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A NEW APPROACH TO CLASS SCHEDULING. FINAL REPORT.
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AN INVESTIGATION OF THE USE OF A PROTOTYPE DEVICE FOR CLASS SCHEDULING WAS MADE. THE BEEKLEY INSITE DEVICE THAT WAS STUDIED USES THE "PEEK-A-BOO" PRINCIPLE OF MATCHING COMPUTER TAPES. A TEST GROUP OF 149 GRADUATE STUDENTS WAS USED. THEIR DESIRED SCHEDULES WERE MATCHED AUTOMATICALLY AGAINST A PROPOSED MASTER SCHEDULE TO EVALUATE THE USEFULNESS OF THE DEVICE. THE STUDY SOUGHT MEANS TO (1) PROVIDE STUDENTS, DURING REGISTRATION, WITH ALL FUTURE TERM SCHEDULES THAT MIGHT BE OFFERED, (2) PROVIDE THE ADMINISTRATION WITH CURRENT AND FUTURE TERM SCHEDULES THAT COULD NOT BE PROVIDED BY ADJUSTMENT OF MASTER SCHEDULES, AND (3) IDENTIFY SCHEDULING VARIBLES TO BE CONSIDERED IN RESOLVING SCHEDULING PROBLEMS. THE TEST RESULTS INDICATED (1) THE "PEEK-A-BOO" APPROACH TO SCHEDULING COULD BE USEFUL TO BOTH THE STUDENTS AND THE ADMINISTRATION, (2) ALTHOUGH THE DEVICE TESTED HAD MANY DESIRABLE CHARACTERISTICS, FURTHER DEVELOPMENT WAS NEEDED TO PROVIDE REAL-TIME OPERATION OF SUCH A SYSTEM, AND (3) A MACHINE-PROCESSIBLE RECORD CREATED BY THE STUDENT DURING REGISTRATION MIGHT SERVE AS A STARTING POINT FOR INVOICING, GRADE REPORTING, AND SIMILAR FUNCTIONS. (AL)

5-8199

A New Approach to Class Scheduling, FINAL REPORT,

by

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I. Summary

The applicability of the prototype Beekley InSite device (employing the peek-a-boo principle of matching tapes) to class scheduling has been investigated. The objectives were to: (1) provide students, during registration, with all future term schedules that might be offered to permit student goals to be attained with the curricular paths available; (2) provide the school administration with current and future term schedules desired by students which could, and would, not be provided by alteration of master schedules; and (3) identify scheduling variables which should be taken into account in resolving complex scheduling problems.

149 students of the Graduate School of Library and Information Sciences of the University of Pittsburgh were used as the test group. Their desired schedules were matched automatically against a proposed master schedule in order to evaluate the usefulness of the prototype device in this application.

The results suggested the usefulness of the peek-a-boo approach to scheduling, both from student and school administration points of view. The prototype device investigated had many desirable characteristics. However, further development is required in order to permit real-time operation of such a system.

There seems to be some potential for developing, from a machine-processible record created by a student during registration, a system which might permit invoicing, grade reporting, and similar functions to be performed using this first record as a starting point. However, considerable developmental activity would be required.

II. Introduction

A. The Problem

With increasing enrollments in colleges and universities, the problem of developing student programs which match degree requirements, student objectives, and available facilities has become a matter of increasing concern. The problem becomes obvious under the real-time pressures of registration, when preconceived schedules of course offerings may not permit the idiosyncratic objectives of students to be fulfilled. The practice has developed in many schools of utilizing faculty (1) as advisors and (2) as registration clerks in an attempt to rationalize these differences--within the constraints of degree requirements and facility limitations.

In some cases, computers have been programmed to handle the onerous task of scheduling, with varied results. The resulting computer programs generally permit the economical development of master schedules, but real-time adjustment during registration pressure is inhibited and inordinately expensive.

Accordingly, the development of a low-cost method of scheduling has been of interest, which would relieve faculty of routine registration tasks, and still provide students with the benefit of faculty advice, but only after exceptions are discovered. The availability of a prototype device (the Beekley Corporation InSite system) provided the opportunity to consider how such a method might be developed.

B. Objectives of the Study

The objective of this study is to perform exploratory investigation of the applicability of the Beekley InSite device to school scheduling problems. To provide an operational environment for this investigation, an actual school scheduling problem at the University of Pittsburgh Graduate School of Library and Information Sciences was selected.

More specifically, the applicability of the prototype Beekley InSite device to school scheduling was to be initially determined by the answer to the following question: "During what time and at what cost can the device be used for purposes of (a) providing students registering in the Graduate School of Library and Information Sciences with all alternate future term schedules that might be offered to permit student goals to be attained within the curricular paths available at the School, and (b) providing to the School the present and future term schedules desired by students, which, by alteration of the School master schedule, could and could not be provided by rescheduling?".

