

necessarily identified as practicing nor aspiring computer scientists. Thus the Committee distinguishes between those interested in computing concepts alone and the larger number interested in computing applications."

"It is recommended that the Department of Computer Science have direct responsibility for a) all freshman-sophomore work in computer science, including programming courses, and b) upper level and graduate work in computer science where the emphasis is not on applications to some specific field. After basic work in computer programming, languages, and algorithmic structures has been acquired in the Department of Computer Science, it is altogether proper, the Committee believes, that advanced instruction in computing applications in several disciplines may be carried out by the faculties in the departments concerned."

"Although recognizing the varying needs of computer users in applications unique to their fields, the Committee believes in a basic efficiency and jurisdictional unity which should characterize the University's instructional program in Computer Science. We believe that the concentration of computer science instruction in the Department is justified both by its academic soundness and its conservation of university resources. Although the identification of duplication may be a matter of judgment and style, it is hoped that the spirit of the foregoing principles is plain enough to serve as a future guide."

Computer Science Faculty. Current members of the departmental faculty are shown in Part III, Resources. The following areas are ones in which additional faculty appointments might be made in the near future: Data Organization, Business Applications, and Programming Systems. The Department believes that joint appointments will be exceedingly useful and that, with proper understandings having been established between departments, they are an effective means of representing mutual academic interests.

We have already initiated this policy of joint appointments by appointing Drs. Ahmed and Calhoun jointly with the Department of Electrical Engineering. We will continue to reach out to other departments in this way.

Courses. The introductory computer science courses in both FORTRAN and PL/1 will be subdivided into separate courses so that students from different disciplines may obtain the knowledge that they need.

Graduate Teaching Assistants. There are currently 2.4 full-time-equivalent graduate teaching assistants (6 assistants, each working four-tenths of full time)

assigned to the Department. With current and prospective instructional demand, this number should be increased to 19.2 within the next 10 years.

Inasmuch as computer science is a field currently in great demand, and its courses show growing enrollments, normal growth can be expected to furnish the base for needed faculty additions. Indeed, by virtue of the cooperative program, the State of Kansas will thus truly be able to assemble and capitalize upon an impressive and diversified staff to serve the needs of students majoring both in computer science and in related fields. As experience is gained the groundwork can be laid for involvement of other schools in the state through networks and for extension of the cooperative pattern to other programs.

#### 6. PROGRAMS FOR EVALUATING EFFECTIVENESS

Our main means of evaluating our effectiveness will be to see whether we meet the goals that we set ourselves. a) Have we given insight to non-computer science majors? b) Have we given computer scientists and non-computer science students the ability to use computer science interdisciplinary projects? c) Have we given computer science majors a knowledge of their own disciplines? d) Have we developed a viable Ph.D. program?

- In order to know whether we are reaching non-computer science majors, we can examine the courses directed to this audience to determine whether these courses draw students from other departments on the campus. In addition to this test of their popularity, we can test these students to determine whether they do have a knowledge of the basics of computer science upon completing the course.

- In order to know whether we have provided training applicable to interdisciplinary projects, we can refer to the computing center records or projects in other disciplines involving computer use. Also, we can see whether non-computer scientists are taking second level computer science courses, and whether

computer scientists are taking sets of courses outside of the department allowing them to carry out such projects. Other departments will provide informal feedback on their student responses to our courses.

- In order to know whether we have developed a core of computer science courses, we can compare our course content with the content of other departments, and with the content recommended by organizations like the Association for Computing Machinery.

- In order to know whether we have developed a viable Ph.D. program, we can examine both the number and the quality of Ph.D. candidates who complete their dissertations. Since these dissertations are filed, and since we are involved in a joint Ph.D. program with the University of Kansas, we can also put the dissertations up for the scrutiny of the computer science faculty from the University of Kansas.

In addition to seeing whether we meet our goals, we can determine the cost-effectiveness of our teaching and research. How many students of each level does each faculty member teach? How much does he make? How much is paid by outside grants? How much does he publish? We can use all of these figures to determine the cost-effectiveness of a faculty member.

