the soil layer were homogeneous, all parts of it would have the same strength. Since, however, the layer has an actual range of strength within itself, the computed lower end of the range should protect against overestimation of soil strength. Such overestimation could occur if the mean value were used blindly.

In studying the results of unconfined compression tests, perhaps you have tended to give stronger emphasis to the lower test values, reasoning that these tests might more conservatively represent the "worst case" strength for the soil layer. With this program, we can specify a degree of confidence; then, using an orderly methodology, we can arrive at the design unconfined compressive strength for the soil layer - a mathematically defined lower limit of the true in-situ strength. Then a reasonable safety factor is applied. Much better engineering.

The confidence interval is derived from a mathematical procedure called the "Student's t test", or simply, "t test". It is used to permit statements about the value of observations in the population from which the set of samples was drawn.

Visualization of the data in a graphic representation is valuable; to aid you in evaluating your data, a histogram plotting routine is provided.

The attached worked out examples should help clarify.

Hope you find this program useful. Our goal is to help you. Write us with your comments.

Note: The software provided in this issue is solely for educational and experimental purposes. It is supplied "as-is" without warranty of any kind. We do not assume any liability for any direct, indirect, incidental or consequential damages relating to the use or application of the programs or information contained herein.

PROGRAMMERS TIP

When many data values must be entered, try this:

```
10 CLEAR
20 INPUT "NEXT NO.=";  P:
   X=P * P:N=N+1:
   LPRINT TAB 5; P; TAB 10;
   X: GO TO 20
30 LPRINT:LPRINT N
40 END
```

Values of P are entered, printed, and used in a calculation, the results of which are also printed (the calculation could be a GOSUB) all within line 20. The number of entries N is counted. To leave the loop (after all entries have been made) press "ENTER" and N is printed. Useful, I hope.

Programmer's Tips will appear in each issue.

NEWS

Our Radio Shack PC-2 is equipped with an 8K RAM memory module. Perhaps you have heard of a 16K RAM module in the future. It would be great for programs requiring a large amount of memory (e.g., two dimensional arrays). Don't raise your expectations too high. Radio Shack says "not possible" at this time (December '82) - "a minimum of one to two years away." Too bad. But as you will know from reading this publication, we think the PC-2 is great - not perfect - but a really significant forward step in hand-held computer technology. We definitely recommend the 8K module.

Future issues will deal with a broad range of civil engineering design problems, such as: structural, geotechnical, statistical, hydrogeological, pavement, surveying, etc.

DOCUMENTATION

Example #1

Suppose you have received the results of eighty 28 day cylinder tests for concrete specified as 3000 psi strength. You are interested in the minimum mean strength for this concrete in-situ; you are willing to accept only a 1:1000 chance that the actual mean value of the in-situ strength will fall below the lower limit. Therefore, you specify 99.9% confidence, lower limit.

There are a large number of tests; the input of these values into the computer is tedious.

Let's look at the range. It extends from 2750 psi, to 3650 psi, or 900 difference. You decide on nine equal* intervals of 100 psi each. You tabulate and enter the results in the following order:

Interval	Strength	Number
1.	2750-2850	2
2.	2850-2950	4
3.	2950-3050	8
4.	3050-3150	14
5.	3150-3250	18
6.	3250-3350	16
7.	3350-3450	10
8.	3450-3550	6
9.	3550-3650	2
	Total =	80

Enter this grouped data as nine groups. Enter the midpoint of the interval (2800,2900, etc.) as well as the number of tests which fall in each interval.

See computer output. The mean value of the 28 day concrete strength in the structure will not be less than 3151 psi with 99.9% confidence.

Note that the histogram assumes a shape which indicates the data is "normally distributed;" therefore the validity of our analysis is strengthened.

*When entering grouped data, always use equal intervals. Otherwise the histogram will be distorted.

