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EXPERIMENTAL PROGRAM IN ENGINEERING AND DESIGN DATA PROCESSING TECHNOLOGY. FINAL REPORT.

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DESCRIPTORS- *JUNIOR COLLEGES, *COMPUTERS, *PROGRAMING, *EXPERIMENTAL PROGRAMS, *CURRICULUM EVALUATION, TECHNICAL EDUCATION, PROGRAM DEVELOPMENT, DATA PROCESSING, PROGRAM EVALUATION, NDEA, IBM PROGRAMMER APTITUDE TEST,

AN EXPERIMENTAL PROGRAM IN ENGINEERING AND DESIGN DATA PROCESSING TECHNOLOGY WAS UNDERTAKEN TO DEVELOP A PROPOSED CURRICULUM OUTLINE AND ADMISSION STANDARDS FOR OTHER INSTITUTIONS IN THE PLANNING OF PROGRAMS TO TRAIN COMPUTER PROGRAMMERS. OF THE FIRST CLASS OF 26 STUDENTS, 17 COMPLETED THE PROGRAM AND 12 (INCLUDING ONE WHO DID NOT GRADUATE) WERE EMPLOYED AS COMPUTER PROGRAMMERS, WHILE THOSE WHO ENTERED MILITARY SERVICE WERE ASSIGNED DIRECTLY TO DATA PROCESSING UNITS. OF THE 12 PROGRAMMERS, EIGHT WORKED IN BUSINESS RATHER THAN IN SCIENTIFIC APPLICATIONS. A FOLLOWUP STUDY SHOWED THE NEED FOR PROVIDING BUSINESS COURSES AND INSTRUCTION IN BUSINESS ORIENTED COMPUTER LANGUAGES, PLUS SOME WORK WITH A HIGH SPEED PRINTER AND MAGNETIC TAPE OR DISC STORAGE DEVICES. A PROGRAM IN BUSINESS ORIENTED COMPUTER SCIENCE WAS THEREFORE DEVELOPED. THE REPORT INCLUDES COURSE DESCRIPTIONS AND SEQUENCES FOR THE SCIENTIFIC AND THE BUSINESS PROGRAMS, A DESCRIPTION OF THE SELECTION TEST BATTERY, A FLOOR PLAN OF THE INSTRUCTIONAL FACILITIES, AND LISTS OF EQUIPMENT, TEXTBOOKS, AND INSTRUCTIONAL MATERIALS. (WO)

FINAL REPORT

Experimental Program

In

Engineering And Design

Data Processing Technology

The Williamsport Area Community College

Williamsport, Pennsylvania

May 1966

FINAL REPORT

EXPERIMENTAL PROGRAM

IN

ENGINEERING AND DESIGN

DATA PROCESSING TECHNOLOGY

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May 1966

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I. INTRODUCTION

Through advancement in electronics and computer technology, computers have become cheaper, more compact, faster, and more versatile. Such progress has led an increasing number of industries and business firms to purchase computers. Consequently, the demand for trained personnel to operate and program computers has risen at an alarming rate. The present state of affairs is aptly described in the October 1965 newsletter of the U.S. Department of Health, Education and Welfare.

> "Programers Needed: The shortage of computer programers is becoming so acute that many users are prevented from using their computers to the fullest advantage, according to Carl Reynolds of IBM. Already about 25,000 more programers are needed to efficiently handle the nation's computers, and the deficit is likely to grow as computer sales continue advancing at the rate of 15 to 20 percent yearly. To combat this shortage, several computer manufacturers are setting up training programs for themselves and their customers and private academic institutions are expanding courses in data processing."

An attempt to answer the situation has also been made by various industries; however, such programs are generally designed to meet the needs of the particular industry. Despite all the efforts to remedy the situation the demand far exceeds the supply.

The above state of affairs represents a definite challange to education. Community Colleges and vocational-technical schools can help meet this challange by offering two year, post-high school courses in computer science to provide trained personnel on the technician level.

The Williamsport Area Community College, formerly the Williamsport Technical Institute, answered this need by instituting an experimental program in Engineering and Design Data Processing Technology in October 1963 supported by federal funds under the NDEA, title VIII program. This experimental program was undertaken to develop a proposed curriculum outline and admission standards to serve as a guide for other institutions wishing to initiate a similar program. This report presents a detailed description and evaluation of the equipment, course content, instructional methods, course objectives, student selection procedures, and staff which were used through the two years of the experimental program in Engineering and Design Data Processing.

II. METHOD

STAFF

Advisory Committee

The first step in developing a curriculum in Engineering and Design Data Processing was the establishment of an advisory committee* consisting of managers of data processing, engineers, mathematicians, systems analysts, or programing managers.

The role of the advisory committee was to aid and advise in the following matters:

1. Selection and purchasing of equipment.
2. Setting up an adequate and efficient laboratory layout.
3. Establishing course objectives; i.e., defining the technical skills and knowledge deemed necessary for an engineering and design data processing technician.
4. Construction of an adequate course of study; i.e., what subject matter to be included (courses), the content of these courses, and the sequence of courses.

*Those individuals who comprise the advisory committee are listed, together with the industries they represent, in Appendix A.

5. Selection of texts, audio-visual aids and other teaching materials.

6. Admission standards; i.e., in reference to type of academic background, particularly in the area of mathematics.

A series of meetings were held in which the above matters were explored and discussed with certain resulting recommendations which will be indicated in various sections of this report.

Technical and Academic Staff

On the recommendation of the advisory committee a man was selected to head the computer science department whose background included graduate work in computer technology and attendance at several IBM educational centers. This individual also taught the technical courses in computer operation and programing and the related mathematics courses.

The other course material (i.e., drafting, English, science and business courses) were taught by certified teachers in the respective departments of The Williamsport Area Community College (formerly, the Williamsport Technical Institute). It should be noted that the available facilities of this institution with respect to both equipment and instructors in technical and academic departments made it unnecessary to obtain any other teachers at the inception of this course.

Psychological Services

The head of the Psychological Services Department, a certified Psychologist with many years of experience in the administration and interpretation of psychological tests as well as in test construction, served as an advisor in the establishment of student selection procedures.

A suitable battery of aptitude tests were assembled and recommendations were made as to a desirable educational background to be sought in the applicant for this course.

The Psychological Services Department also assumed the responsibility for the statistical evaluation of the test battery and the establishment of norms for the tests used in the selection procedures.

STUDENT SELECTION

The procedure for selecting students involved certain requirements from the high school background, acceptable scores from a battery of aptitude tests, and a personal interview.