As the student enrollment grows, the department will consider more cost effective devices such as utilizing large lecture sections to replace the current small class sections, using canned computer programs to judge students' computing capabilities. Furthermore, we will continue to use student-oriented compilers such as WATFIV and PLC which are comparatively cheap to use. Using the computer to grade tests and student programs, are also cost effective. Although interactive programs on the computer are not cost effective on this campus, they are an example of an expensive procedure we must maintain in order to introduce the

students to important current computer techniques. Quite often, similar comments may be made about dedicated faculty teaching essential courses.

Another cost effective techniques which we should introduce are multiple choice exams with an optical Mark scorer for grading.

Not only each individual faculty member, but also the group comprising the department, should be subject to analysis and evaluation. Group activities, such as committee projects, should be written up, and the man-hours spent on the projects should be compared to the production by the committee. The many committee activities should be summarized by man-hours spent, positive results, and the summaries should be used as a guide for future committee organizations.

From committees, we proceed to the class room, where we will teach experimental classes in order to evaluate possible classes. We may teach experimental classes on occasion in order to test alternative ways of teaching a course.

Since evaluation is so important, one faculty member should devote four-tenths of his time to it, and should have available both \$500 per year and two-tenths of the secretary's time in order to carry out the evaluation. He should write an annual report evaluating the success of the department in meeting its goals.

Finally, we can evaluate our effectiveness in serving national needs by observing whether our students find jobs, keep them, and achieve success on them.

Our main goal for the next ten years is to keep abreast of current developments in computer science, and to teach these developments to our students. Although it is impossible to predict the exact nature of or time of appearance of these developments, specific examples of the kinds of events we envision are listed.

COMPUTER SCIENCE DEPARTMENT MILESTONES

1972 Microprogramming speeds efficiency of program.

1973 Parallel processing computers allows weather prediction, epidemiological models, to be implemented.

Metacompilers in wide use to allow individually designed compilers for specialized uses.

1974 Automated theater bookings, dentist appointments, health surveillance, flexible, reschedule as directed.

1975 Real time simulation enables urban planners to walk through simulated cities before the real cities are built.

Grid of computers to obtain programs, data and the processing power of remote specialized machines. Local computer interrogating a directory computer to find out where it can find the services it needs. One huge organism of linked computers which help each other.

1976 Urban planning by computer, using simulation, to see city before it is built.

1977 Computer terminal in kitchen, living room.

1978 Computerized traffic direction and work schedules.

1979 Kindergarten use of touch type terminals.

1980 Data banks on individuals, available, but not used to oppress. Used for crime prevention.

1981 Artificial intelligence in computers increases their adaptability in performing tasks.

Multipurpose screen used for television, picturephone, and computer data.

### III. FACULTY AND RESOURCES

The faculty of the Computer Science Department is quite diffuse in character, as might well be expected, for a field with such broad applications and so many ramifications in its nature. Faculty experience ranges from linguistics to nuclear physics and from chemistry to biological simulation, as well as the more usual backgrounds of mechanical engineering, electrical engineering, mathematics, statistics, and numerical analysis. These diverse backgrounds of the faculty allow them to mingle in a manner necessary for an evolving field which has a need to be responsive to change. Because of the broad range of responsibilities of the computer science department, the practice of joint appointments with other departments and divisions of the university will be strongly encouraged.

The faculty of the Computer Science Department has the opportunity to participate in a unique program for the granting of the Doctor of Philosophy degree. The Boards of Regents, State of Kansas, has approved a joint doctoral program in Computer Science between the University of Kansas, at Lawrence, and Kansas State University. The determining principle for such a joint program allows the marshaling of talent under the plan which will afford the student a much wider range of educational opportunity than either school would be able to provide separately. In combining the resources of the University of Kansas and Kansas State University at the doctoral level, a division of labor within the field of Computer Science has been made so that the expected development may proceed without overt and wasteful duplication. The current classification of doctoral research specialties in Computer Science is outlined in Section IV the Curriculum.