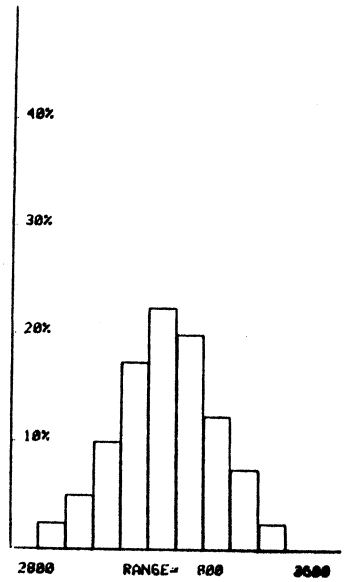
```
**STATISTICS PGM**

FREQ.#  1
# DATA PTS=  2
              2800
FREQ.#  2
# DATA PTS=  4
              2900
FREQ.#  3
# DATA PTS=  8
              3000
FREQ.#  4
# DATA PTS=  14
              3100
FREQ.#  5
# DATA PTS=  18
              3200
FREQ.#  6
# DATA PTS=  16
              3300
FREQ.#  7
# DATA PTS=  10
              3400
FREQ.#  8
# DATA PTS=  6
              3500
FREQ.#  9
# DATA PTS=  2
              3600
****ONE-SIDED****
****CONFIDENCE***

LOWER LIMIT=
          3150.837
CONFIDENCE LEVEL=
            99.9%

BASED ON:

MEAN    =
          3215.000
STD DEV(EST POP)=
       179.3800861
# DATA PTS =  80
```



HISTOGRAM

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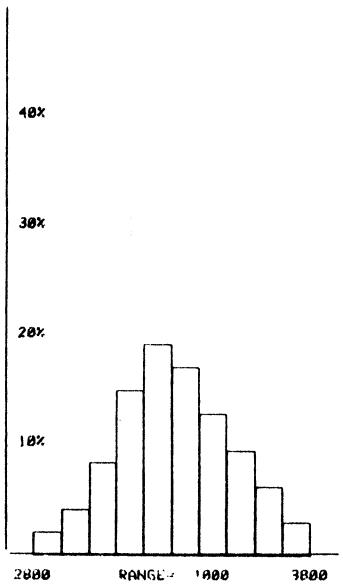
Example #2

Suppose you had eleven intervals instead of nine. The program will regroup the data into 10 intervals for purposes of plotting the histogram. Input data:

Interval	Strength	Number
1.	2750-2850	2
2.	2850-2950	4
3.	2950-3050	8
4.	3050-3150	14
5.	3150-3250	18
6.	3250-3350	16
7.	3350-3450	12
8.	3450-3550	9
9.	3550-3650	6
10.	3650-3750	3
11.	3750-3850	1
	Total =	93

There will be a rather long pause after printing "Data Pts.=93", then the histogram is plotted. Be patient.

The histogram plot is similar to the "nine-interval" plot on page 4. Note the ten intervals. The range is wider by 200 (1000 vs 800).



HISTOGRAM

```
**STATISTICS PGM**

FREQ.#  1
# DATA PTS=  2
                2800
FREQ.#  2
# DATA PTS=  4
                2900
FREQ.#  3
# DATA PTS=  8
                3000
FREQ.#  4
# DATA PTS=  14
                3100
FREQ.#  5
# DATA PTS=  18
                3200
FREQ.#  6
# DATA PTS=  16
                3300
FREQ.#  7
# DATA PTS=  12
                3400
FREQ.#  8
# DATA PTS=  9
                3500
FREQ.#  9
# DATA PTS=  6
                3600
FREQ.#  10
# DATA PTS=  3
                3700
FREQ.#  11
# DATA PTS=  1
                3800
****ONE-SIDED****
****CONFIDENCE***

LOWER LIMIT=
          3195.736
CONFIDENCE LEVEL=
            99.9%

BASED ON:

MEAN    =
          3266.667
STD DEV(EST POP)=
        214.8474309
# DATA PTS =  93
```

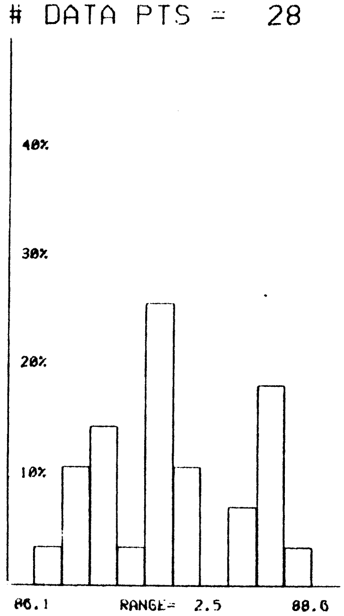
Example #3

Suppose you were testing a fluid for some parameter (say, dissolved concentration) and you are concerned that the concentration fall within a certain range.

Twenty eight tests were made. We are willing to accept only a 1:10000 chance that the actual mean value will fall outside the range calculated by the program.