It was recognized at the start of the investigation that it might not be possible to reach the initial objective because of unknowns involved in dealing with a prototype device whose operating characteristics were not fully known (even though functional characteristics were known). Accordingly, a secondary objective was to identify, in as much detail as feasible, those scheduling variables which would have to be taken into account in considering the development of effective approaches to the resolution of complex scheduling problems.

III. Procedures

A. General Design

Attempts have been made by both computer manufacturers and university users of computer and other data processing equipment to solve a variety of school scheduling problems. In many of these pursuits, models of theoretical scheduling situations have first been developed, followed by the introduction of practical problems in an attempt to rationalize the theoretical with the real world.

It was the intent of this investigation to proceed from the empirical point of view by selecting a problem area for initial examination of the applicability of the Beekley InSite device to school scheduling problems. The Graduate School of Library and Information Sciences of the University of Pittsburgh has proposed a master schedule of classes intended to cover an indefinite period of time. This schedule of course offerings was to be compared with various combinations of student schedules consisting of (1) previous schedules of former students and (2) current and pending schedules which students are seeking to have fulfilled. Where schedules desired by students could not be matched successfully with the existing School master schedule, the master schedule was to be revised and all previous comparisons replicated.

B. Population and Sample

The school master schedule and student schedules were obtained from the Graduate School of Library and Information Sciences of the University of Pittsburgh. Offering a professional degree, the Graduate School attracts a wide variety of student types at a rapidly increasing rate of enrollment. These two factors have strained the faculty resources, thereby demanding careful planning of course offerings. At the same time, an enrollment of approximately 400 permitted a sufficiently large number of student schedule combinations, but without excessive quantities of data to be manipulated in an exploratory investigation.

C. Instrumentation

In the field of information storage and retrieval, the peek-a-boo technique* has been utilized in the past for determining which documents from a sizeable file of information might be directly applicable to a given problem or request. The advantages of such a system are low cost, ease of manipulation, and ability to search large volumes of information readily. The peek-a-boo system works on the principle that appropriate "document" numbers may be posted (recorded) by punching out portions of a unit record card reserved for those numbers. Each unit record card is dedicated to a particular characteristic, or aspect of subject matter, with the numbers posted therein representing those documents which are characterized by that aspect of subject matter. Searches for "documents" which have two or more characteristics in common may be conducted by superimposing unit record cards for relevant characteristics, in order to discover which document numbers are recorded in common (light passes through all cards which have identical numbers punched out at identical positions reserved on each card for that number, leading to the name "peek-a-boo".

This principle was interesting in connection with the class scheduling and registration application since it was hypothesized

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* Kent, A., Textbook on Mechanized Information Retrieval, ed. 2, John Wiley, New York, 1966, 48-50.

that master schedules could be recorded in one set of peek-a-boo cards as geometric patterns of course numbers, and desired student schedules could be recorded in other sets of cards. These could, then, be compared quickly and inexpensively to determine legality of proposed student schedules.

However, there are practical limits to peek-a-boo card size that can be handled conveniently and to hole size that can be positioned accurately and punched economically.

One manufacturer has attempted to overcome the limitations of the peek-a-boo cards in the device called InSite. This device uses spools of punched tape to represent aspects, effectively free of limitations with regard to numbers of documents, that can be handled. Matching of aspect (recording) tapes to permit identification of punched-in document numbers is conducted photoelectrically with such numbers printed out, as well as counted, to determine frequency of identification. The search function is performed at a scanning speed of 10,000 references per minute, with reference print-out at the same speed. There is no theoretical limit to the number of input tapes that can be handled for simultaneous scanning. However, the prototype is set up for six tapes.

Twenty-four input tapes, stored on bobbins, were provided for experimental use. All tapes are identical and each accommodates, in its 100 foot length, 50,000 reference-number positions. These positions are arranged in blocks of 100, each block having ten columns and each column having ten positions. Position numbers are indicated by repetitive printing, on the tapes, of these blocks.

The blocks are consecutively numbered along the tape, having numbers such as "462XX", etc. The "XX" is used as a symbol to represent the two lower-order digits of a reference number; the tens digit being printed at the head of each column and all ten unit digits being printed in each column.

A reference number is recorded on a tape by punching a hole in the tape in the position belonging to that number. For instance, to record the reference number 46372, a hole would be punched in unit-position 2, in column 7, in block number 463XX.

The prototype provided no automated method for punching the input tapes. Punching is done by a solenoid-operated punch, manually positioned, which is included in the scanning unit.

