PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION
Cover Page

FOR CONSIDERATION BY NSF ORGANIZATIONAL UNIT (Indicate the most specific unit known, i.e. program, division, etc.)	ARE ANY FUNDS IN THIS PROPOSAL BEING REQUESTED ELSEWHERE IN NSF OR IN ANOTHER FEDERAL AGENCY
Instructional Scientific Equipment Program - ISEP	YES ☐ NO ☒ IF YES, EXPLAIN UNDER REMARKS.

PROGRAM ANNOUNCEMENT/SOLICITATION NO.:	CLOSING DATE (IF ANY):
SE 79-32	March 2, 1979

NAME OF SUBMITTING ORGANIZATION TO WHICH AWARD SHOULD BE MADE (INCLUDE BRANCH/CAMPUS/OTHER COMPONENTS)

Hope College

ADDRESS OF ORGANIZATION (INCLUDE ZIP CODE)

Holland, MI 49423

TITLE OF PROPOSED PROJECT

A Microcomputer Laboratory for Use in Teaching Statistics

$ REQUESTED FROM NSF	$ LOCAL CONTRIBUTION	$ TOTAL PROJECT COSTS
$10,300	$10,330	$20,630

PROPOSED DURATION	DESIRED STARTING DATE
2 years	September, 1979

PI/PD NAME AND SOCIAL SECURITY NO. (SSN)*	PI/PD PHONE NO.
Elliot A. Tanis 481-34-8023	OFFICE: 616-392-5111 Ext 3001 HOME: 616-396-2228

PI/PD DEPARTMENT	PI/PD ORGANIZATION
Mathematics	Hope College

ADDITIONAL PI/PD AND SSN*	ADDITIONAL PI/PD AND SSN*
Herbert L. Dershem	
ADDITIONAL PI/PD AND SSN*	ADDITIONAL PI/PD AND SSN*

REMARKS:

*Submission of social security numbers is voluntary and will not affect the organization's eligibility for an award. However, they are an integral part of the NSF information system and assist in processing the proposal. SSN solicited under NSF Act of 1950, as amended.

PRINCIPAL INVESTIGATOR/ PROJECT DIRECTOR	AUTHORIZED ORGANIZATIONAL REP.	OTHER ENDORSEMENT (optional)
NAME (Prof., (Dr.) Mr., Ms.) Elliot A. Tanis	NAME (Prof., (Dr.) Mr., Ms.) Sheldon Wettack	NAME (Prof., Dr., Mr., Ms.)
SIGNATURE Elliot A. Tanis	SIGNATURE Sheldon Wettack	SIGNATURE
TITLE Professor of Mathematics, Chairman of Mathematics Department	TITLE Dean, Divisions of Natural and Social Sciences	TITLE
DATE February 26, 1979	DATE February 26, 1979	DATE

DETAILED BUDGET

G. COMPUTING EQUIPMENT		Each	Total
(1)	10 16K RAM Level-II BASIC, TRS-80 Microcomputers	$988	$9880
(2)	10 Expansion Interface	299	2990
(3)	10 Disk Drives	499	4990
(4)	1 Line Printer, Tractor Feed	1599	1499
(5)	1 Quick Printer	499	499
(6)	2 Printer Connection Cables	39	78
(7)	2 RS-232-C Boards	99	198
(8)	2 Telephone Interfaces	198	396
			$20,630

NATIONAL SCIENCE FOUNDATION

UNDERGRADUATE SCIENTIFIC EQUIPMENT PROGRAM

Project Summary Form

1. NAME OF INSTITUTION
Hope College

2. ADDRESS OF INSTITUTION (INCLUDE BRANCH/CAMPUS & COMPONENT)
Holland, Michigan 49423

3. PRINCIPAL INVESTIGATOR
Elliot A. Tanis

4. MAJOR DISCIPLINE CODE
MA

5. FIELD OF SCIENCE AND ENGINEERING CODE(S)
MH21

6. THIS PROJECT IS PRINCIPALLY AIMED AT STUDENTS EXPECTED TO PURSUE CAREERS:
[X] A. AS SCIENTISTS [ ] B. AS PRE-COLLEGE SCIENCE TEACHERS [X] C. IN FIELDS NOT DIRECTLY SCIENCE RELATED

7. HIGHEST DEGREE OFFERED IN SCIENCE BY ANY DEPARTMENT ON THE CAMPUS SUBMITTING THIS PROPOSAL.
CHECK ONE: ASSOCIATE [ ] BACCALAUREATE [X] MASTER [ ] DOCTOR [ ] OTHER, SPECIFY

8. TYPE OF INSTITUTION [ ] PUBLIC [X] PRIVATE [ ] CONSORTIUM

9. TITLE OF PROJECT
A Microcomputer Laboratory for Use in Teaching Statistics

10. SUMMARY OF PROPOSED WORK

A laboratory room containing ten Radio Shack TRS-80 microcomputer systems will be used to implement laboratory courses which are adjunct to three different statistics courses at Hope College. The three courses are Introductory Statistics for non-science majors, Mathematical Statistics and Probability for mathematics majors, and Statistics for Scientists. The computer laboratory exercises for the first two courses have already been developed and are being used in many colleges. The exercises for the third laboratory will be developed under a CAUSE grant to Hope College.

The laboratory courses will be enhanced by the addition of this equipment because it will permit the completion of laboratory experiments within the classroom environment under conditions controlled and supervised by the instructor. This will result in more efficient use of both instructor and student time and a more conducive environment for learning statistical concepts.

11. INSTITUTION'S OPENING FTE UNDERGRADUATE FALL ENROLLMENT AS REPORTED IN FALL ENROLLMENT IN HIGHER EDUCATION 1976, NATIONAL CENTER FOR EDUCATION STATISTICS, NCES# 78-310 2150.