Educational Background: With respect to educational background the following minimum requirements were established:

1. high school graduate
2. one year of algebra
3. one year of geometry preferred but not required

Entrance Test Battery: The following comprised the battery of aptitude tests used in student selection:

1. Personnel Research Institute Classification Test, Form A (1954 Revision), Personnel Research Institute, Western Reserve University, Cleveland 6, Ohio.

This test provides a measure of general mental ability and consists of 100 multilpe choice items of approximately uniform difficulty covering vocabulary. arithmetic, general information, and verbal analogies.

2. Revised Minnesota Paper Form Board, Form AA. The Psychological

Corporation, 1948.

This test provides a measure of the ability to perceive spatial relations. It is particularly useful in predicting success in fields involving design.

3. Williamsport Area Community College Test of Mathematical Aptitude. Unpublished Test. The Williamsport Area Community College, Williamsport, Pennsylvania.

A test constructed in 1956 for the purpose of providing a better estimate of mathematical ability than the existing published tests in order to meet the needs of this particular educational institution.

4. Revised Programmer Aptitude Test. International Business Machines Corporation, 1959.

This test is composed of number series, figure analogies, and arithmetic reasoning and is intended as an aid in selecting individuals for training as computer programers.

5. Test of Mechanical Comprehension, Form AA. The Psychological Corporation, 1940.

This test is designed to determine an individual's ability to perceive and apply mechanical principles.

Stanine Scores: The original group of applicants for the Engineering and Design Data Processing course were given the above five tests. From the distribution of scores on each of the five tests a set of norms, in terms of stanine scores was constructed. Then, the five stanine scores were summed to yield a total stanine score for each individual.

More recently an applicant has been required to reach a total stanine score of 25 or higher, with a stanine score of not less than three on any one of the tests, in order to qualify for the computer science course. Initially, students were accepted even though their total stanine score was less than 25.

Since the original stanine distributions were computed, a recalculation has been performed using all the test scores of individuals who have been tested for the data processing course. Even with the enlarged sample size the newly computed stanine distributions were essentually the same as the original norms. Such a finding lends confidence to the stability of the initial stanine distributions. For the reader's reference the stanine distributions for each of the five tests are presented in Appendix B.

Evaluation of the Test Battery: The adequacy of a test battery for choosing students for any educational endeavor must be how well it will predict success in that course. An evaluation of the present test battery was made by performing a series of intercorrelations among the aptitude tests, total stanine score, and academic achievement. Table I presents the intercorrelations as well as the mean scores and standard deviations for the test scores, total stanine scores, and achievement.

TABLE I

	Intercorrelations of Test Battery								
	Mech Comp.	P.F.B.	Math	Class	Prog. Apt.	Total Sta.	Achiev.	Mean	Std. Dev.
Mech C.	.	.15	.19	.42	.36	.65	.33	41.00	6.92
P.F.B.	.15		-.03	.03	.32	.42	.20	43.33	8.54
Math	.19	-.03		.36	.42	.61	.31	33.20	6.31
Class.	.42	.03	.36		.42	.68	.32	68.11	12.34
Prog. A.	.36	.32	.42	.42		.79	.57	35.67	11.80
Tot. Sta.	.65	.42	.61	.68	.79		.55	26.48	6.34
Achiev.	.33	.20	.31	.32	.57	.55		82.04	7.08

N = 46

It should be noted that the sample size for this evaluation was 46. This figure was obtained by combining the scores of students of both the original class in engineering and design data processing and the second class which started a year later. Such a procedure provides a sample of sufficient size to permit the confident use of statistical analyses. Achievement here, represents grades (recorded as percentages) from the same subject matter taken by both the first and second classes during their respective first year of coursework.

From an inspection of Table I it may be noted that the correlations between the entrance tests (raw scores) and achievement range from .20 to .57. The total stanine score was inserted into the matrix of intercorrelations because it had developed into a major method in student selection. The correlation between the total stanine score and achievement was found to be .55.

A regression analysis was also completed using the raw scores from the five entrance tests as predictor variables and achievement as the criterion variable. This analysis revealed that the programmer aptitude test provided by far the largest contribution in prediction with mechanical comprehension showing the second highest loading and the remaining three tests yielding very slight weightings. The multiple correlation coefficient between the combined effect of the five predictor variables and achievement was .59, only a slight improvement over the programmer aptitude test alone.

The major conclusion of this analysis is that the IBM Programmer Aptitude Test is the best single indicator of performance in the computer science course. Other tests may be added to the battery in accordance with the objectives of the curriculum.

OBJECTIVES

The Engineering and Design Data Processing Technology curriculum is designed to provide an understanding of the equipment and the concepts, principles, systems and techniques involved in data processing, with emphasis upon scientific applications. The curriculum also includes sufficient academic and related material to fortify the student's computer training and give him the background necessary for him to be immediately employable and to progress in the field.

This program will prepare the successful student for the following:

1. Apply standardized mathematical formulas, principles and methodology to technical problems in engineering and physical science in relation to specific industrial, commercial, and research objectives, processes, equipment and products.

2. Analyze and reduce data to meaningful and manageable terms consistant with project objectives.

3. Select most economical and reliable combination of processing methods, systems and equipment.

4. Confer with professional, scientific and engineering personnel to determine objectives, conditions and delineation of problems.

5. Write technical reports and draw charts and diagrams to record data processing procedure used, results, conclusions and translation for subsequent interpretation and application by professional scientific personnel.

Although the curriculum places emphasis on scientific application, the students are capable of similar performances on business applications.

COURSE SEQUENCE

At the time of conception of the Engineering and Design Data Processing Technology course, the former Williamsport Technical Institute was operating on a twelve month school year. This school year was divided into six, eight-week terms. Each school day was composed of five, seventy-minute periods and the students were required to be in attendance a minimum of 230 hours per term.

Following is the course of study as designed by the instructional staff and advisory committee for this experimental program:

FIRST YEAR

Term I

Course	Hours
Written Communications	46
Chemistry, General	46
Math.I - Basic Algebra	46
Basic Data Proc. Machines I (Unit record machines)	46
Lab.*	46

Term II

Course	Hours
Oral Communications	46
Business Machines	46
Math.II - Basic algebra	46
Basic Data Proc. Machines II	46
Lab.	46

*Laboratory hours are used as supplemental time for student projects and exercises on data processing and computer equipment.