Searches are accomplished by selecting the input tapes corresponding with the desired descriptive terms. These tapes are then run simultaneously through the scanning unit. Since they are all kept in accurate alignment, any position which has been punched in all of those tapes will appear as a hole completely through the group of tapes. The sensing head comprises an illumination source over the tapes and a row of ten photoelectric cells under the tapes. This row of cells is arranged transverse of the tapes and the individual cells are positioned to be directly under the ten individual unit-digit positions. When a hole passes over a cell, the cell is light-activated; and a pulse, identifying which unit digit, or hole, is punched, is fed into the electronic system. If more than one hole appears in a single column, each cell produces a discrete pulse.

A by-product output of the electronics system is used to operate an electronic counter which counts the "hits" during the scanning process and displays the result.

The high-speed printer is completely different in concept from printers commonly used in data-processing systems. The InSite printer includes two separate elements which operate in unison: a mechanical printing-counter which keeps in step with the block and column numbers as the tape passes through the scanning head; and the unit-digit printer, which is selectively responsive to the photoelectric cells in the scanning head. When one or more of the cells is activated, the related unit digit (or digits) is printed; and, simultaneously, the mechanical counter-printer is actuated to print the four higher-order digits of the reference number. Print-out is in the form of a conventional adding-machine tape, automatically ejected from the printer unit. Print-out is on-line at the scanning speed of 10,000 reference numbers (1,000 columns) per minute.

Input into the Beekley device was to be performed using punched Mylar tape. One set of tapes was to contain the proposed master schedule of the Graduate School of Library and Information Sciences. A second set of tapes was to contain the prerequisites for those courses requiring them. A third group of tapes was to hold the information corresponding to the historical and current and proposed student schedules. These three sets of tapes were to be fed simultaneously to the Beekley InSite device, which would rapidly scan the records for "hits" through the peek-a-boo imposed tapes and permit contact to be made with the sensing element. An electronic counter adds the total number of successful schedules, while a printer records the coded numbers corresponding to the valid applications.

D. Data Collection

1. Program Variables

The investigation was predicated upon the existence of a long-range master schedule of classes and of certain prescribed curricula which students, based upon their interests and subject majors, could pursue. Accordingly, a necessary first step was a detailed analysis of the opinions and desires of the faculty and administration of the Graduate School of Library and Information Sciences with regard to such prescribed curricular paths.

The faculty of the Graduate School of Library and Information Sciences were interviewed to ascertain their views on courses of study and class schedules. Since all of those interviewed advise students in course selection, there was an attempt to discover the type of direction given students and the problems confronting an adviser in outlining programs of study for students. Basic curriculum and areas of specialization were the original issues the interviewers had intended to consider. Additional issues (e.g., class size and half-trimester sessions) were added by the faculty during the interviews.

2. Student Requirement Variables

Concurrent with the investigation of faculty opinions and desires with regard to program, data was gathered from records of students enrolled in the School during the period September, 1963 to June, 1965 regarding course registration. Also, the April, 1966 class was involved in a trial registration in order to determine how students might register if they had relatively free choice of schedule for the remainder of the terms until completion of degree requirements.

E. Processing of Data via InSite

Data collected on student registration desires ~~was~~ were recorded by punching, on Mylar recording tape; and each student course configuration, as represented by a geometric pattern of punched holes, was matched against the master schedule for "legality".

IV. Results

A. Program Variables

A set of curricula paths in the Masters degree program of the Graduate School of Library and Information Sciences, each consisting of required courses, as well as electives, was hypothesized for the following specializations:

public librarianship

college and university librarianship

school librarianship

special librarianship

children's librarianship

and for the following functions:

acquisitions

cataloging

reference

administration

(For a detailed list of these hypothesized curricula, see Appendix A).

The faculty of the School was interviewed individually in order to elicit comments on the curricula and on class scheduling problems.

Each of the ten persons interviewed saw a need for scheduling courses for several terms in advance of the terms in which current registration was taking place. However, it was recognized that scheduling in advance does present problems, such as lack of knowledge of future availability of faculty members qualified to teach particular courses; however, it was believed that the benefits derived by the faculty members in advising students greatly outweighed any disadvantages such a plan might have.

It was generally agreed that, given the current requirement of 32 credits for completion of the Masters program, approximately half should be required of all students (course numbers 110, 120, 150, 180, and 261). The introductory course (LS 100 or 110) should precede all other courses according to most of the faculty. After the completion of the introductory course, either LS 120 Collections Development and Use or LS 150 Organization of Library Materials may be taken. The only core course having prerequisites is LS 180 Principles of Library Administration.

It was suggested that LS 110 Orientation has a greater value than LS 100 Introduction to Librarianship. One faculty member suggested that new full-time students be admitted to the School only when it is feasible to offer LS 110. A related suggestion was that the admission of full-time students be limited to September, January, and June; and LS 110 would be offered at these times.