12. NUMBER OF STUDENTS TO BE AFFECTED BY THE PROJECT OVER A 5-YEAR PERIOD 1345.

13. FROM 12, ESTIMATE THE NUMBER:

A. TO TERMINATE SCIENTIFIC STUDIES WITH THE ASSOCIATE DEGREE 0.

B. TO TERMINATE SCIENTIFIC STUDIES WITH THE BACCALAUREATE DEGREE 980.

C. TO CONTINUE SCIENTIFIC STUDIES BEYOND THE BACCALAUREATE DEGREE 300.

D. TO ENTER SCIENCE TEACHING CAREERS AT THE JUNIOR 15 OR SENIOR 50 HIGH SCHOOL LEVEL.

NARRATIVE

A. NEED: THE PRESENT SITUATION

The computer is presently being used in several ways as an instructional tool in statistics classes at Hope College. An introductory statistics class with no calculus prerequisite is offered for students in the social sciences. This one semester, three credit-hour course has had an average annual enrollment of 232 over the past three years. A one-credit-hour laboratory is offered as an optional adjunct to the course. This laboratory utilizes the computer as a tool to aid in the learning of statistics through the use of simulations, graphical displays, and analyses performed on data sets stored in the computer. Unfortunately less than 20% of the students elect to take the laboratory.

A two-course sequence in Mathematical Statistics and Probability is also offered each year. This course is three credit hours each of two semesters. It is offered primarily for Mathematics majors at the junior and senior level and has a calculus prerequisite. During the past three years this course has had an average enrollment of 25 students first semester and 19 students second semester. A one-credit-hour computer laboratory is also offered as an option for students enrolled in this course. Approximately one-half of the students elect this laboratory which seeks to use the computer as a tool to illustrate and reinforce the theoretical concepts in probability and statistics through extensive use of graphics and simulations. The students who do not elect the laboratory receive only a minimal exposure to the computer.

A third course in statistics, intended primarily for natural science students, is being developed with support from a National Science Foundation CAUSE grant. A version of this course was offered during the spring of 1978 with an enrollment of 15 students. Based on our first

experience with this course, we plan to integrate computer laboratory work, similar to that now offered in the two present courses, into this one-semester calculus based course.

A summary of past enrollments in the two present statistics offerings and their laboratories is found in Table I. Detailed descriptions of the courses are found in Appendix B.

Course	1976-77	1977-78	1979-80	Average
Introductory Statistics	239	227	230	232
Intro Stat Laboratory	51	36	31	39
Math Stat-no lab (fall enrollment)	15	11	10	12
Math Stat-with lab (fall enrollment)	19	10	9	13

Table I

In spite of relatively stable enrollments in statistics courses at Hope over the past three years, the total number of students enrolled in statistics computer laboratories has decreased from 70 to 40 (see Table I). This decrease does not appear to have occured because the students do not find the laboratory valuable. On the contrary, student evaluations of the laboratories consistently indicate that the laboratory has increased the students' understanding of statistical concepts and given them a valuable experience with data analysis and interpretion. In addition students who enroll for the laboratory generally receive higher grades in the statistics class. No doubt this is due in part to the fact that often the better students elect the laboratory.

The faculty who teach the laboratories feel that one of the important reasons for the enrollment decrease is the large amount of time spent by the students working on the computer outside of class. The use of our present computer system has often been a frustrating experience for the laboratory students because of limited terminal availability and slow response time.

This is the result of the limitations of the current Hope College computer system and the large number of students using the computer for instructional purposes. Each semester the computer is used in courses with enrollments totaling more than 500.

The college has a Honeywell Sigma 6 computer system which is shared by all academic and administrative users. Only six terminals are provided for general student use on campus. This number cannot be increased without further enhancement of the computer system to accomodate more users.

Our current typical laboratory for both courses meets for a two hour block each week. The first part of each period is spent discussing the results of the experiments assigned during the previous week. (See Appendix C for some typical experiments.) A new experiment is then described. The students can spend the remainder of the lab time in preparation for the experiment. Generally there is at most one terminal available for the students to begin performing the experiment on the computer.

Under the restrictions of the present computing equipment, most of the students must perform the experiment sometime during the week between laboratories. This must be done at times when the instructor is not available for assistance and at a time separated from the laboratory discussion. This is one of the frustrating aspects of the laboratory for the students. Other frustrations are the lack of an adequate number of terminals and slow system response time, resulting in a large amount of wasted student time. This proposal is an attempt to improve this situation so that a more ideal instructional sequence can be implemented.

B. PROJECT DESCRIPTION: THE IMPROVEMENT PLAN

Based on our past experience, the ideal scenario for the statistics laboratories would be for the instructor to present the background and techniques for the experiment during the first part of the two hour

period. After this presentation, the students, in teams of 2 or 3, should perform the experiment at a terminal under the instructor's supervision. At the end of the period, after all the data has been collected, the instructor would further explain any points brought out by the experiment.

The proposed equipment would allow us to establish a dedicated laboratory classroom where the statistics computer laboratory courses could be taught. This classroom would contain ten computer stations, allowing up to 20 students per laboratory class, with two students assigned to each station. This would allow the instructors to conduct classroom demonstrations with each pair of students following a step-by-step procedure on their own data. It would also permit the students to conduct the experiments during class time and with direction and supervision from the instructor.

An added benefit that the proposed equipment would give is improved graphics ability compared to our present system. We are currently using printer grpahics. (See Appendix C for examples.) The TRS-80 graphics, though not as high resolution as some systems, does provide adequate graphics for the purposes of statistics laboratory materials. The graphical displays used in our statistical experiments include histograms with superimposed probability density functions, scattergrams, graphical illustrations of confidence intervals, and graphical illustrations of the behavior of sample statistics in comparison with population parameters as sample size is varied.

The students will also have the ability to create and maintain their own personal data sets on a minidisk which could then be loaded into the system when needed. Each student in the class would purchase a minidisk which would then be used for storage of any data that the student might wish to use in the class experiments.

D. EQUIPMENT

1. The Equipment Request

Each station will consist of a TRS-80 computer with Level II BASIC and 16K of memory. This is a minimal configuation for running the programs in our software package. In addition, one minidisk drive and an expansion interface are requested for each station. The expansion interface is necessary for use of disks. The disk drive is requested because the loading of programs and data by cassette tape is very slow on the TRS-80 system. The length of time required by program and data loads would be incompatible with the goal of efficient use of class time. In addition, it would discourage the use of large, realistic data sets.