Based on the data, we find the mean value to be 87.3 and the range for the mean value of the population (actual concentration) to be 86.7 to 87.9. The Standard Deviation for the population is 0.698.

```
**STATISTICS PGM**   LOWER LIMIT=
                                86.730
              86.6   UPPER LIMIT=
              87.1              87.934
                88   CONFIDENCE LEVEL=
              88.1              99.99%
              88.2
              86.4   BASED ON:
              87.9
              86.8   MEAN    =
              87.2              87.332
              87.3   STD DEV(EST POP)=
              87.5      6.981741001E-01
              86.1   # DATA PTS =   28
              88.4
              86.4
              88.2
              87.2
              88.6
              86.9
              87.4
              86.7
              87.1
              87.2
              87.1
              86.4
              88.1
              86.7
              87.5
              88.2
****TWO-SIDED****
****CONFIDENCE***
```



HISTOGRAM

Example #4

<u>Minimum Number of Tests</u>
In the above example, we used 28 tests to establish a range of mean (population) values of 86.7 to 87.9. Suppose you are willing to accept a range from 84.8 to 89.8. If you assume a mean of 87.3 and a standard deviation of 1.2, how many tests would be required to achieve this range?

Trial #1
Try 8 tests
Range 84.0 to 90.6
No Good.

Trial #2
Try 12 tests
Range 85.25 to 89.3
O.K. but try fewer tests.

Trial #3
Try 10 tests
Range 84.8 to 89.8
O.K.

Conclusion: Run not less than 10 tests.

```
ASSUMED NO.TESTS=
 8
LOWER LIMIT=
              83.994
UPPER LIMIT=
              90.606
CONFIDENCE LEVEL=
              99.99%

ASSUMED NO.TESTS=
 12
LOWER LIMIT=
              85.251
UPPER LIMIT=
              89.349
CONFIDENCE LEVEL=
              99.99%

ASSUMED NO.TESTS=
 10
LOWER LIMIT=
              84.808
UPPER LIMIT=
              89.792
CONFIDENCE LEVEL=
              99.99%
```

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Program Runs for PC-1

Example #1

```
PGM:STATISTICS:
ONE-SIDED
CONFIDENCE
***************
LOWER OR UPPER
RANGE?
***************
ENTER NUMBER OF
DATA POINTS
***************
ENTER 80.
DATA  POINTS
              2800.
              2800.
              2900.
              2900.
              2900.
              2900.
              3000.
              3000.
              3000.
              3000.
              3000.
              3000.
              3000.
              3100.
              3100.
              3100.
              3100.
              3100.
              3100.
              3100.
              3100.
              3100.
              3200.
              3200.
              3200.
              3200.
              3200.
              3200.
              3200.
              3200.
              3200.
              3200.
              3200.
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              3400.
              3400.
              3400.
              3400.
              3400.
              3400.
              3400.
              3400.
              3400.
              3500.
              3500.
              3500.
              3500.
              3500.
              3500.
              3500.
              3600.
              3600.
LOWER LIMIT=
          3150.837
AT CONFIDENCE
LEVEL= 99.9 %

MEAN=
              3215.
STD DEV=
       179.3800858
NUMBER  OF DATA
POINTS= 80.
```

Example #3

```
PGM:STATISTICS;
TWO-SIDED
CONFIDENCE
***************
ENTER NUMBER OF
DATA POINTS
***************
ENTER 28.
DATA  POINTS
              86.6
              87.1
               88.
              88.1
              88.2
              86.4
              87.9
              86.8
              87.2
              87.3
              87.5
              86.1
              88.4
              86.4
              88.2
              87.2
              88.6
              86.9
              87.4
              86.7
              87.1
              87.2
              87.1
              86.4
              88.1
              86.7
              87.5
              88.2
LOWER LIMIT=
            86.730
UPPER LIMIT=
            87.934
AT CONFIDENCE
LEVEL= 99.99 %

MEAN=
       87.33214286
STD DEV=
       6.98173E-01
NUMBER  OF DATA
POINTS= 28.
```

Example #4

```
PGM:STATISTICS;
TWO-SIDED
CONFIDENCE
***************
LOWER LIMIT=
            83.962
UPPER LIMIT=
            90.637
AT CONFIDENCE
LEVEL= 99.99 %

MEAN=
              87.3
STD DEV=
               1.2
NUMBER  OF DATA
POINTS= 8.
```

```
PGM:STATISTICS;
TWO-SIDED
CONFIDENCE
***************
LOWER LIMIT=
            85.247
UPPER LIMIT=
            89.352
AT CONFIDENCE
LEVEL= 99.99 %

MEAN=
              87.3
STD DEV=
               1.2
NUMBER  OF DATA
POINTS= 12.
```

```
PGM:STATISTICS;
TWO-SIDED
CONFIDENCE
***************
LOWER LIMIT=
            84.797
UPPER LIMIT=
            89.802
AT CONFIDENCE
LEVEL= 99.99 %
```