Term III

Course	Hours
Accounting	46
Math.III - Adv. algebra	46
Basic Computing Systems	92
Lab.	46

Term IV

Course	Hours
Principles of Business	46
Math.IV - Adv. algebra	46
Symbolic Programming I	46
Lab.	92

Term V

Course	Hours
Graphics I	92
Math.V - Adv. algebra	46
Symbolic Prog. II	46
Lab.	46

Term VI

Course	Hours
Graphics II	46
Math.VI - Trigonometry	46
Algebraic Prog. I	46
Lab.	92

SECOND YEAR

Term VII

Course	Hours
Physics I - Mechanics	46
Math.VII - Matrix Theory	46
Algebraic, Prog. II	46
Lab.	92

Term VIII

Course	Hours
Physics II - Electricity, heat, light	46
Math.VIII - Analysis of functions	46
Applied Technical Prog.	46
Lab.	92

Term IX

Course	Hours
Electronics and Instrumentation	46
Math.IX - Intro. to Calculus	46
Advanced Programming	46
Lab.	92

Term X

Course	Hours
Economics and Job Procurement	46
Math.X - Calculus	46
Numerical Methods	46
Lab.	92

Term XI

Course	Hours
Math.XI - Calculus	46
Systems Development	46
Programming Systems	46
Lab.	92

Term XII*

Course	Hours
Math.XII - Calculus (optional)	46
Field and Research	138
Lab.	46

*A student needed 2650 hours to graduate. However, it was the policy of the Williamsport Technical Institute to allow the student to acquire employment and obtain the last 10% of his time on-the-job. Consequently, the last term was left open to accommodate the student in this respect.

COURSE DESCRIPTIONS

Written Communications - 46 hours

Basic principles of technical report writing; grammar, composition, effective writing techniques, gathering data, first draft, proofreading.

Oral Communication - 46 hours

Basic course in the organization of oral reports with emphasis on the fundamentals of speech. Speech practice and evaluation are stressed.

Economics and Job Procurement - 46 hours

Fundamentals of American capitalism, labor management, relationships, real estate and concepts of job interviewing with application and resume' writing.

Business Machines - 46 hours

Use and operation of basic business machines which are found in any business office; ten-key adding - listing, full-keyboard adding-listing, rotary calculators, key driven calculators.

Accounting - 46 hours

A study of the basic accounting principles to develop an understanding of the elements of accounting, preparation of statements and reports and interpretation of them as they apply primarily to the proprietorship and partnership forms of business.

COURSE DESCRIPTIONS

Principles of Business - 46 hours

This course provides the student with a basic understanding of business procedures and the various roles of business in our American economic system.

Physics I - Mechanics - 46 hours

A lecture, demonstration, problem solving course in elementary mechanics. Includes basic concepts of scientific method, metric system, vectors, motion, work energy, liquids, solids and gases.

Physics II - Electricity, heat, light - 46 hours

Fundamental concepts of electrostatics, electrolysis, AC and DC circuits, magnetism and electromagnetic induction.

Chemistry - 46 hours

Lecture, demonstration course covering the basic concepts and principles of chemistry.

Graphics I, II - 138 hours

Theory and drawing on: geometric construction, orthographic projection, auxiliary projections and developments, true lengths and revolution of points, lines, planes and solids.

Electronics and Instrumentation - 46 hours

Lecture-demonstration course in electronics and principles of electro-mechanical instruments; sensing elements, indicators, recorders, controllers, mechanisms, etc.

Math I, II - Basic Algebra - 92 hours

Review of the elementary topics in algebra; equations, formulas, fractions, linear equations, polynomials, factoring, quadratics, irrational numbers and right triangle.

Math III, IV, V - Advanced Algebra - 138 hours

Topics in advanced algebra; equations and inequalities, factored forms, fractions, irrational numbers, functions, exponents and logarithms, coordinate geometry, graphs, sequences and series.

COURSE DESCRIPTIONS

Math VI - Trigonometry - 46 hours

Elementary and advanced study in trigonometry; includes solution of right and oblique triangles, functions of the general angle, reduction formulas, radian measure, identities, trigonometric equations and inverse functions.

Math VII - Matrix and Determinant Theory - 46 hours

Introductory course in matrices and determinants. Topics include multiplication and division of matrices, scalars, vectors and linear equations, evaluation of determinants, cofactors, adjoint matrix and inversion.

Math VIII - Analysis of functions - 46 hours

Basic course in the analysis of functions. Topics include sets, inequalities, absolute values, functional notations, limits of a function, continuity and delta-episilon techniques.

Math IX, X, XI, XII - Calculus - 184 hours

Basic courses in calculus. Topics include rate of change, differentiation, integration, transcendental functions, hyperbolic functions and polar coordinates.

Basic Data Processing Machines I, II - 92 hours

Theory and practice on unit record systems including wiring, operation and machine functions of card punch, verifier, interpreter, sorter, reproducer, collator and accounting machine.

Basic Computer Systems - 92 hours

Introduction to basic computer systems and components, programming logic, flow charting, machine language, program writing and testing.

Symbolic Programming I, II - 92 hours

Introduction to Symbolic Programming Systems with applied problems. Includes program flow charting, writing, testing, debugging, and documentation. This course emphasizes the acquisition of sound programming techniques.

Algebraic Programming I, II - 92 hours

Fortran programming as applied to engineering, mathematics and business problems. Utilization of an X-Y plotter to various types of these problems.

COURSE DESCRIPTIONS

Applied Technical Programming - 46 hours

Training in the application of computers to such technical areas as numerical control and civil engineering utilizing plotter system and numerical controlled point-to-point drilling machines. Characteristic of such language as AUTOSPOT, COGO, etc.

Advanced Programming - 46 hours

Continuation of Symbolic Programming with advanced business applications. Topics include: accounts receivable, accounts payable, inventory control, subroutines, tape system, random access, timing and macro programming.

Numerical Methods and Programming - 46 hours

Basic understanding of the various methods for numerical solution of functions and problems in mathematics and engineering. Concepts of calculus, matrix and statistics studied thus far are applied to the computer solution of problems.

Systems Development - 46 hours

This course is designed to guide the student through the stages in the evolution of a complete system: analysis, system specifications, equipment selection, flow charting, programming, testing, documentation and implementation of the system. Solution of advanced problems from conception to documentation.

Programming Systems - 46 hours

Analyzing and evaluating the concepts of various programming systems to familiarize the student with their purpose, use and function. Topics include: assembly programs and compilers, macro-generators, report generators, utility programs, sort-merge, monitor and I/O control.