In addition, two of the systems will be further enhanced by the addition of RS232 communication interface boards, telephone interfaces, and printers. This would permit Professors Tanis and Dershem to convert our present programs to the TRS-80 system and to develop new software. The communications equipment will permit the transfer of data and programs from the Hope College central computer to the TRS-80 and back. The printers will be used to obtain program listings to assist in the development and debugging of programs and for computer text editing of laboratory materials.

The TRS-80 computer system has been used extensively by Professor Dershem for over a year and a half in various instructional applications, including heavy usage by elementary school children. Based on his experience, the TRS-80 is a sufficiently rugged and reliable machine for use in the statistics laboratories. In addition, he has successfully implemented about 20% of his experiments in the elementary statistics lab on a TRS-80 system to test the feasibility of this project.

Because of the versatility and ruggedness of the TRS-80, we expect to utilize this new equipment in several other ongoing courses. For example, our basic mathematics course for liberal arts students devotes about 1/3 of its time to the computer and BASIC programming. Another example is the laboratory for elementary education students which currently uses personally owned TRS-80's for demonstration purposes.

2. The Equipment on Hand

Hope College owns a Honeywell Sigma 6 computer with 96K of memory and 24 communication ports. Also included are six 24½ megabyte disk storage units and one tape drive. Terminals available for student use include 2 Decwriters, 1 Teleray CRT, and 3 Teletype KRS 33 terminals. The use of additional terminals is limited by the memory of the central processing unit and the size and speed of current disk storage. In addition, it is impossible under present circumstances to obtain exclusive use of a bank of terminals for a given class or laboratory.

Hope College also owns one Tektronix 4051 graphic system which could be an effective tool for use in the statistics laboratories. Our use of this equipment is limited to classroom demonstrations because only one system is available. The Tektronix 4051 is too expensive for us to purchase a sufficient quantity to allow students to have hands-on usage during class time.

3. Equipment Maintenance

Hope College will provide proper maintenance of the purchased equipment with a time and material agreement through the local Radio Shack store.

D. PERSONNEL

1. Faculty Expertise

The experience of Professors Dershem and Tanis in the area of computer-based statistics instruction is extensive. Curriculum vitae listing pertinent experiences are found in Appendix A.

With support from a grant by the Office of Computing Activities of NSF, Professors Tanis and Dershem wrote a computer software package for statistics instruction. This package is currently being distributed by CONDUIT. Both are authors of laboratory manuals for computer-based statistics laboratories and have authored or delivered many papers on the use of the computer in teaching statistics. Professor Dershem is Series Editor in statistics for CONDUIT.

Both Dershem and Tanis are owners of Radio Shack TRS-80 computer systems and have experience in the use of such a system.

2. Information on Current or Proposed Projects

Professor Dershem is serving as director of the project, "A Modular Approach to the Introductory Course in Computer Science", funded by the Local Course Improvement Program of the National Science Foundation. This project will be completed in August, 1979.

Professor Tanis will be a participant in a project funded by a National Science Foundation CAUSE grant to Hope College. His participation involves the design and implementation of a one-semester statistics course for natural science students. This work is closely related to the proposed project since the requested equipment would be used to provide a computer laboratory for this new course. Professor Tanis will be working on this project during the summer and fall of 1979.

E. EVALUATION

The project will be evaluated by the participating faculty, the students enrolled in the laboratories, and faculty teaching statistics courses at other institutions.

One important measure of the success of this new approach to the laboratories will be the trend in enrollment in the laboratories over the next three years. A high student opinion of the value of a class is best measured by the way that opinion influences students who are possible future enrollees. Formal student evaluations will also be used and compared with those which have been received when the present approach to the laboratory has been used.

The instructors of the laboratory will evaluate the new approach by comparing it to the previous situation in the productive use of faculty and student time, in the perceived and measured learning taking place, and in the facility with which the students operate the equipment and use it to learn statistical concepts and practices.

Finally, the evaluation of this project by colleagues at other institutions will be accomplished by presenting our approach in papers at regional and national conferences and publishing results in journals. Software developed will also be made available for use by others. As the number of TRS-80's in education increases rapidly, there will be a need for software that makes efficient use of this computer for educational purposes.

APPENDIX A

Staff Vitae

I. Director - Elliot A. Tanis

Education:

B.A. Central College, Pella, Iowa, 1956
M.S. University of Iowa, 1960 (Mathematics)
Ph.D. University of Iowa, 1963 (Mathematics)
Thesis: "Linear Forms in the Order Statistics from an Exponential Distribution".

Professional Experience:

Assistant Professor of Mathematics, University of Nebraska, 1963-65.

Member of the faculty, Hope College, 1965-present
Currently Professor of Mathematics and
Chairman of the Department of Mathematics.

Associate Director, NSF Summer Institute for Advanced Placement Teachers of Mathematics, Hope College, 1967, 1968.

Director, NSF Summer Institute for Advanced Placement Teachers of Mathematics, Hope College, 1969.

Director, A project: "Introduction of the Computer in the Statistics Curriculum", under the Office of Computing Activities, NSF, 1971-73, with H. Dershem.

Professional Affiliations:

Mathematical Association of America
American Mathematical Society
Institute of Mathematical Statistics
American Statistical Association
Society of Sigma Xi
Pi Mu Epsilon

Relevant Publications:

"Theory of Probability and Statistics Illustrated by the Computer", Proceedings of the 1972 Conference on Computers in the Undergraduate Curricula, June 1972.

"A Computer Laboratory for Mathematical Probability and Statistics", Proceedings of a Fourth Conference on Computers in the Undergraduate Curricula, June, 1973.

"Mathematical Probability and Statistics Computer Laboratory", International Journal of Mathematical Education in Science and Technology, April, 1974.

Elliot A. Tanis cont...

Probability and Statistical Inference
with Robert V. Hogg, 1977, Macmillan Publishing Company.

Laboratory Manual for Probability and Statistical Inference
1976, distributed by CONDUIT, the University of Iowa.

"A Computer-Based Laboratory for Mathematical Statistics and Probability", Proceedings of an Eighth Conference on Computers in the Undergraduate Curricula, June, 1977.

Relevant Papers Presented:

"Theory of Probability and Statistics Illustrated by the Computer", 1972 Conference on Computers in the Undergraduate Curricula, Atlanta, Georgia, June, 1972.