A LITTLE ENGINEERS POCKET COMPUTER MONTHLY

LISTINGS:
Statistics - Confidence Program PC-1

```
  3:"B"CLEAR :
    GOSUB 300
  4:GOTO 7
  5:"A"CLEAR :
    GOSUB 350
  7:PRINT "ENTER
     NUMBER OF D
    ATA POINTS":
    PRINT "*****
    **********"
  8:INPUT N:
    PRINT "ENTER
     ";N:PRINT "
    DATA  POINTS
    "
  9:FOR W=1TO N
 10:INPUT "PARAM
    ETER VALUE="
    ,E:PRINT E
 15:F=EE:I=I+F:H
    =H+E:X=H/W
 18:NEXT W
 20:S=((I-NXX)/(
    N-1))^.5
 30:GOTO 110
 40:"F"CLEAR :
    GOSUB 350:
    GOTO 60
 50:"G"CLEAR :
    GOSUB 300
 60:INPUT "MEAN=
     ",X
 70:INPUT "STD D
    EV= ",S
 80:INPUT "NO.OF
     DATA POINTS
    = ",N
110:"C"INPUT "DE
    SIRED CONFID
    ENCE,%=",C:
    IF A(27)<>1
    THEN 125
115:A=N-1:P=1-C/
    100:U=(LN (1
    /P/P))^.5
120:GOTO 130
125:A=N-1:P=(1-C
    /100)/2:U=(
    LN (1/P/P))^
    .5
130:Z=U-((2.3075
    3+.27061*U)/
    (1+.99229*U+
    .04481*U*U))
140:G=(79*Z^9+77
    6*Z^7+1482*Z
    ^5-1920*ZZZ-
    945Z)/92160/
    A^4
150:T=(384AAAZ+9
    6AA*(ZZZ+Z)+
    4A*(Z*(ZZ*(5
    ZZ+16)+3))+Z
    *(ZZ*(ZZ*(3Z
    Z+19)+17)-15
    ))
155:T=T/384/A^3+
    G
160:B=TS/N^.5:L=
    X-B:U=X+B:
    USING "#####
    ##.###"
161:IF A(27)<>1
    THEN 170
163:IF Q$="U"
    THEN 180
165:PRINT "LOWER
     LIMIT= ",L:
    GOTO 190
170:PRINT "LOWER
     LIMIT= ",L
180:PRINT "UPPER
     LIMIT= ",U
190:USING :PRINT
    "AT CONFIDEN
    CE   LEVEL=
    ";C;" %":
    PRINT " "
195:INPUT "CONTI
    NUE?(1=YES)"
    ;A(28):IF A(
    28)=1THEN 21
    0
200:END
210:PRINT "MEAN=
     ",X:PRINT "
    STD DEV= ",S
    :PRINT "NUMB
    ER  OF DATA
    POINTS= ";N
220:PRINT " ":
    PRINT " ":
    PRINT " ":
    END
300:PRINT "PGM:S
    TATISTICS: O
    NE-SIDED":
    PRINT "CONFI
    DENCE":PRINT
    "**********
    ****"
310:A(27)=1:
    PRINT "LOWER
     OR UPPER  R
    ANGE?":INPUT
    "(U OR L)";Q
    $:PRINT "***
    **********
    ":RETURN
350:PRINT "PGM:S
    TATISTICS; T
    WO-SIDED":
    PRINT "CONFI
    DENCE":PRINT
    "**********
    ****":RETURN
```

Instructions (PC-1)

SHIFT A - "Two-Sided" Confidence
- Clears Memory
- Receives No. of Data Points
- Receives Data
- Receives Desired Confidence Level, %
- Printout:
  - Lower Limit
  - Upper Limit
  - Confidence Level %
  - At User Option it will print:
    - Mean
    - Standard Deviation (pop.)
    - No. Data Points

SHIFT B "One-Sided" Confidence
- Same as A except
- Printout: either Upper or Lower Limit, as selected by user

SHIFT F "Two-Sided" Confidence
- Clears Memory
- Receives Mean
- Receives Standard Deviation (pop.)
- Receives No. of Data Points
- Receives Desired Confidence, %
- Printout: Same as A

SHIFT G "One-Sided" Confidence

- Same as F, except
- Printout: Same as B

SHIFT C - RERUN
- Does not clear Memory
- Receives Desired Confidence, %
- Printout: Same as above