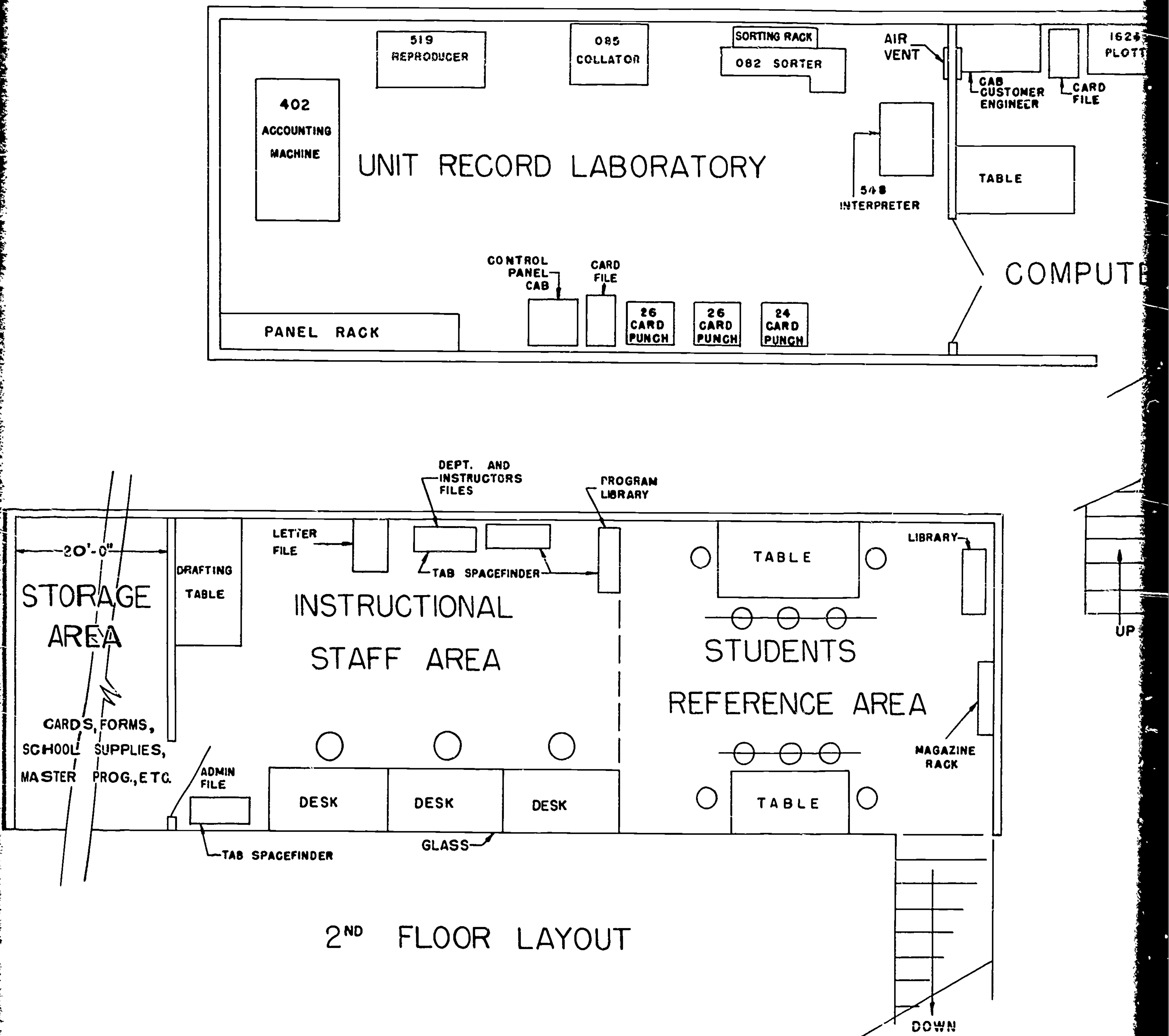
Field and Research - 138 hours

Assignment to a local industrial data processing installation to acquaint the student with the practical aspects of data processing. Student's performance is evaluated during this period by the local installation and the educational staff.

CLASS ROOM & LABORAT

COMPUTER SCIENCE DEPARTM

ENGINEERING AND
DESIGN DATA PROCESSING
SCALE 1/4"= 1'0"