"A Computer Laboratory for Mathematical Probability and Statistics", Fourth Conference on Computers in the Undergraduate Curricula, Claremont, California, June, 1973.

"Mathematical Probability and Statistics Computer Laboratory", First British Conference on Computers in Higher Education, Lancaster, England, April, 1974.

"A Computer-Based Laboratory for Mathematical Statistics and Probability", NATO Advanced Study Institute on Computer-Based Science Instruction, Universite de Louvain, Belgium, July, 1976.

"A Computer-Based Laboratory for Mathematical Statistics and Probability", Annual meeting of the American Mathematical Society, St. Louis, Missouri, January 1977.

"Distribution Theory Illustrated Empirically", Annual meeting of the American Statistical Association, Chicago, Illinois, August, 1977.

"A Computer-Based Laboratory for Mathematical Statistics and Probability", Michigan Association of Computer Users for Learning, Second Annual Convention, Grand Rapids, Michigan, March, 1978.

II. Herbert L. Dershem

Education

B.S. (cum laude) University of Dayton, 1965 (Mathematics)
M.S. Purdue University, 1967 (Computer Science)
Ph.D. Purdue University, 1969 (Computer Science)

Professional Experience

Member of the faculty, Hope College, 1969-present.
Currently Associate Professor of Mathematics and Computer Science and Chairman of the Department of Computer Science.

Herbert L. Dershem cont...

Participant, A Project: "Introduction of the Computer in the Statistics Curriculum", Supported by The Office of Computing Activities, NSF, 1971-73, with E. Tanis

Participant, Project COMPUTe, Dartmouth College, 1974.

Member, CONDUIT National Mathematics Advisory Committee, 1974-present.

Statistics Series Editor, CONDUIT, 1977-present.

Director, A Project: "A Modular Approach to the Introductory Course in Computer Science", supported by Local Course Improvement Program, NSF, 1978-79.

Professional Affiliations

Mathematical Association of America
Association for Computing Machinery
IEEE Computer Society
Society of Data Educators
Society of Sigma Xi
Pi Mu Epsilon

Relevant Publications

"A Course on computing and statistics for social science students", Proceedings of the 1972 Conference on Computers in the Undergraduate Curricula, Atlanta, Georgia, 1972, pp. 525-528.

"Exercise Manual for a Computer-Augmented Applied Statistics Course", ComPress, Inc., 1979.

"A relationship between approximation theory and statistical measurements", Pi Mu Epsilon Journal, 6, 2(Spring, 1974), pp. 69-74.

"Factor Game"
Personal Computing, 2,6(June, 1978), pp. 44-49.

"Introducing Elementary School Children to the Computer", Calculator/Computers Magazine, 2,6(September/October, 1978), pp. 69-71, with J. Whittle

"Computers in Teaching Mathematics", Computers in Undergraduate Teaching" 1977 CONDUIT State of the Art Reports in Selected Disciplines, CONDUIT, 1978, with D. McLaughlin, A. Ziebur, and D. Smith.

"Experiments in Statistics with BASIC Programs: A Laboratory Manual", in preparation.

APPENDIX B

Catalog descriptions of our current statistics courses

210. INTRODUCTORY STATISTICS - A general introduction to the area of statistics for students majoring in other departments. Includes study of the binomial and normal distributions with applications of estimation and testing of hypotheses, non-parametric methods, regression and correlation, and analysis of variance.

212. LABORATORY FOR INTRODUCTORY STATISTICS - The computer is used as a tool to aid in the learning and understanding of statistics. Experience given in the use of statistical analysis packages. Prerequisite or Co-requisite, Mathematics 210.

361. MATHEMATICAL PROBABILITY AND STATISTICS I - Concepts of probability, probability as relative frequency, random variables, probability density functions, cumulative distribution functions, mathematical expectation, mean, variance, confidence intervals. Lecture, three hours per week for three hours credit. Prerequisite: Mathematics 235 - Calculus III. Optional Laboratory, two hours per week for an additional hour credit. Prerequisite: Mathematics (Computer Science) 120 - Introduction to Computer Science.

362. MATHEMATICAL PROBABILITY AND STATISTICS II - Continuation of Mathematics 361 emphasizing statistics. Estimation, testing of statistical hypotheses, regression and correlation, analysis of variance. Lecture, three hours per week for three hours credit. Prerequisite: Mathematics 361. Optional laboratory, two hours per week for an additional hour credit. Prerequisite: Mathematics (Computer Science) 120 - Introduction to Computer Science.

APPENDIX C

In this appendix we give the table of contents for the introductory statistics laboratory along with one set of experiments for this laboratory. We also give the table of contents for the mathematical statistics laboratory, one problem for this laboratory along with the solution for this problem.

Table of Contents

Table of Contents (continued)

Computer Exercises (continued)

Description of the Subprograms

Laboratory 4

Purpose: The purpose of this laboratory is to learn how to generate frequency distributions and histograms on the computer, to verify Chebyshev's Theorem, and to use the computer programs to test for normality.

Experiments:

1. A data set called STUDENT is stored in the computer's storage. There are two variables in this data set, HSGPA and SATV, and 150 samples. Use the procedures from Laboratories 2 and 3 to retrieve and print measures of central tendency and dispersion for this data set.

2. Generate a frequency distribution and histogram for both variables of data set STUDENT.

3. Use the program FREQ to verify Chebyshev's Theorem for k = 1.5, 2, 5, and 10 with either variable of data set STUDENT.

4. Create and save a data set of your own choosing. It should have at least 2 variables and 20 samples.

5. For one of the variables of the data set you entered in Experiment 4, use FREQ to determine what proportion of sample values are within one, two, and three standard deviations of the mean.

Analysis:

1. In Experiment 2, how can you use the results of Experiment 1 to determine the limits for the frequency classes?

2. Summarize the results of Experiment 3 in the table below:

k	Number of sample values within k standard deviations	Lower bound predicted by Chebyshev's Theorem
1.5		
2		
5		
10		

3. Describe the data set you created in Experiment 4.

Population from which samples were taken:

Variables in the data set:

4. Summarize the results of Experiment 5 in the table below:

k	Proportion of sample values within k standard deviations	Expected proportion for normal distribution
1		
2		
3		

Do these results indicate that your variable might be normal?