CIRCUIT ENGINEER'S POCKET COMPUTER MONTHLY

LISTINGS:
Statistics - Confidence Program PC-2

```
10:"A"CLEAR :DIM
   DV(100)
20:LPRINT "**STAT
   ISTICS PGM**":
   LPRINT
30:WAIT 80:PRINT
   "**STATISTICS
   PROGRAM**"

40:BEEP 4:PRINT "
   **INSTRUCTIONS
   **"
50:PRINT "DATA HA
   VING SIMILAR"
60:PRINT "OR IDEN
   TICAL VALUE"
70:PRINT "MAY BE
   GROUPED"
80:PRINT "AT USER
    OPTION"
90:INPUT "GROUPED
    DATA?(Y/N)";G
   D$
100:IF GD$="Y"THEN
   210
115:K=0
130:INPUT "DATA VA
   LUE= ";DV:K=K+
   1:DV(K)=DV:
   GOSUB 600:
   LPRINT DV(K):
   GOTO 130
150:GOTO 400
210:K=0:INPUT "NO.
   OF FREQUENCIES
   = ";NF
215:IF MQ=1THEN 23
   0
220:DIM NP(NF):MQ=
   1
230:FOR I=1TO NF
240:PRINT "FOR FRE
   QUENCY # ";I:
   LPRINT "FREQ.#
    ";I
250:INPUT "NO.OF D
   ATA POINTS= ";
   NP(I):LPRINT "
   # DATA PTS= ";
   NP(I)
260:INPUT "DATA VA
   LUE= ";DV:
   LPRINT DV
270:FOR L=1TO NP(I
   )
275:K=K+1
280:DV(K)=DV
290:GOSUB 600
300:NEXT L
310:NEXT I
400:X=AV:S=SM:N=K:
   YZ=0
405:"C"INPUT "1,2-
   SIDED CONF? EN
   TER1OR2";XX
406:IF AB=1THEN 41
   0
407:AB=1:DIM BB(10
   )
410:INPUT "DESIRED
    CONFIDENCE,%=
   ";C:IF XX<>1
   THEN 425
415:A=N-1:P=1-C/10
   0:U=(LN (1/P/P
   ))^.5
420:GOTO 430
425:A=N-1:P=(1-C/1
   00)/2:U=(LN (1
   /P/P))^.5
430:Z=U-((2.30753+
   .27061*U)/(1+.
   99229*U+.04481
   *U^2))
440:G=(79*U^9+776*
   Z^7+1482*Z^5-1
   920*Z^3-945*Z)
   /92160/A^4
450:T=384*Z*A^3+96
   *A^2*(Z^3+Z)+4
   *A*(Z*(Z^2*(5*
   Z^2+16)+3))
460:T=T+Z*(Z*Z*(Z*
   Z*(3*Z*Z+19)+1
   7)-15)
470:T=T/384/A^3+G
480:B=T*S/N^.5:L=X
   -B:U=X+B
485:USING "#######
   #.###"
490:IF XX<>1THEN 5
   15
495:LPRINT "****ON
   E-SIDED****":
   LPRINT "****CO
   NFIDENCE***":
   LPRINT
497:INPUT "LOWER/U
   PPER RANGE?(U/
   L)";Q$
500:IF Q$="U"THEN
   530
510:LPRINT "LOWER
   LIMIT= ":
   LPRINT L:GOTO
   540
515:LPRINT "****TW
   O-SIDED****":
   LPRINT "****CO
   NFIDENCE***":
   LPRINT
520:LPRINT "LOWER
   LIMIT= ":
   LPRINT INT (10
   00*L+.5)/1000
530:LPRINT "UPPER
   LIMIT= ":
   LPRINT INT (10
   00*U+.5)/1000
540:LPRINT USING ;
   "CONFIDENCE LE
   VEL=":LPRINT
   TAB 11;C;"%":
   LF 1
543:IF YZ=1THEN 98
   0
545:USING "#######
   #.###"
550:LPRINT "BASED
   ON:":LPRINT
555:X=INT (X*1000+
    5)/1000
560:LPRINT "MEAN
   = ":LPRINT X:
   LPRINT USING ;
   "STD DEV(EST P
   OP)=":LPRINT S
570:LPRINT "# DATA
    PTS = ";N:LF
   3
575:IF NF>10GOSUB
   800:END
580:"X"IF GD$="Y"
   GOSUB 950:
   GOSUB 700:END
590:"V"GOSUB 800:
   END
600:SU=SU+DV(K):F=
   DV(K)^2:J=J+F:
   AV=SU/K:IF K=1
   RETURN
610:SM=((J-K*AV^2)
   /(K-1))^.5:
   RETURN
700:SS=0:FOR I=1TO
   NF:SS=SS+NP(I)
   :NEXT I
705:IF AB=1THEN 71
   0
706:DIM BB(10):AB=
   1
710:FOR I=1TO NF:B
   B(I)=7*NP(I)/S
   S*100:NEXT I
720:AA=18:A=AA/2:
   LF 14:GRAPH
730:RLINE -(0,350)
   :LINE (0,0)-(2
   50,0)
735:LINE (0,70)-(3
   ,70):CSIZE 1:
   LPRINT " 10%":
   LINE (0,140)-(
   3,140):LPRINT
   " 20%"
737:LINE (0,210)-(
   3,210):LPRINT
   " 30%"
738:LINE (0,280)-(
   3,280):LPRINT
   " 40%"
740:FOR I=1TO NF
750:A=A+AA
760:GLCURSOR (A,0)
770:RLINE -(-AA/2,
   0)-(0,BB(I))-(
   AA,0)-(0,-BB(I
   ))-(-AA/2,0)
```