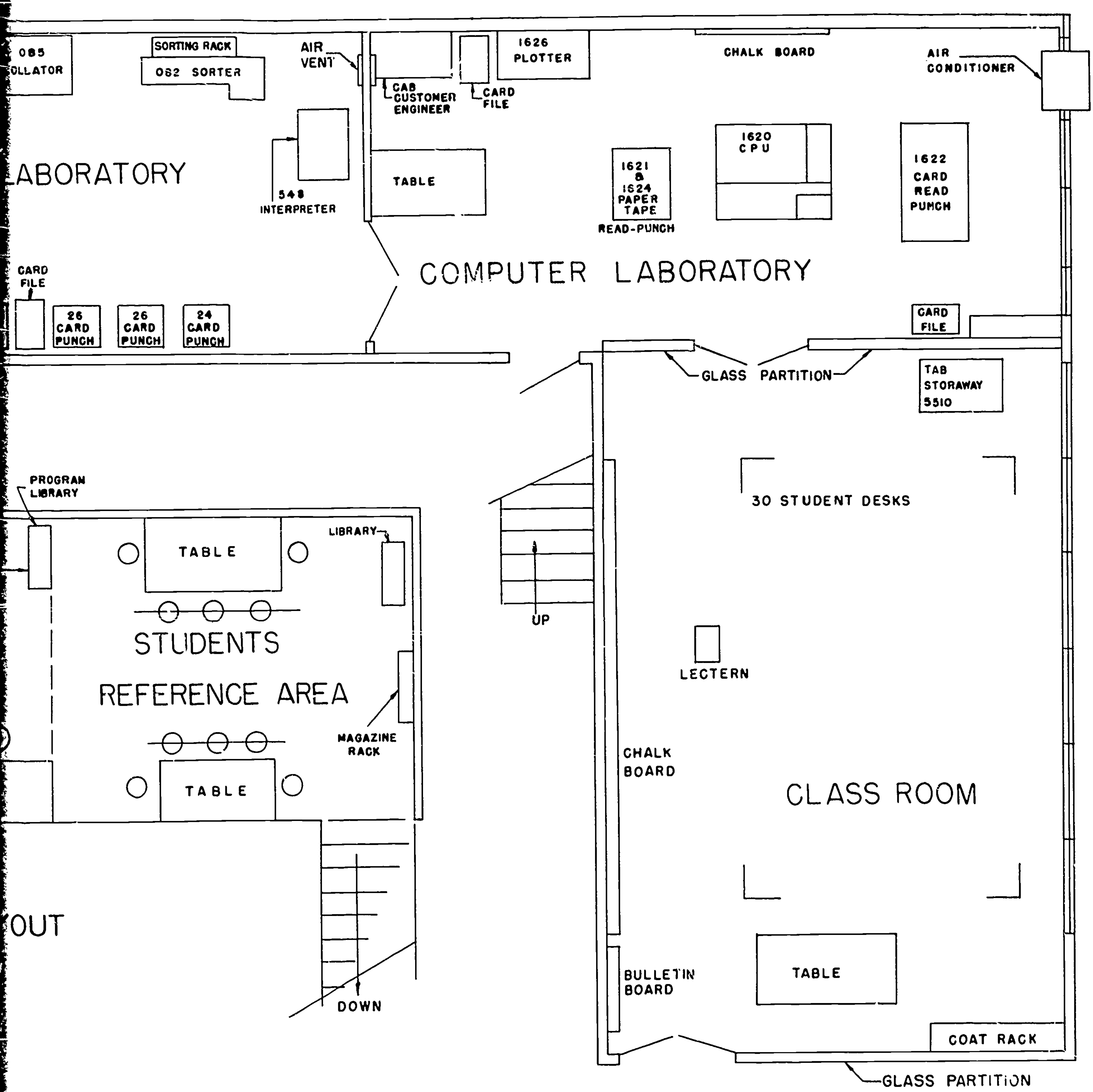


2ND FLOOR LAYOUT

CLASS ROOM & LABORATORY
COMPUTER SCIENCE DEPARTMENT

ENGINEERING AND
DESIGN DATA PROCESSING

SCALE 1/4" = 1'0"



MATERIALS AND EQUIPMENT

EQUIPMENT USED FOR THE ENGINEERING AND DESIGN DATA PROCESSING CURRICULUM

COMPUTER SYSTEM

Manufactured by International Business Machines:

Quantity	Model	Description
1	1620-1	Central Processor (with indirect addressing, automatic divide and additional instruction feature)
1	1622	Card Read Punch
1	1621	Paper tape reader
1	1624	Tape Punch
1	1626	Plotter

Unit Record Equipment - Manufactured by: International Business Machines:

2	026	Card Punch
1	024	Card Punch
1	082	Sorter
1	402	Accounting Machine
1	085	Collator
1	519	Reproducer
1	548	Interpreter
1	5011	Mark Sense

Miscellaneous Equipment - Following obtained from TAB Sales of Pennsylvania:

1	1531	14 drawer card file
2	1661	20 drawer card file
1	5510	storaway cabinet
1	3407	sorter rack
1	1010	control panel rack
2	3409	card auxiliary rack
5	4404	document cabinets
1	80	machine tool cabinet
3	1825	posture chairs
2	5565	plastic wire trays
1		run book holder
30	402	control panels
14	548	control panels
15	519	control panels
10	085	control panels
30		complement of various size wires

EQUIPMENT AND MATERIALS

COMPUTER SYSTEM (continued)

Obtained from International Business Machines:

Quantity	Model	Description
1		selectric typewriter

Obtained from Phillips Office Supply Company:

1		executive steel desk
1		Clary 10-key electric adding machine

Obtained from school shop or supply room or from government surplus:

Quantity	Description
1	drafting table
2	wood desk
2	letter filing cabinets
1	coat rack
1	wood control panel rack
4	wood tables (3' x 6')
1	air conditioner
30	student desks and chairs
1	3 shelf magazine rack

TEXT MATERIALS

Textbooks - Data Processing

Reference Manual - IBM 082 Sorter - International Business Machines Corp.
" " - IBM 024,026 Card Punch - " " " "
" " - IBM 402,403,419 Accounting Machine - International Business Machines Corp.
" " - IBM Functional Wiring Principles - International Business Machines Corp.
" " - IBM Operators Guide - International Business Machines Corp.
General Information Manual - Introduction to IBM Data Processing Systems - International Business Machines Corp.

Textbooks - Data Processing (continued)

Reference Manual - IBM 1620/1710 Symbolic Programming System - International Business Machines Corp.

Reference Manual - 1620 Fortran (with format)- " " " "
" " - COGO I - " " " "
" " - Autospot II - " " " "

Leeson & Dimitry - Basic Programming Concepts and the IBM 1620 Computer - Holt, Rinehart and Winston

Germain - Programming the IBM 1620 - Prentice-Hall
Anderson - Basic Computer Programming - Appleton-Century-Crofts
Organick - A Fortran Primer - Addison-Wesley
Laden & Gildersleave - System Design for Computer Applications - Wiley
McCracken & Dorn - Numerical Methods and Fortran Programming - Wiley
Fisher & Swindle - Computer Programming Systems - Holt-Rinehart-Winston

Textbooks - Mathematics

Weeks & Adkins - First Course in Algebra - Ginn
" " - Second Course in Algebra - Ginn
Smith - Limits and Continuity - Macmillan
Schwartz - Introduction to Matrices and Vectors - McGraw-Hill
Schwartz - Analytic Geometry and Calculus - Holt-Rinehart-Winston

Other Textbooks

Effective Revenue Writing I and II - U.S. Superintendent of Documents
French & Vierck - Graphic Science - McGraw-Hill
Bieser - Mainstream of Physics - Addison-Wesley
Grob - Basic Electronics - McGraw-Hill
Dull - Modern Chemistry - Holt-Rinehart-Winston
Price, Musselman & Weeks - General Business for Everyday Living - Gregg Div. of McGraw-Hill
Carson, Sherwood & Boling - College Accounting - South Western
Goodfellow & Agnew - Key Driven Calculator Course - South Western
" " - Rotary Calculator Course - " "
" " - 10 Key Adding-Listing - " "
" " - Full Key Board Adding-Listing - " "
Hailstones - Basic Economics - South Western

Students' Reference Area

It is the philosophy of the Computer Science Department that the students have a ready access to reference material and also be exposed to professional literature.

Because of the specialized nature of the reference materials and the need for continuous accessibility, a book library was provided for the students. This library contained a fine selection of books on data processing, mathematics and manufacturers' equipment.

In addition to the book library, the department maintains an indexed program library for student reference. Copies of programs and their documentations obtained from IBM and other companies as well as programs written by the students made up this particular library. It should be noted that the students shared the responsibility of maintaining this library and that no student's program would be added unless it was completely documented as prescripted by the department.

To encourage professional reading and to offer the current literature in data processing, a magazine area was provided which included periodicals and encyclopedias pertinent to this field. Following is a list of the subscribed material:

Name	Publisher
"Computers and Automation"	Berkeley Enterprises
"Datamation"	F. D. Thompson Publications
"Data Processing System Encyclopedia"	American Data Processing, Inc.
"Automated Education Handbook"	Automated Education Center
"Data Processing for Education"	American Data Processing, Inc.
"Data Processor"	IBM

We found that this student reference area is an invaluable aid for the students in preparing assignments and reports, as reference source for the solution of problems and the study of equipment not available at the school.