LABORATORY MANUAL FOR

PROBABILITY AND STATISTICAL INFERENCE

CONTENTS

4.2-6. Let U and V be independent random variables with uniform distributions U(0,1). Show empirically that W = U + V has a triangular distribution. In particular generate 500 pairs of random numbers.

(a) Use the subroutine RFHPF to plot a relative frequency histogram with the p.d.f. $g(w) = 1 - |w - 1|$, $0 \leq w \leq 2$, superimposed.

(b) Use the subroutine OGIVE to plot a relative frequency ogive curve with the distribution function of W superimposed.

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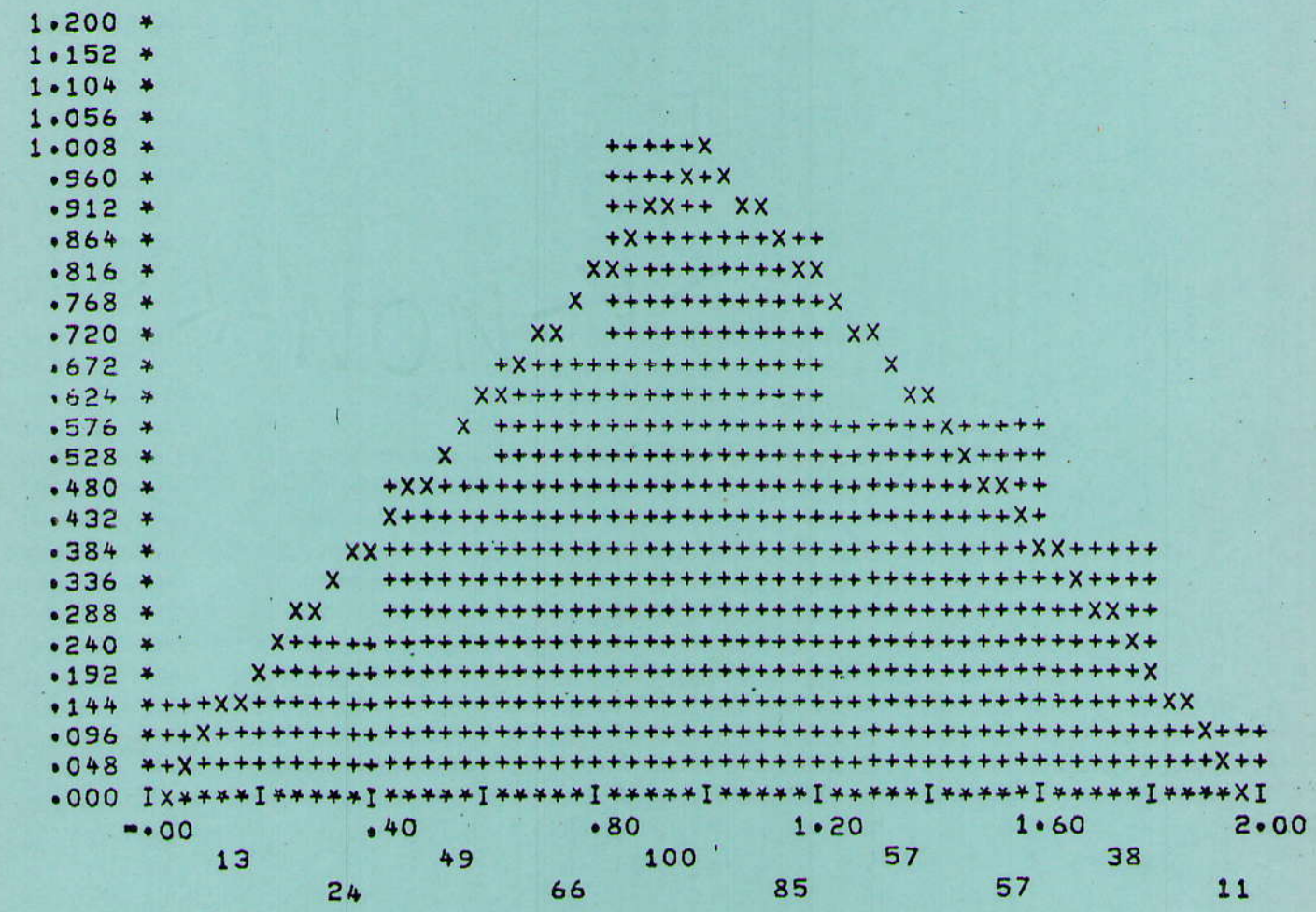
C . . . PROBLEM 4.2-6.
C
C . . . DEFINE THE PDF AS A FUNCTION SUBPROGRAM.
C . . . REMARK: IT COULD HAVE BEEN DEFINED AS A STATEMENT
C . . . FUNCTION USING A DUMMY VARIABLE.
C
      FUNCTION G(W)
      G = 1. - ABS(W - 1.)
      RETURN
      END
C
C . . . DEFINE THE DISTRIBUTION FUNCTION AS A FUNCTION SUBPROGRAM.
C
      FUNCTION DF(W)
      IF(W.LE.1.) DF = (W**2)/2.; RETURN
      DF = 1. - (2. - W)**2/2.
      RETURN
      END
C
C . . . DIMENSION W TO HOLD THE 500 OBSERVATIONS.  BE SURE TO
C . . . INCLUDE THE EXTERNAL STATEMENT WITH THE FUNCTION
C . . . NAMES ON IT.
C
      DIMENSION W(500), NOBS(20)
      EXTERNAL G, DF
C
C . . . GENERATE 500 OBSERVATIONS OF THE SUM OF TWO U(0,1) VARIABLES.
C
      DO 10 K=1,500
      U = RAN(1)
      V = RAN(1)
      W(K) = U + V
   10 CONTINUE
C
C . . . PLOT THE RELATIVE FREQUENCY HISTOGRAM WITH THE PDF
C . . . SUPERIMPOSED.  PLOT THE OGIVE CURVE WITH THE
C . . . DISTRIBUTION FUNCTION SUPERIMPOSED.  BOTH ARE
C . . . PLOTTED WITH AP AND 20 CLASSES FOR ILLUSTRATIVE
C . . . PURPOSES.
C
      DO 20 NINT = 10,20,10
      CALL RFHPF(1,NINT,0.0,2.0,1.2,500,W,NOBS,G)
      WRITE(108,800)
  800 FORMAT('0',10X,'SUM OF TWO U(0,1) RANDOM VARIABLES')
      CALL OGIVE(1,NINT,0.0,2.0,500,W,DF)
      WRITE(108,805)
  805 FORMAT('0',10X,'OGIVE CURVE FOR THE SUM OF TWO U(0,1) RANDOM VARIA
     XBLES')
   20 CONTINUE
      STOP
      END
```

OUTPUT FOR PROBLEM 4.2-6.



SUM OF TWO U(0,1) RANDOM VARIABLES

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D. C. 20550

SEP 14 1979

GRANT NO. SER-7914334
PROPOSAL NO. SER-7914334

DR GORDON VAN WYLEN
HOPE COLLEGE
HOLLAND MI 49423

THE NATIONAL SCIENCE FOUNDATION HEREBY AWARDS A GRANT OF $10,315 TO HOPE COLLEGE FOR SUPPORT OF THE PROJECT DESCRIBED IN THE PROPOSAL REFERENCED ABOVE.

THIS PROJECT, UNDER THE DIRECTION OF ELLIOT A TANIS, DEPARTMENT OF MATHEMATICS, IS ENTITLED:

"A MICROCOMPUTER LABORATORY FOR USE IN TEACHING STATISTICS."

THIS AWARD IS EFFECTIVE OCTOBER 1, 1979 AND EXPIRES MARCH 31, 1982. A 6 MONTH UNFUNDED FLEXIBILITY PERIOD IS INCLUDED IN THIS AWARD.

THIS GRANT IS AWARDED PURSUANT TO THE AUTHORITY OF THE NATIONAL SCIENCE FOUNDATION ACT OF 1950 (42 U.S.C. 1861 ET SEQ.) AND IS SUBJECT TO THE FOLLOWING TERMS AND CONDITIONS:

FL 118 GRANT GENERAL CONDITIONS (REV. OCT/78) AND SE 79-32.
IT IS UNDERSTOOD THAT THE GRANTEE WILL SHARE IN THE COSTS OF THE PROJECT IN THE AMOUNT OF AT LEAST 50% OF TOTAL PROJECT COSTS.

THE BUDGET INDICATES THE AMOUNTS, BY CATEGORIES, ON WHICH NSF HAS BASED ITS SUPPORT.

THE COGNIZANT NSF PROGRAM OFFICIAL FOR THIS GRANT IS JOHN MACCINI (202) 282-7033. THE COGNIZANT NSF GRANTS OFFICIAL IS KAREN L SANDBERG (202) 632-5940.

SINCERELY YOURS,

ENCLOSURES

Elmer G. Havens

Elmer G. Havens
Grants Officer

HOPE COLLEGE NEWS
HOLLAND, MICHIGAN 49423

OFFICE OF INFORMATION SERVICES: Van Raalte Hall, Room 104/Tom Renner, Director of Information Services/Office: (616) 392-5111, ext. 2030/Home: (616) 637-2892

FOR IMMEDIATE RELEASE October 1, 1979

HOLLAND, Mich. -- Hope College has been awarded a grant from the National Science Foundation (NSF) for the establishment of a microcomputer laboratory.

The laboratory, consisting of 10 microcomputer systems along with supporting equipment, will cost $20,630. The National Science Foundation will contribure one-half of this amount and Hope College the remainder.