LISTINGS:
Statistics - Confidence Program PC-2 (continued)

```
780:NEXT I
785:GLCURSOR (0,-1
    5):LPRINT BN:
    GLCURSOR (75,-
    15):LPRINT "RA
    NGE= ";10*RR:
    GLCURSOR (180,
    -15):LPRINT TN
    :TEXT
790:LF 2:CSIZE 4:
    LPRINT "HISTOG
    RAM":CSIZE 2:
    LF 2
795:RETURN
800:JJ=1E98
810:FOR I=1TO K
820:IF DV(I)>JJLET
    JJ=DV(I)
830:NEXT I
840:TN=JJ:JJ=1E98
845:IF MQ=1THEN 85
    0
846:DIM NP(10):MQ=
    1
850:FOR I=1TO K:IF
    DV(I)<JJLET JJ
    =DV(I)
860:NEXT I:BN=JJ:R
    R=(TN-BN)/10:N
    F=10
870:FOR J=1TO 10
880:FOR I=1TO K
890:IF DV(I)>=BN+(
    J-1)*RRAND DV(
    I)<BN+(J*RR)
    LET NP(J)=NP(J
    )+1
900:NEXT I:NEXT J
910:GOSUB 700:
    RETURN
950:BN=DV(1):TN=DV
    (K):RR=(TN-BN)
    /10:RETURN
960:"B"CLEAR :
    LPRINT "**STAT
    ISTICS PGM**":
    LPRINT :WAIT 8
    0
970:INPUT "ENTER M
    EAN ";X:INPUT
    "ENTER STD DEV
     ";S
975:LPRINT "MEAN=
        ";X:LPRINT
    "STD.DEV.=  ";
    S:GOTO 985
980:INPUT "RERUN?(
    Y/N)";EE$:IF E
    E$="N"THEN 999
982:LPRINT "RERUN"
    :PRINT "RERUN"
985:INPUT "ENTER N
    O.TESTS ";N.YZ
    =1:LPRINT "NO.
    TESTS= ";N
990:GOTO 405
999:END
```

Instructions (PC-2)

SHIFT A - "One- and Two-Sided" Confidence
- Clears Memory
- Receives Data (individual data points* or grouped)
- Receives decision: one or two sided confidence
- Receives Desired Confidence Level, %
- Printout:
  - All Data
  - Lower Limit, Upper Limit or both, at user option
  - Confidence Level %
  - Mean
  - Standard Deviation (pop.)
  - No. Data Points
  - Plots Histogram

SHIFT B "One- or Two-Sided" Confidence
- Receives and Prints Mean
- Receives and Prints Standard Deviation (pop)
- Receives and Prints No. of Data Points
- Receives and Prints Desired Confidence, %
- Printout:
  - Lower Limit, Upper Limit, or both, at user option

SHIFT C - RERUN
- Does not clear Memory
- Receives Desired Confidence,%
- Printout:
  - Same as A above including Histogram Plot

*Continue entry of individual data points until done, then press "ENTER" to tell the computer to continue running.

CIVIL ENGINEERS
POCKET COMPUTER MONTHLY

Premier Issue
Statistics Confidence Program

It has been brought to our attention that some copies of the PC2 listing were poor.

Enclosed are copies which we trust are satisfactory.

Note that line 440 was corrected ("G" changed to "Z").

Send us your comments.

Just in case you haven't subscribed as yet, we're enclosing a subscription form.

If you like our publication, won't you pass the word to others? Thanks.