INSTRUCTIONAL METHODS

Training Materials and Aids

Films - Data processing and allied films were shown to the students approximately one period per week. Some of the more instructional and interesting films are as follows:

International Business Machine Corp.

"The Next Step"
"The Information Machines"
"The IBM 1428 Alphameric Optical Reader"
"Data Processing for Hospitals"
"What is EDP"
"Search at San Jose"
"Next Step"
"Disks that are a Cylinder"
"How to Succeed at Cards"
"By the Numbers"

Burroughs Corp.

"More than Miraculous"
"Program for Progress"
"Mark of Computence"
"The First Alert"

National Cash Register Co.

"The National 390"
"An EDP Site-seeing Tour"

General Electric

"This is Automation"

Films (continued)

Systems Development Corp.

"Programming Languages"
"Computer Programming"

Univac Division of Sperry Rand Corp.

"Then and Now"
"Numerical Control - Solid State"
"Introduction to Digital Computers"
"Decisions, Decisions, Decisions"
"Census Sixty"
"Automation in Air Traffic"
"Truck Route to Better Records"

Bell Telephone

"Memory Devices"

Training Aids

The Williamsport Technical Institute was very fortunate in having an excellent Graphics Arts department which kept the Computer Science department well supplied with the following necessary forms and reference materials:

- Machine language coding sheets
- SPS coding sheets
- Fortran coding sheets
- Cogo coding sheets
- Autospot coding sheets
- Memory maps
- Flow charting sheets
- Card layout forms
- Program Documentation Write-up Sheets
- 1620 operation instructions
- 1620 reference cards
- Autospot Reference Manual
- Cogo Reference Manual
- Pert Reference Manual
- Student exercises

Where applicable, permission to reproduce the above material was obtained from IBM.

The instructional staff was able to obtain certain machine components, devices and documents which they used as aids in their various lectures.

Training Aids (continued)

These include: a Heath Kit Analog Computer, cores and core planes, integrated circuit, reading brushes, magnetic tape, binary number circuit demonstrator and an assortment of cards and system flow charts for various industrial installations.

Field Trips

We have found that field trips to various industrial data processing installations were very inspiring to the students and greatly fortified the learning process. These field trips afforded the student the opportunity to observe the procedures, control, system layout and operation of the industrial installations as well as viewing the hardware of different manufacturers. On many occasions the hosts presented lectures, discussions and films on their specialized applications and any unique features of their system. Following is the list of field trips taken by the experimental group:

Bell Telephone - Data Communication Displays - Williamsport, Pa.
Darling Valve Manufacturing - Williamsport, Pa.
School District Data Processing Center - Williamsport, Pa.
Avco Manufacturing (accounting data processing) - Williamsport, Pa.
Computational Center - Penn State University - University Park, Pa.
HRB - Singer - State College, Pa.
IBM Corp. - Endicott, N. Y.
Avco Manufacturing (numerical control machine) - Williamsport, Pa.
Northern Central Bank - Williamsport, Pa.
Pennsylvania Power and Light - Allentown, Pa.
Bethlehem Steel Corp. - Bethlehem, Pa.
West Branch Data Processing Assoc. - Business Show - Williamsport, Pa.

GUEST LECTURERS

The experimental program was very fortunate in having a well informed, progressive and cooperative advisory committee. Several of the committee

GUEST LECTURERS (continued)

members, notably, Messrs. Chester D. Wolfe, Wayne Gephart, Floyd Roller have availed themselves to addressing the class relative to their areas of specialty.

In addition, Sales and Systems Representative, Customer Engineers and various forms representatives were invited to have discussions with the class.

The students were very receptive to the guest lecturers, who were able to satisfy the students' inquisitive minds and their anxieties of the hard-core facts of industrial and governmental employment.

STUDENT INSTRUCTION AND EVALUATION

The Computer Science instructional staff, academic instructors who were involved with the experimental group and the advisory committee together or in subgroups, prepared the tentative course outlines and study guides. However, each instructor was free to decide on the actual units of instruction, time to devote to each topic, necessary supplemental material, preparation of exercises and exams and the proper applications of the concepts outlined in the curriculum. These educational guides were reviewed, modified and saved for subsequent use.

It is the philosophy of the Computer Science Department that the students should get as much "hands-on" experience as possible. For this reason the instructional staff emphasized performance and programming skill. The students were rewarded according to the quantity and quality of exercise submitted and not on note memorizations and the manipulation of examinations.

STUDENT INSTRUCTION AND EVALUATION (continued)

Exams and quizzes were used principally for diagnostic purposes.

Each computer science course consisted of several lecture sessions and a number of laboratory hours. During the lecture sessions the instructor presented new topics and an explanation of the assigned laboratory exercises. The laboratory time was devoted to solution of problems, program preparation and execution and machine operation. The labs were under supervision of the instructor who in most cases was able to give individualized instruction.

The laboratory exercises were carefully selected or designed by the department to offer a concise continuity of material and a progressive degree of difficulty and sophistication. Every exercise was required to be completely documented - description, I/O, operational, requirements, math, development, hand computation, flow chart, program listing - before submitted to the instructor for evaluation and grading. The students usually submitted between 15 to 20 exercises for the basic course (term 1-8) and 2 to 5 for the more advanced courses.

The instructional staff encouraged the students to help each other and to submit extra exercises for additional grade credit.

The Computer Science Department was able to work in close harmony with other departments of the school. The machine shop's Pratt-Witney, tape - o-matic N/C drilling machine was used to process AUTOSPOT exercises which allowed the student to actually produce a finished machined piece.

STUDENT INSTRUCTION AND EVALUATION (continued)

The drafting and civil technology departments supplied drawings and line surveying data for processing with the plotter and COGO program systems.

LABORATORY EXPERIENCE AND SCHEDULING

Since every student was required to process his own programs, machine time is a prime concern to all. As is generally the case, ambitious and eager students tend to monopolize the machines. To assure that all students had an opportunity on the computer, a schedule was inaugurated which required a student to sign up for computer time. This schedule prevented the students from using the computer for more than twenty minutes at any one time during the regular school hours. However, the students had open access to the computer lab after school hours until 10:00 P.M. when school closed.

A computer log was maintained which required the computer operator to submit a time card after use of the machine. This log provided the department with information on the computer use and student activities.

All students took their turn on the daily clean-up crews and in processing any departmental or school administrative jobs.