The project will be directed by Dr. Elliot Tanis, chairman of the department of mathematics and Dr. Herbert Dershem, chairman of the department of computer science.

One of the uses of these computers will be to improve laboratory experiments in statistics courses. This is a continuation of work begun with support from an earlier NSF grant awarded to Hope College in 1971. As a result of that grant, Prof. Tanis has published a laboratory manual for probability and statistical inference and Prof. Dershem has published an exercise manual for computer-augmented applied statistics course. They plan, with the addition of this new equipment, to adapt this work done on large computer systems to micro-computers.

The laboratory will give Hope students exposure to the capabilities of microcomputers, to enhance classroom instruction in a variety of courses and to provide research equipment for computer science majors. Every Hope student and faculty member will have the opportunity to gain experience in the use of micro-

- more -

computers through this laboratory.

The College has been active in providing education in the use of microcomputers for the Holland community. Prof. John Whittle, along with professors Tanis and Dershem, have used microcomputers with elementary school children in the Quest program and in classroom demonstrations. A workshop in the use of microcomputers for 19 local elementary and secondary school teachers was offered last summer by professors Whittle and Dershem. With this new equipment the College will be able to continue and expand these activities for area students and teachers.

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D. C. 20550

SEP 14 1979

GRANT NO. SER-7914334
PROPOSAL NO. SER-7914334

DR GORDON VAN WYLEN
HOPE COLLEGE
HOLLAND MI 49423

THE NATIONAL SCIENCE FOUNDATION HEREBY AWARDS A GRANT OF $10,315 TO HOPE COLLEGE FOR SUPPORT OF THE PROJECT DESCRIBED IN THE PROPOSAL REFERENCED ABOVE.

THIS PROJECT, UNDER THE DIRECTION OF ELLIOT A TANIS, DEPARTMENT OF MATHEMATICS, IS ENTITLED:

"A MICROCOMPUTER LABORATORY FOR USE IN TEACHING STATISTICS."

THIS AWARD IS EFFECTIVE OCTOBER 1, 1979 AND EXPIRES MARCH 31, 1982. A 6 MONTH UNFUNDED FLEXIBILITY PERIOD IS INCLUDED IN THIS AWARD.

THIS GRANT IS AWARDED PURSUANT TO THE AUTHORITY OF THE NATIONAL SCIENCE FOUNDATION ACT OF 1950 (42 U.S.C. 1861 ET SEQ.) AND IS SUBJECT TO THE FOLLOWING TERMS AND CONDITIONS:

FL 118 GRANT GENERAL CONDITIONS (REV. OCT/78) AND SE 79-32.
IT IS UNDERSTOOD THAT THE GRANTEE WILL SHARE IN THE COSTS OF THE PROJECT IN THE AMOUNT OF AT LEAST 50% OF TOTAL PROJECT COSTS.

THE BUDGET INDICATES THE AMOUNTS, BY CATEGORIES, ON WHICH NSF HAS BASED ITS SUPPORT.

THE COGNIZANT NSF PROGRAM OFFICIAL FOR THIS GRANT IS JOHN MACCINI (202) 282-7033. THE COGNIZANT NSF GRANTS OFFICIAL IS KAREN L SANDBERG (202) 632-5940.

SINCERELY YOURS,

ENCLOSURES

Elmer G. Havens

Elmer G. Havens
Grants Officer

September 26, 1979

Mr. Elmer G. Havens
Grants Officer
National Science Foundation
Washington, D.C. 20550

Re: Grant #SER-7914334
Proposal #SER-7914334

Dear Mr. Havens:

Thank you for your letter of September 14. We were grateful to learn that the National Science Foundation has made a grant of $10,315 to Hope College for the program, "A Microcomputer Laboratory for use in Teaching Statistics." This grant will be of great help to us as we develop our program in Mathematics.

We accept this grant in accordance with the conditions outlined in your letter.

We ask that you extend our appreciation to all those who were responsible for making this grant available to Hope College.

Sincerely yours,

Gordon J. Van Wylen

GJVW:cam

bcc: Elliot Tanis
William Anderson

COPY

M E M O

DATE: January 4, 1980

TO: Herb Dershem

FROM: Sheldon Wettack

SUBJECT: Capital equipment expenditures

This memo constitutes approval for you to purchase the terminal for use in the Computer Science Department which was requested under capital equipment. Up to $1200 has been allotted for this purpose. When it is prepared please forward a purchase order to my office for final approval and designation of the account number.