The present faculty of the department consists of one professor, four associate professors, and seven assistant professors. Ten different highly

regarded institutions granted the terminal degrees to the faculty. The vitae are included in the KU/KSU Ph.D. proposal, and are reproduced at the end of this report. The faculty members at the University of Kansas who are participating in the joint Ph.D. program consist of three professors, four associate professors, and five assistant professors. The vitae for these members are also included in the KU/KSU Ph.D. proposal.

#### FACULTY EFFECTIVENESS

During the fall semester of 1970, educational resources group of the university prepared a questionnaire. This questionnaire was administered to certain students enrolled in computer science courses. It was the first attempt to advise the faculty of the student reaction to their instructional methods; the individual instructors received a composite of the students' reaction to their course, primarily as an aid for self-improvement. Because of the experimental nature of the program, and the emphasis on individual faculty confidentiality, the results of an individual instructor's performance were available only to that individual instructor. Elsewhere in the total report for the university, the compilation of student reaction to instructional methods will be given.

Another questionnaire (see Appendix III-A) was used within the Department of Statistics and Computer Science to aid in student reaction to faculty teaching methods. Each student is asked to rate his instructor on many items using a graduated 5-point scale. In addition, other information pertaining to mannerisms and habits of presentation which may distract from the total teaching environment is requested. These ratings are collected and tallied by the department secretary (without regard to students' names) and are made available to the individual instructors.

The Computer Science Department does not use any single instrument to evaluate the student reaction to faculty advising, but it assigns a faculty advisor to each student, guaranteeing personal contact. Although the choice of the advisor is arbitrary for beginning students, as students progress they can seek an advisor who is compatible both professionally and personally.

Faculty research effectiveness is based primarily on the number and quality of articles accepted by refereed journals. Certainly, another measure is the willingness of sources external to the university to support research activities.

#### ADEQUACY OF PHYSICAL PLANT

Present Facilities. The Computing Center has the charge of providing the academic community at Kansas State University with instructional and instructional-support computing service. Instructional computing includes formal classroom usage at the undergraduate and graduate levels, and computing support for masters reports and theses and doctoral dissertations. Instructional-support includes faculty and undergraduate research computing support, and administrative computing associated directly with instruction.

The computer is run using IBM's Operating System in a Multiprogramming environment with a Fixed number of Tasks (OS-MFT). The capability of OS is enhanced by two additional processors. The first of these, Houston Automatic Spooling Priority (HASP), is an input-output spooling program which provides accounting and services the job queue on a priority basis. The other, Baylor Executive System for Teleprocessing (BEST), is a time-sharing system system which runs under control of the Operating System.

Language Processors and Systems:



COBOL ANS (Common Business Oriented Language-American National Standard)  
Coursewriter III CAI (Computer Assisted Instruction)  
CSMP (Continuous System Modeling Program)  
ECAP (Electronic Circuit Analysis Program)  
FLOWCHART (Flowchart generator for OS)  
FORTRAN IV E, G & H (Formula Translation Language)  
GPSS (General Purpose System Simulator)  
ICES (Integrated Civil Engineering System)  
LISP 1.5 (List Processing Language)  
MATLAN (Matrix Language)  
MPA (Multiple Precision Arithmetic Package)  
MPS (Mathematical Programming System)  
NEATER2 (PL/I formatter)  
PL/C (Cornell PL/I)  
PL/I F (Programming Language I)  
RASS (Remote Access Statistical System)  
RPG (Report Program Generator)  
SPASM (Single Pass Assembler)  
SNOBOL4 (String Manipulation Language)  
SORT/MERGE (Sorting Language)  
TESTRAN (Assembler Debugging Package)  
TEXT-360 (Text Processing System)  
VSP (Vehicle Scheduling Program)  
WATFIV (Waterloo FORTRAN IV)

In addition to the language processors and systems of programs listed above, the library contains a variety of application packages which provide for mathematical analyses, linear programming, simulation, statistical analyses, information retrieval, and structural analysis.