Cliff Hall, P.E.
Editor

LISTINGS:
Statistics - Confidence Program PC-2

```
10:"A"CLEAR :DIM
   DV(100)
20:LPRINT "**STAT
   ISTICS PGM**":
   LPRINT
30:WAIT 80:PRINT
   "**STATISTICS
   PROGRAM**"

40:BEEP 4:PRINT "
   **INSTRUCTIONS
   **"
50:PRINT "DATA HA
   VING SIMILAR"
60:PRINT "OR IDEN
   TICAL VALUE"
70:PRINT "MAY BE
   GROUPED"
80:PRINT "AT USER
    OPTION"
90:INPUT "GROUPED
    DATA?(Y/N)";G
   D$
100:IF GD$="Y"THEN
   210
115:K=0
130:INPUT "DATA VA
   LUE= ";DV:K=K+
   1:DV(K)=DV:
   GOSUB 600:
   LPRINT DV(K):
   GOTO 130
150:GOTO 400
210:K=0:INPUT "NO.
   OF FREQUENCIES
   = ";NF
215:IF MQ=1THEN 23
   0
220:DIM NP(NF):MQ=
   1
230:FOR I=1TO NF
240:PRINT "FOR FRE
   QUENCY # ";I:
   LPRINT "FREQ.#
    ";I
250:INPUT "NO.OF D
   ATA POINTS= ";
   NP(I):LPRINT "
   # DATA PTS= ";
   NP(I)
260:INPUT "DATA VA
   LUE= ";DV:
   LPRINT DV
270:FOR L=1TO NP(I
   )
275:K=K+1
280:DV(K)=DV
290:GOSUB 600
300:NEXT L
310:NEXT I
400:X=AV:S=SM:N=K:
   YZ=0
405:"C"INPUT "1,2-
   SIDED CONF? EN
   TER1OR2";XX:WZ
   =0
406:IF AB=1THEN 41
   0
407:AB=1:DIM BB(10
   )
410:INPUT "DESIRED
    CONFIDENCE,%=
   ";C
412:IF XX<>1THEN 4
   25
415:A=N-1:P=1-C/10
   0:U=(LN (1/P/P
   ))^.5
420:GOTO 430
425:A=N-1:P=(1-C/1
   00)/2:U=(LN (1
   /P/P))^.5
430:Z=U-((2.30753+
   .27061*U)/(1+.
   99229*U+.04481
   *U^2))
440:G=(79*Z^9+776*
   Z^7+1482*Z^5-1
   920*Z^3-945*Z)
   /92160/A^4
450:T=384*Z*A^3+96
   *A^2*(Z^3+Z)+4
   *A*(Z*(Z^2*(5*
   Z^2+16)+3))
460:T=T+Z*(Z*Z*(Z*
   Z*(3*Z*Z+19)+1
   7)-15)
470:T=T/384/A^3+G
480:B=T*S/N^.5:L=X
   -B:U=X+B
485:USING "#######
   #.###"
490:IF XX<>1THEN 5
   12
492:IF YZ=1LPRINT
   "1-SIDED":
   LPRINT
495:IF YZ<>1LPRINT
   "****ONE-SIDED
   ****":LPRINT "
   ****CONFIDENCE
   ***":LPRINT
497:IF WZ<>1INPUT
   "LOWER/UPPER R
   ANGE?(U/L)";Q$
500:IF Q$="U"THEN
   530
510:LPRINT "LOWER
   LIMIT= ":
   LPRINT L:GOTO
   540
512:IF YZ=1LPRINT
   "2-SIDED":
   LPRINT
515:IF YZ<>1LPRINT
   "****TWO-SIDED
   ****":LPRINT "
   ****CONFIDENCE
   ***":LPRINT
520:LPRINT "LOWER
   LIMIT= ":
   LPRINT INT (10
   00*L+.5)/1000
530:LPRINT "UPPER
   LIMIT= ":
   LPRINT INT (10
   00*U+.5)/1000
540:LPRINT USING ;
   "CONFIDENCE LE
   VEL=":LPRINT
   TAB 11;C;"%":
   LF 1
543:IF YZ=1THEN 98
   0
545:USING "#######
   #.###"
550:LPRINT "BASED
   ON:":LPRINT
555:X=INT (X*1000+
   .5)/1000
560:LPRINT "MEAN
    = ":LPRINT X
   LPRINT USING
   "STD DEV(EST P
   OP)=":LPRINT S
570:LPRINT "# DATA
    PTS = ";N:LF
   3
575:IF NF>10GOSUB
   800:END
580:"X"IF GD$="Y"
   GOSUB 950:
   GOSUB 700:END
590:"V"GOSUB 800:
   END
600:SU=SU+DV(K):F=
   DV(K)^2:J=J+F:
   AV=SU/K:IF K=1
   RETURN
610:SM=((J-K*AV^2)
   /(K-1))^.5:
   RETURN
700:SS=0:FOR I=1TO
   NF:SS=SS+NP(I):
   :NEXT I
705:IF AB=1THEN 71
   0
706:DIM BB(10):AB=
   1
710:FOR I=1TO NF:B
   B(I)=7*NP(I)/S
   S*100:NEXT I
720:AA=18:A=AA/2:
   LF 14:GRAPH
730:RLINE -(0,350)
   :LINE (0,0)-(2
   50,0)
735:LINE (0,70)-(3
   ,70):CSIZE 1:
   LPRINT " 10%":
   LINE (0,140)-(
   3,140):LPRINT
   " 20%"
737:LINE (0,210)-(
   3,210):LPRINT
   " 30%"
738:LINE (0,280)-(
   3,280):LPRINT
   " 40%"
740:FOR I=1TO NF
750:A=A+AA
```