I am assuming that, as you stated in the request, this terminal will be also utilized in the computer science laboratory and hence constitute a portion of our matching for the NSF-ISEP grant.

If you have any questions about this expenditure, please do not hesitate to contact me.

cc - Elliot Tanis✓

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Hope College Holland, MI 49423	ISEP	SER-7914334
	4. Award Period From 10/1/72 To 3/31/82	5. Cumulative Award Amount $10,315

6. Project Title

A Microcomputer Laboratory for Use in Teaching Statistics

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

Ten Radio Shack TRS-80 microcomputers were purchased to provide a laboratory setting for courses in statistics and for other mathematics courses. Two printers were purchased to provide hard copy for some of the output.

Computer based exercises and supporting computer software were developed for use in our statistics curriculum. The materials are being used in several ways. Students in Mathematical Statistics and Probability meet weekly in a laboratory setting and solve a variety of problems, including simulations and data analysis. These students write their own programs and thus gain a greater appreciation of theoretical concepts in probability and statistics. Also professors have used the materials to prepare demonstrations for students in lower level statistics courses. A third potential use of the materials is for undergraduate research projects.

The computers have also been used in our course for the liberal arts student, "The Nature of Mathematics." For many of these students, microcomputers provide a first hands-on exposure to computers. Fortunately microcomputers are very friendly for students who fear both mathematics and computers.

Student in the statistics laboratory have given positive evaluations to this type of educational experience. The opportunity to write simulation programs to illustrate theoretical concepts and then obtain immediate results at the computer is instructive and satisfying for them.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (√)	Approx. Date
a. Abstracts of Theses	√				
b. Publication Citations		√			
c. Data on Scientific Collaborators		√			
d. Information on Inventions	√				
e. Technical Description of Project and Results		√			
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Elliot A. Tanis		5/28/82

NSF Form 98A (5-78) Supersedes All Previous Editions

Form Approved OMB No. 99R0013

THE USE OF MICROCOMPUTERS FOR UNDERSTANDING CONCEPTS IN PROBABILITY AND STATISTICS

Elliot Tanis
Hope College
Holland, Michigan 49423
United States of America

To appear in the Abstracts booklet of the First International Conference on Teaching Statistics, University of Sheffield, Sheffield, England, 9-13 August 1982.

THE USE OF MICROCOMPUTERS FOR UNDERSTANDING CONCEPTS IN PROBABILITY AND STATISTICS

Elliot Tanis
Hope College
Holland, Michigan 49423
United States of America

Computers can be used in a variety of ways in the statistics curriculum. One way is to help students better understand basic concepts in probability and statistics. Two important ingredients are necessary to accomplish this:

(a) a good software package that makes effective use of the graphics capabilities of the computer,

(b) exercises and examples that have sound educational value.

Materials have been developed to accompany a year long course in mathematical statistics and probability. There are more than 200 exercises of varying degrees of difficulty. The supporting computer software includes subroutines for:

(a) depicting a histogram and/or an empirical distribution function with the option of superimposing the theoretical probability density function and/or distribution function, respectively;

(b) illustrating confidence intervals;

(c) scatter diagrams;

(d) giving values of important distribution functions and their inverses;