The computer in operation at the Kansas State University Computing Center is an IBM S 360/50. The configuration for the machine is shown in Figure 1. This computer has several associated pieces of peripheral equipment including an Express Terminal and five communication terminals. The Express Terminal, a

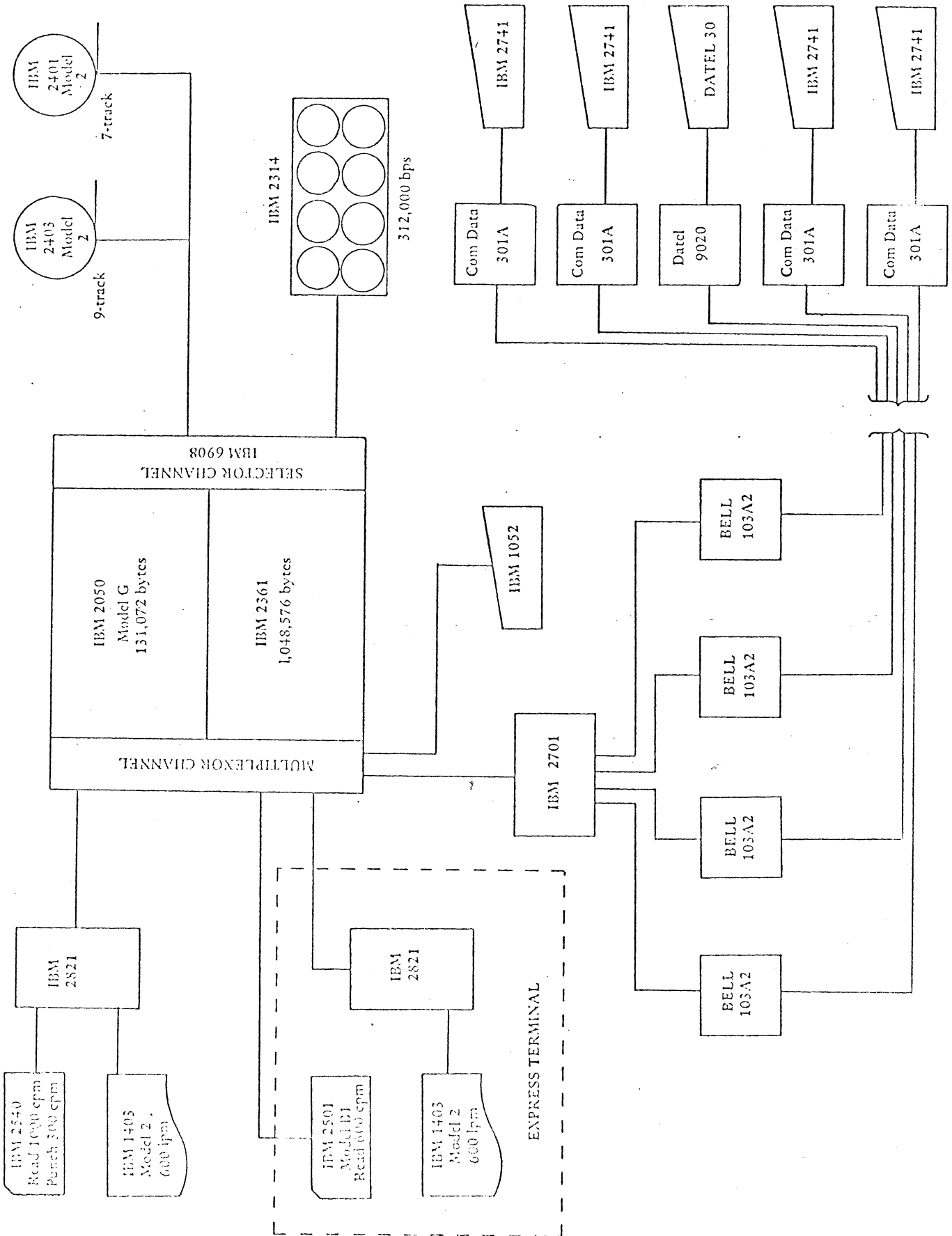


FIGURE 1. COMPUTER HARDWARE CONFIGURATION

self-service batch facility, consists of a six hundred card per minute reader for input and a six hundred line per minute printer for output. It serves one dedicated partition of the IBM S 360/50 and handles PL/C, WATFIV, SPASM, and a utility program to list decks. This facility is available to all users of the Center. The communication terminals include four IBM 2741 devices and one DATEL 30.