FOLLOW-UP INVESTIGATION OF GRADUATES

It was felt that useful information could be obtained by carrying out a follow-up study of the graduates of the experimental program in engineering and design data processing. This was done by preparing an outline showing the outcome of the students, both graduates and non-graduates, who returned questionnaires and from the employers of the graduates.

The following outline illustrates what has happened to the first class:

Graduates (17)

Obtained job as computer programmer (business applications)	7
Obtained job as computer programmer (scientific applications)	4
Military service (direct assignment to data processing unit)	3
Military service (reserves - six months active duty)	1
Continued education (college)	2
	17

Non-Graduates (9)

Obtained job as computer programmer after one year of schooling (business application)	1
Transferred to another course (electronics)	2
Entered college	1
Terminated for academic deficiency	3
Other	2
	9

It should be noted that of the 12 who obtained jobs as computer programmers (11 graduates, one non-graduate) only four were in scientific applications as opposed to eight in business. This fact lends support to the anticipation that some of the graduates of the engineering and design data processing course might procure jobs in the business field.

As a means of evaluating the adequacy of the experimental course information was received from: (1) questionnaires sent to graduates concerning the nature of their particular job and the adequacy of their training for the present job, and (2) letters sent to the employers of the graduates of the experimental program regarding the adequacy of the training of the graduates in relation to meeting the needs of the particular employer.

Of the questionnaires sent to the 17 graduates ten were returned. Three of the ten graduates who returned their questionnaires were unable to fill them out because they were either continuing their education or had recently entered the military service and hence, were not working in the data processing field at that time. This leaves seven questionnaires from which useful information was obtained. It is obvious from the small sample size that a qualitative rather than a quantitative approach be made in analyzing the information supplied by the questionnaires.

The answers to some of the items on the student questionnaire were too diverse to yield even tentative conclusions. In part, this reflects the variety of positions obtained by the graduates. The following summarizesthe findings of those items which provided the most helpful information with respect to the adequacy of the experimental course.

The major emphasis of the experimental program, as the title implies, was toward scientific applications; consequently, those graduates who indicated that their training had been adequate obtained jobs in the scientific field. Those who contended that their training had not been sufficient were, without exception, graduates who procured jobs in the business field and therefore, felt a need for more business courses and business oriented computer languages. This deficiency has been largely overcome through the development of a curriculum for business applications of computer programing. The reader may consult Appendix C for the outline of the business computer science course presently being offered at the Williamsport Area Community College.

The I.B.M. 1620 was considered to be a good training machine by the students who later got jobs where 1620 was used. Those graduates who indicated that another computer would be better for training purposes were using a different computer in their job. Relevant to this discussion is some information acquired from both the questionnaire returns and from various other sources. It was learned that only four of the 15 original class members who are currently working in data processing are actually working on a 1620. The remaining eleven are working with other computer systems. The 15 class members referred to in the above passage include the one non-graduate who obtained a job, the eleven graduates who found jobs, and the three graduates who received direct assignments to data processing units in the military service.

When asked whethter they felt the equipment used in the course was sufficient the responderts were unanimous in their recommendation that magnetic tape and/or disc storage devices together with high speed printers be added.

As a further attempt to gain feedback on the adequacy of the experimental program, letters were sent to the employers of the eleven graduates who found jobs. Six employers answered the request; however, the consensus of opinion was that the graduates had not been working long enough such that a fair judgement of their capabilities and training could be made. These employers did indicate that in the two to three months in which the graduates were in their employ each had lived up to the company's expectations and that, upon request, they would prepare an evaluation after at least six months had transpired.

In summary, the student questionnaire and employer's evaluation have produced only scanty information concerning the adequacy of the experimental course in engineering and design data processing. The most important findings with respect to course improvement were:

(1) the need for a high speed printer along with magnetic tape and/or disc storage devices,

(2) the importance of including more business courses and business oriented computer languages in the curriculum in order to provide better background for those students who may eventually obtain jobs in the business field.

It is anticipated that as more students graduate and acquire jobs, data from student questionnaires and employer's evaluations will continue to accumulate and form an increasingly useful body of information.

III. RECOMMENDATIONS

STUDENT SELECTION

Educational Background

The recommended pre-requisite educational background for a course comparable to the experimental program in engineering and design data processing is: (a) high school diploma, and (b) background in mathematics which shall include algebra I and II, plane geometry, and trigonometry.

Entrance Tests

It is recognized that other educational institutions may wish to utilize different tests as student selection devices than those used by the Williamsport Area Community College. However, on the basis of the statistical findings it is recommended that an entrance test battery be constructed around the I.B.M. Programmer Aptitude Test. The selection of additional tests, if desired, should be made in accordance with the objectives of the computer programming course being offered. It is further recommended that each institution develop its own norms and carry out a statistical evaluation of its test battery in a manner similar to the one presented in this report. Such an undertaking will accomplish two things. First, it will provide the necessary feedback to make decisions as to whether certain tests should be retained or discarded. Secondly, it will assure that the proper weightings are assigned to each test retained in a battery. For the reader's reference a table of norms established for the computer science program is presented in Appendix B.

STAFF

The instructional staff of a computer science department should consist of two types of personnel; those skilled in scientific applications and those with commercial application experiences. With this combination the students will obtain the overall insights of the complete data processing and computer world.

Since it is virtually impossible today to obtain instructors with graduate degrees in computer science, additional staff members were procured from industry. We have found that individuals with a minimum of six years experience and who have served in the capacity as data processing managers, systems analyst, or head programmers make excellent instructors.

It is strongly recommended that the instructional staff of a computer science department not be obligated and burdened with any school business or administrative data processing functions. This practice definitely overloads the instructors and corrodes the quality and efficiency of his instruction.

EQUIPMENT

The objectives of a technology curriculum is to provide sufficient training so that a student may be immediately productive in his supporting role as a technician. To accomplish this the school must provide training for all the prime tools and equipment of the field. It is imperative, therefore, that a computer science curriculum afford training on magnetic tape and/or magnetic disc processing and on high speed printers. Every student who obtains employment will be exposed to this equipment and be expected to operate them. Consequently, a great deficiency exists in any computer science curriculum that does not include this training.

It is recommended that there be at least one card punch for every ten students.

Instruction on the programming and operation of an X-Y incremental plotter proved very profitable and it is recommended that scientific computer science curricula include this device.

All other equipment used in this experimental program was adequate and sufficient for the scope of the program.

COURSE SEQUENCE

This experimental program was fortunate in having an excellent course of study outlined from the very beginning. There is little that can be recommended as a change to the original design. This is a tribute to the advisors and instructional staff for their keen foresight.

Following are the recommendations:

1. The graphics course should place the emphasis on machine shop terminology and practices and less time on the drawing board. Drawing interpretation rather than preparation should be stressed.