(e) simulating random samples from several distributions.

These materials can be used in a variety of ways. For example, all of the students in a class could be asked to solve the exercises by writing computer programs and, in so doing, gain a greater appreciation of theoretical concepts in both probability and in statistics. Or a professor and/or some students could solve an exercise and prepare a demonstration for a statistics class that is taught at any level. Or a student could use these materials as a part of an undergraduate research project.

Currently the software that has been developed is written in BASIC for the Radio Shack TRS-80 computer* We plan to make the necessary modifications so that the materials can be used with an Apple computer. An earlier version of this package is written in FORTRAN and can be used in either batch or interactive mode on most large computer systems. That package is distributed by CONDUIT, P.O. Box 388, Iowa City, Iowa 52240, USA.

To give some appreciation of the types of exercises and the graphical output, four examples are summarized and one figure is given for each.

Example 1. Simulate 200 observations of a binomial random variable X for which n = 11 and p = 0.6. Use the fact that X is the sum of 11 Bernoulli

* Ten Radio Shack TRS-80 computers were purchased with support from the National Science Foundation under Grant No. SER-7914334.

trials. Superimpose the binomial probability function on the relative frequency histogram of the observations of X. See Figure 1 for a typical solution.

Example 2. Illustrate empirically that the sum of two "random numbers," selected at random from the interval (0,1), has a triangular distribution. Superimpose the probability density function on the relative frequency histogram of 200 observations of sums of pairs of random numbers. See Figure 2.

Example 3. Simulate 50 random samples of size 10 from a normal distribution having mean $\mu = 40$ and variance $\sigma^2 = 12$. For each sample, calculate the endpoints for a 90% confidence interval for μ, assuming that μ and σ^2 are unknown, using $\bar{x} \pm 1.833s/\sqrt{10}$. The confidence intervals are depicted in Figure 3. A horizontal line is drawn at $\mu = PM = 40$.

Example 4. Simulate a random sample of size $n = 50$ from a bivariate normal distribution for which $\mu_X = 50$, $\sigma_X^2 = 36$, $\mu_Y = 70$, $\sigma_Y^2 = 64$, and $\rho = 0.75$. Figure 4 shows a scatter plot for such a simulation.

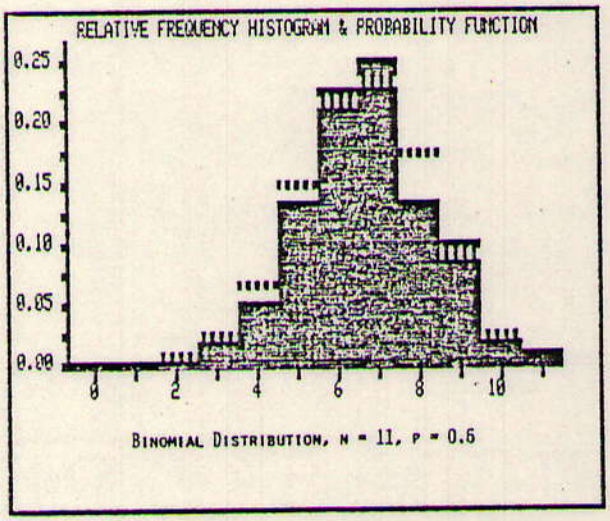


FIGURE 1

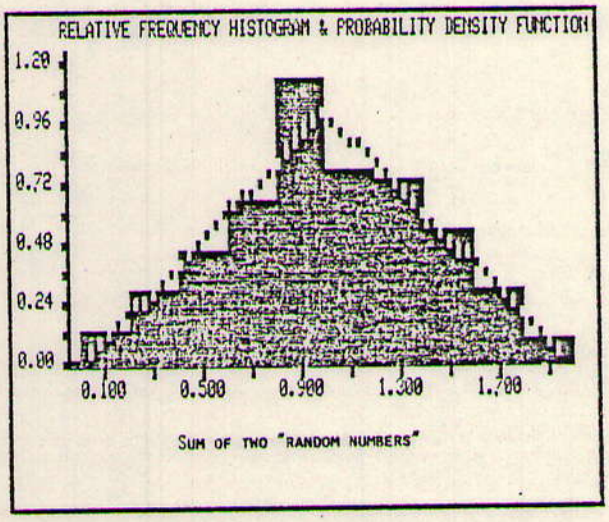


FIGURE 2

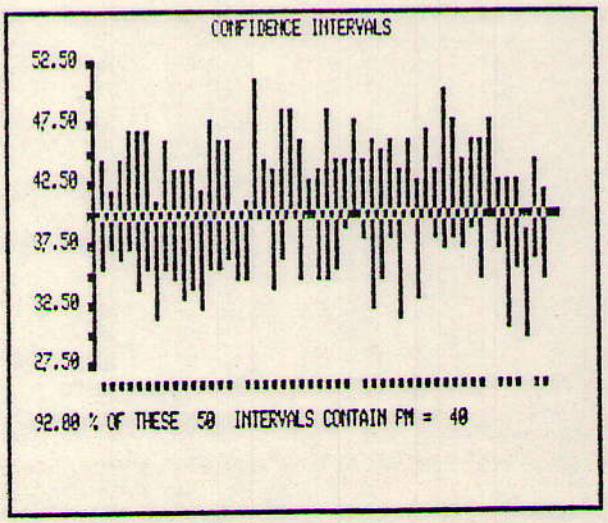


FIGURE 3

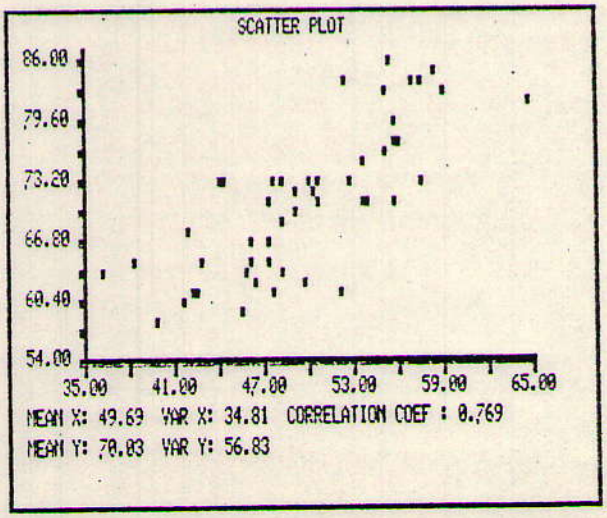


FIGURE 4

PART III - TECHNICAL INFORMATION

1.c. Data on Scientific Collaborators

Herbert L. Dershem
Professor of Mathematics and Computer Science
Hope College
Holland, MI 49423

1.e. Technical Description of Project and Results

The purpose of this project was to establish a microcomputer laboratory to enhance the learning of statistics. We purchased the proposed equipment and established a computer laboratory in a room in the college library. The college library is adjacent to the mathematics building. By having the laboratory in the library, we believed that it would be readily available to all of our students. This concept met with mixed success. Students did appreciate the availability of the computers. However because we did not continuously supervise the computers, we did have more equipment failures than we would have liked.

This coming year permanent space will become available in the mathematics building. Hope College has committed some of this space for the microcomputer laboratory and funds to supervise this laboratory.

Because of the availability of a microcomputer laboratory, we have been developing educational materials that make use of this equipment. Thus far good progress has been made in the development of materials for our statistics course.