The Center maintains eighteen IBM 029 Key punches, an IBM 059 Card Verifier, an IBM 082 Sorter, an IBM 552 Interpreter, an IBM 407 Accounting Machine, an IBM 514 Reproducing Punch, an IBM 1230 Optical Mark Sense Reader and its associated IBM 534 Punch. Some of these devices are located around the campus for the convenience of users.

Departments that used more than five percent of the total services rendered by the Center in Fiscal Year 1970-1971 are Statistics and Computer Science (18.4%), Industrial Engineering (11.0%), Physics (8.3%), Nuclear Engineering (7.1%), and Chemical Engineering (6.1%). It is estimated that computer science usage was approximately 14% of the total usage. Of this amount 87% was used for instructional purposes and 13% for research.

Future Facility Expansion. The expansion of computing facilities will, in a large part, be determined by the recommendations of the Board of Regents' statewide Computer Advisory Committee and the acceptance and support of the recommendations by the Council of Chief Academic Officers. The general goal for computing as proposed by the Computer Advisory Committee is -

"to provide contemporary computing resources for the instructional and instructional-support responsibilities for all of the institutions under the governance of the Board of Regents, State of Kansas."

After a general goal is identified, the next step in planning requires the specification of the goal in terms of specific objectives. The objectives of the Computer Advisory Committee are included below:

"One may distinguish between instructional, which is defined as computer use directly related to specific class enrollment, and instructional support, which is the use of the computer in the areas of administration (including the library), research, public service, and computer center.

"The following objectives result from the process of describing the general goals for the two major areas:

A. Instructional Objectives:

1. To provide access to computing facilities for faculty and students for development of computer awareness (introductory courses)
2. To provide access for understanding the use of computing as a tool in all subject areas (instructional use in specific courses for every student level)
3. To provide access for training and teaching of professionals to use or design computers for their particular field (professional training in engineering, business management, pharmacy, medicine, education, law, journalism, etc.)
4. To assist students and faculty who are studying computing as an independent study area (the computer and its related technology as the object of instruction, e.g., computer science)
5. To provide access to adequate computing resources for graduate students in their required theses research projects (specialized and intensive use as a necessary research tool)

B. Instructional Support Objectives:

1. Administrative Objectives:

- a. To provide services and facilities for processing information required for recording, reporting, and planning in the efficient operation of an educational institution and all of its related activities.
- b. To assist in the design and implementation of compatible data bases and information systems to improve the quality of administrative support for all institutions
- c. To Provide information dissemination services from available machine-readable data bases when requested for all institutions

2. Research Objectives:

- a. To provide a high level of service computing which includes the development of generalized and specialized application systems.
- b. To provide consultation and interaction with researchers concerning (a) special purpose computers, (b) research proposals, and (c) special research problems
- c. To provide necessary support for investigation of computer languages and systems, both hardware and software.

3. Public Service Objectives:

- a. To assist educational and governmental groups in areas, within our existing expertise, where service can be provided
- b. To cooperate with other educational institutions, agencies, and consortiums in regard to computing activities
- c. To provide low priority service on a contractual basis for special business and industry projects, when requested, if resources are available.

4. Computer Center Objectives:

- a. To provide computer system software maintenance, backup, and development adequate to serve the needs of the academic community.
- b. To maintain a software library of programs for general use of the computer center customers.
- c. To assist students, faculty, and staff in using the facilities available in the most effective and efficient manner.

The Board of Regents' universities and colleges have operated in an independent structure for computing activities on the campuses. This has resulted primarily from the varying rates of maturity of computer usage on the individual campuses. Federal grants have assisted some of the universities and colleges in obtaining the needed computing power, while other institutions have increased their computing capability through incremental increases in expenditures for instructional usage upon a center designed primarily for the administrative business of the university. Thus, the various institutions have organized their computing activities within a scheme which was most suited for that particular institution."