LISTINGS:
Statistics - Confidence Program PC-2 (continued)

```
760:GLCURSOR (A,0)
770:RLINE -(-AA/2,
    0)-(0,BB(I))-(
    AA,0)-(0,-BB(I
    ))-(-AA/2,0)
780:NEXT I
785:GLCURSOR (0,-1
    5):LPRINT BN:
    GLCURSOR (75,-
    15):LPRINT "RA
    NGE= ";10*RR:
    GLCURSOR (180,
    -15):LPRINT TN
    :TEXT
790:LF 2:CSIZE 4:
    LPRINT "HISTOG
    RAM":CSIZE 2:
    LF 2
795:RETURN
800:JJ=-1E98
810:FOR I=1TO K
820:IF DV(I)>JJLET
    JJ=DV(I)
830:NEXT I
840:TN=JJ:JJ=1E98
845:IF MQ=1THEN 85
    0
846:DIM NP(10):MQ=
    1
850:FOR I=1TO K:IF
    DV(I)<JJLET JJ
    =DV(I)
860:NEXT I:BN=JJ:R
    R=(TN-BN)/10:N
    F=10
870:FOR J=1TO 10
880:FOR I=1TO K
890:IF DV(I)>=BN+(
    J-1)*RRAND DV(
    I)<BN+(J*RR)
    LET NP(J)=NP(J
    )+1
900:NEXT I:NEXT J
910:GOSUB 700:
    RETURN
950:BN=DV(1):TN=DV
    (K):RR=(TN-BN)
    /10:RETURN
960:"B"CLEAR :
    LPRINT "**STAT
    ISTICS PGM**":
    LPRINT :WAIT 8
    0
970:INPUT "ENTER M
    EAN ";X:INPUT
    "ENTER STD DEV
     ";S
975:LPRINT "MEAN=
        ";X:LPRINT
    "STD.DEV.=  ";
    S:GOTO 985
980:INPUT "RERUN?(
    Y/N)";EE$:IF E
    E$="N"THEN 999
982:LPRINT "RERUN"
    :PRINT "RERUN"
    :WZ=1
985:INPUT "ENTER N
    O.TESTS ";N:YZ
    =1:LPRINT "NO.
    TESTS= ";N
987:IF WZ=1THEN 41
    2
990:GOTO 405
999:END
```

Instructions (PC-2)

DEF A - "One- and Two-Sided Confidence"
- Clears Memory
- Receives Data (Individual Data Points* or Grouped)
- Receives Decision: One or Two Sided Confidence
- Receives Desired Confidence Level, %
- Printout:
  - All Data
  - Lower Limit, Upper Limit or both, at User Option
  - Confidence Level %
  - Mean
  - Standard Deviation (population)
  - Number of Data Points
  - Plots Histogram

DEF B "One- or Two-Sided Confidence"
- Clears Memory
- Receives and Prints Mean
- Receives and Prints Standard Deviation (pop)
- Receives and Prints No. of Data Points
- Receives and Prints Desired Confidence, %
- Printout:
  - Lower Limit, Upper Limit, or both, at User Option

DEF C - RERUN
- Does not clear Memory
- Receives Desired Confidence, %
- Printout:
  - Same as A above including Histogram Plot

*Continue entry of individual data points until done, then press "ENTER" to tell the computer to continue running.

Cassette Tapes Available:

Statistics-Confidence Program	
PC-1	$20.
PC-2	$20.