2. It has been noted previously in this report that the majority of the graduates obtained employment in business application. In view of this, an additional course in general accounting or cost accounting should be offered.

3. Addition of an Advanced Programming Systems course to teach the logic, structure and concepts of programs for computer systems control as studied in the first course in Programming Systems. This course would qualify the student to analyze, evaluate and make minor modifications to such system. This course should also include the latest concepts of time-sharing, data communication, etc.

Except for the aforementioned, the content and sequence of the subjects were adequate and presented a good continuity in the learning experiences of the class.

TRAINING AREA

With the experiences obtained from this experimental group and subsequent groups the computer science department of the Williamsport Area Community College can make the following suggestions for the layout of a desirable training area:

Room	Min. Sq. Ft. (student group of 25)
Computer Lab	600
Unit Record Lab	700
Card Punch Room	250
Ready Room	400
Lecture Room	600
Reference Area	300

The laboratories should have glass partitions and contain a card punch for immediate card corrections. The card punch room should have sound proofing qualities and contain storage for a ready supply of stock cards.

The ready room is used for student program writing, debugging, hand computations and documentations. This room should contain adding machines for test computations and all the necessary forms, cards, etc. needed for programming.

The reference area contains the libraries and reference material available to students.

The labs and lecture rooms should be equipped with the appropriate machine chalk boards.

APPENDIX A

MEMBERS OF ADVISORY COMMITTEE

Mr. Jeffrey Baker, Engineer, Sylvania Electric Products, Inc.

Dr. Kenneth E. Carl, President, The Williamsport Area Community College

Mr. R. M. Edwards, Engineer, Sylvania Electric Products, Inc.

Mr. Dwayne Gephart, Mathematical Analyst, Avco Manufacturing Corp.

Dr. John Hale, Director Computer Science, Bucknell University

Mr. Richard F. Paulson, Director Psychological Services, The Williamsport Area Community College

Mr. Floyd Roller, Director Data Processing, Susquehanna University

Mr. Art Sweeten, President, Tab Sales of Pennsylvania

Mr. Chester D. Wolfe, Director Program Systems, Wright-Patterson Air Base

Mr. George P. Wolfe, Chairman Computer Science Dept., The Williamsport Area Community College

APPENDIX B

NORMS FOR ENTRANCE TEST BATTERY

Stanine Score	Bennett Mechanical Comprehension	Revised Minn. Paper Form Board	Williamsport Area Comm. College Math Test	P.R.I. Classification Test	I.B.M. Programmer Aptitude Test
9	54-60	57-64	45-50	85-100	64-86
8	47-53	55-56	40-44	80-84	49-63
7	43-46	52-54	37-39	75-79	40-48
6	41-42	48-51	34-36	69-74	37-39
5	37-40	42-47	30-33	64-68	33-36
4	34-36	39-41	26-29	60-63	28-32
3	32-33	33-38	24-25	56-59	23-27
2	25-31	29-33	20-23	46-55	17-22
1	1-24	1-28	1-19	1-45	1-16

N = 166

APPENDIX C

PRESENT COMPUTER SCIENCE CURRICULA

The Williamsport Area Community College considered it advisable to offer two programs in Computer Science: - Engineering Computer Science and Business Computer Science. This decision was based on the following:

1. Varied academic background and preparation of student applicants
2. Varied interest and objectives of student applicants
3. Varied demands of industry
4. Philosophy and objectives of a two-year college

As an addend to item 4, we point out that a four-year college can be more restrictive and selective of its applicants and also in the course of four years offer sufficient courses to accomplish their sole objective of producing computer scientists per se. This is not so at a two-year college.

In addition to acceptable entrance test scores, the entrance requirements for the Computer Science Department at The Williamsport Area Community College demands a high school diploma or its equivalent and,

1. Engineering majors - Algebra I, II, Trigonometry, Plane Geometry
2. Business majors - Algebra I

The Engineering Computer Science Curriculum is fairly similar to the curriculum of the experimental Engineering and Design Data Processing Technology program. However, since The Williamsport Area Community College is operating on a four semester program, it was necessary to delete some of the less relevant courses and combine others to make a full semester course.

APPENDIX C (continued)

It is expected that a student majoring in Engineering Computer Science will be employable in the commercial field as well as in the scientific. This is not true, however, for the Business Computer Science majors.

BUSINESS COMPUTER SCIENCE

FIRST SEMESTER

COURSE	CLASS HOURS*	CREDITS
Algebra	3	3
Accounting I	3	3
Business Machines	5	2
Basic Data Processing Mach.	6	3
Computer Programming	8	4
Totals	25	15

SECOND SEMESTER

COURSE	CLASS HOURS*	CREDITS
Trigonometry	3	3
Finite Math	3	3
Accounting II	3	3
Programming Systems	4	3
Algebraic Programming	6	3
Physical Education	3	1
	22	16

THIRD SEMESTER

COURSE	CLASS HOURS*	CREDITS
Statistics	3	3
Accounting III	3	3
Business Organization	3	3
English	3	3
Advanced Programming	6	3
Physical Education	3	1
Totals	21	16

FOURTH SEMESTER

COURSE	CLASS HOURS*	CREDITS
English - Oral	3	3
Economics & Job Procure.	3	3
Cost Accounting	3	3
Advanced Programm. Systems	6	3
Systems Development	6	3
	21	15

*Class Hours includes lecture and lab hours.

ENGINEERING COMPUTER SCIENCE

FIRST SEMESTER

COURSE	CLASS HOURS*	CREDITS
Algebra-Trigonometry	5	5
English Composition	3	3
Accounting I	3	3
Basic Data Processing Mach.	6	3
Computer Programming	8	4
Totals	25	18

SECOND SEMESTER

COURSE	CLASS HOURS*	CREDITS
Finite Math	3	3
Calculus I	4	4
English - Oral	3	3
Basic Electricity	3	3
Algebraic Programming	6	3
Programming Systems	4	3
	23	19

THIRD SEMESTER

COURSE	CLASS HOURS*	CREDITS
Calculus II	3	3
Statistics	3	3
Physics-Mechanics	4	4
Advanced Programming	6	3
Applied Technical Prog.	5	3
Physical Education	3	1
Totals	24	17

FOURTH SEMESTER

COURSE	CLASS HOURS	CREDITS
Physics - Heat, Light	3	3
Economics & Job Procure.	3	3
Advanced Programm. Systems	6	3
Systems Development	6	3
Numerical Methods	5	3
Physical Education	3	1
	26	16

*Class Hours includes lecture and lab hours.