Department Facility Needs. The department's available computer resources could be determined largely by external sources as pointed out in the foregoing text. However, it is felt that access to virtual machine capability or "hands-on" experience is essential. A mini-computer in the price range of \$100,000 is needed within two years to support adequately the hardware and system software design phases of the program. Physical proximity to the Computing Center is recommended and convenient access to data preparation equipment, remote batch terminals and interactive terminals is essential.

#### BOOKS AND PERIODICALS

Dr. R. Farley, Director of Libraries, made a survey of Farrell Library at KSU in the fall of 1970, for current holdings related to computer science. He used two lists of periodicals as a basis for his evaluation. These lists are:

1. "List of Periodicals Abstracted" Computer Abstracts (London, 1957-)
2. Sections on "Automation, Computers, Data Processing and Operations Research; Documentation" Ulrich's International Periodicals Directory 13th ed., 1969-70)

Updating this evaluation we found that the library has current subscriptions and substantial backfiles of 106 of the 145 journals abstracted on Item 1 and has current subscriptions to 59 of the 192 titles listed on Item 2. See Appendix III-B: Library Resources for a list of active subscriptions to periodicals on the lists mentioned above.

When technology is included, as in Item 1, the library resources are good. Item 2 points up the fact that library holdings in automation tend toward those produced in the United States. There has been little or no interest in the international journals, which are so important in many of the other disciplines. The library has standing orders for most monographs in the English language in computer science.

Due to the reduction of funds with the fiscal year 1971-1972, the Library was forced to terminate subscriptions to 39 periodicals from the two lists mentioned previously. This trend cannot continue without affecting the usefulness of the library to the computer science program. Back files of many of the journals are limited. Because the library lacks funds to purchase back files, Kansas State University depends on the Linda Hall Library in Kansas City and University of Kansas Library for these resources. There are no plans to purchase extensive back files.

The general collection of library books, reference works, and periodicals related to computer science is sound, offering strong support for doctoral research. Good representation is indicated from among pertinent periodicals identified by Computer Abstracts and Ulrich's Directory. It is felt that most of the publications in computer science which are important to a good doctoral and research program are available but steps are being taken to add a few journals. Kansas State University's significant history in technical research assures significant coverage in related areas of computer applications as well. Appendix III-A, Library Resources, provides a list of periodicals which should be added as money becomes available.

#### TEN YEAR BUDGET

Our present faculty and resources will be expanded during the next ten years (Appendices III-C through III-I) in order to handle our increased student enrollment (Appendix III-E). Since we expect more than five thousand students in the University to take at least one computer science course by 1981 (based on data from Hoyt Tarrant's research report, see Appendix III-E), we will need 30 faculty by that time, and a total budget of \$1,103,000.

This million dollar budget is based on certain key assumptions on student enrollment and participation in computer science: 1) all undergraduates will be taking introductory computer science by 1977; 2) by 1981, there will be 30 doctoral candidates, 40 Master's candidates, 300 undergraduate computer science majors and 300 minors in computer science (see Appendix III-E). The other figures are derived from these basic assumptions extrapolating from current statistical data on faculty/student ratios, costs, and resource support.



#### IV. THE CURRICULUM

##### 1. OBJECTIVES

The chief limitation to the use of electronic digital computers is the lack of highly trained and ingenious people to devise ways to utilize fully the potentialities of existing computers, to create still better ones, and to help educate all levels of society (and our young people in particular) to appreciate and to use these new machines. For this reason higher education in computer science at all levels is critically important today.

With the realization of the potential of the computer has come the development of an academic discipline. While its parameters are yet to be fully understood, an academically sound core of knowledge has been discerned and, to a great degree, agreed upon, by many institutions of higher education offering courses in computer science. The proposed curriculum, known as "Curriculum 68," was originally published by the Communications of the ACM, Volume 11, Number 3, March 1968. The Computer Science Department has fashioned a curriculum consistent with the guidelines outlined in "Curriculum 68."

Currently, the faculty in the department recognizes the need to train majors as well as non-majors. In the future, we fully expect that every student entering college will come to this department for at least one course in computer fundamentals. For those who wish to minor in computer science, we provide a wide range of options in programs of study.

For majors, depending upon the level at which the student is studying, the overall goal of educating students in Computer Science will receive different emphasis. At the undergraduate level the department strives to provide a broad, applied knowledge. The student is encouraged to look to related fields for information which will support his primary interest in computing. For example, a typical undergraduate major is expected to complete the following requirements

for a major in this department in addition to the broad, flexible requirements of the College of Arts and Sciences.

MATHEMATICS & STATISTICS	<u>Hours</u>
Calculus I	4
Calculus II	4
Determinants and Matrices	0
or	3
Elements of Applied Linear Algebra	0
Introductory Statistics Course	<u>3</u>
Total	14

## COMPUTER SCIENCE

Fundamentals of Computer Programming	3
Introduction to Algorithmic Processes	3
Computer Organization and Programming	6
Numerical Analysis	4
Data Structures	3
Programming Languages	<u>3</u>
Total	22

## ELECTIVES

Two additional courses in Science or Engineering	6
Electives from supporting area(s)	15

It is obvious from this list that the student can select courses from a wide spectrum of subjects.

When the twenty-two hours of computing courses are completed the student will have had two years (four semesters) of studies in high-level languages. In addition, the student will have had one year of assembly language programming which provides a clear understanding of the why and how of computing. Over and above these requirements the department suggests to the student that he also take a

business-oriented data processing course to give him additional capabilities in the business world.

The two courses, Numerical Analysis and Data Structures, are designed to provide the student with both new factual information as well as an environment where his knowledge of programming can be used. The remaining course in Programming Languages serves both as a review of features of previously encountered languages, and also as an introduction into other concepts of both formal and actual programming languages.

The student should utilize the twenty-one hours of electives to gain information from departments such as electrical engineering, industrial engineering, mathematics, linguistics, statistics, business and economics, as well as computer science. Hopefully, the courses selected in these departments will contain information pertaining to the application of computers to their areas. Unfortunately, too little joint effort has as yet taken place between this department and others to encourage joint and/or cross-listings as well as elimination of duplicate offerings.

At the Masters level, the emphasis may shift from a broad education to a more narrow area of interest. At this level the requirements stated by the Graduate School stipulate that 18 hours must be taken in a major area of concentration, while 12 are to be taken in a minor area. Depending on the interests of the student and upon the recommendation of the major professor, the student may elect to remain very broad in his scope or begin to concentrate within the department. It is suggested that each Masters level student consider a course from the following specialties of the faculty; simulation, systems and programming languages, artificial intelligence, numerical analysis, and hardware design and construction. However, for the most part, a student will usually complete at least one course

from each of the five areas with the other course being taken in his area of interest.

In addition to course requirements, the student may elect to complete a publishable paper, a thesis, a report, or a course option. The department interprets this first option to mean that the student and his major professor will produce a technical paper to be submitted for publication listing the student as principal author. This option encourages both the faculty member and the student to engage in scholarly work which introduces current research into the department without all the formalities associated with a thesis.

Finally, at the Ph.D. level the primary objective is to produce a creative leader who is capable of contributing to the growth of knowledge in computer science by teaching, by engaging actively in research, or by excellence in applying computers to the problems of the world. Our goal at this level is to provide the student with tools capable of supporting his curiosity as it leads him into new areas. At this level it is expected that the faculty members associated with the student will provide him with the opportunity for self-direction in a rewarding research area.

The Ph.D. program is a joint program between Kansas State University and the University of Kansas. The primary purpose of this joint program is so that the students, will have, to some degree, the benefits to be derived from the faculties and curriculums of both universities. At the Ph.D. level the research activity, as well as the curriculum are divided between the two universities as described in Section II, Goals, and the following quote from the proposal for the joint Ph.D. program. The tentative nature of this division should be noted; the passage of time will undoubtedly serve to strengthen the bond of cooperation between the two universities.