There were several other suggestions of additions to the required 17 credits. One faculty member suggested LS 267 Languages for the Library and Information Sciences be a required course. Another suggested it be included only if the total Masters program was increased to 38 credits. Another course recommended as a requirement was LS 252 Technical Processes, the reason being that there is a great demand for catalogers; and LS 150 Organization of Library Materials is not sufficient preparation for students. Opposing the inclusion of an additional cataloging course, one faculty member suggested that the current trend is toward mechanization of the cataloging process and central cataloging which does not indicate a continued need for expert catalogers.

On the subject of specialization, there was a great diversity of thought. Two of those interviewed stated there is little opportunity for specialization in the 32 credit Masters program. This idea is suggested in the GSLIS catalog's statement, "Specialization-in-depth on the fifth year level is not regarded as either desirable or feasible."

Most of the others thought there was adequate opportunity for specialization at this level. There was no consensus on what the areas of specialization are. However, the clearest statement divided specialization into two categories: (1) type of library; and (2) function in the organization. The five possibilities suggested under type of library were: public, college and university, school, special, and children's work. The functions suggested were: acquisition, organization, reference service, and administration (see Appendix A). Another person offered division by the four areas in the catalog: foundations and research, resources, technical operations and systems, and management and special services. The three areas of specialization suggested by another faculty member were the information sciences, technical processes and children's work.

In this connection, the School catalog states:

> ...students may well have when they enter the school or will soon develop an interest in one or more types of professional service; and, so in planning study schedules, faculty members will take into account the following anticipated professional service areas--general, instructional, academic and research, and special information centers.

As to when a student should decide on specialization, many of the faculty thought it better for the student to complete the basic, required courses, before making commitments.

As a result of the faculty interviews, a series of proposed prescribed courses and curricular paths were derived (Appendix A).

B. <u>Student Requirement Variables</u>

There are several different types of students in the Masters program: full-time day, part-time day, full-time night, or part-time night. Each group desires classes at different times of the day. The part-time day students, primarily married women, prefer classes during the time their children are in school, while the persons who work during the day require late afternoon, night or Saturday classes. When these two groups wish the same course, a tug-of-war results because what is offered for one group will not be convenient for the other. Since he can usually attend either day or night courses, the full-time day student is the most flexible. It has been the School's practice to register day students for some night courses, in order to unify the student body.

Course configurations of students enrolled in the School from September, 1963 through June, 1965 were studied in an attempt to discern how past schedules had been exploited by full- and part-time students (both night and day).

The distribution of students entering the School by time of year was as follows:

Term Entered	Number of Students			
	Full-time		Part-time	
	Day	Night	Day	Night
Fall	146	17	61	99
Winter	15	12	28	43
Spring (half-term)	22	4	30	28
Summer (half-term)	54	6	37	7

The distribution of students according to number of terms taken to complete masters degree requirements was as follows:

Number of Terms		Number of Students
2	------------	5
3	------------	90
4	------------	57
5	------------	25
6	------------	29
7	------------	17
8	------------	7
9	------------	1
10	------------	1

From these data, it was obvious that a significant percentage of full- and part-time, day and night, students had been accommodated and, presumably, would have to be accommodated in the same approximate distribution in the future.

However, in order to determine how students _might_ register, given considerable latitude in choice of courses and in schedules, a trial registration was undertaken. The forms used were of two types.

In Appendix B are shown the three forms which were utilized to determine student desire. The first form (Figure 1, Appendix B) is the Student Time Selection Chart. The purpose of this form was to determine grossly the periods of time when students would both be able and would desire to attend classes. The first half of this form was designed to elicit student reponses relative to the periods of time when it would be impossible, for various reasons, to attend classes, both by time of day and by term.

The second form (Figure 2, Appendix B) is the Student Library Interest Form. Its purpose was to: (1) determine into which broad area of interest each student would categorize himself; (2) within that broad categorization, to determine what special interest(s) the student might have.

The final form (Figure 3, Appendix B) is the Student Course Determination Form. The purpose of this form was to determine what courses each student had taken in the past and was planning to take in the future. The courses are listed for a period of eight consecutive terms, with "N's" signifying night classes and "D's" signifying day classes. In order to place some initial constraints upon the selection of courses, a round-robin schedule of classes was hypothesized. This schedule was developed as a result of analyzing the comments and suggestions of faculty and after investigating the historical patterns of class selection which had been exhibited by students who had completed the masters program.

The function of the three forms in Appendix B, when taken together, was to provide some initial correlations between classes, terms, and hours offered, and the types of students (by their library major) who requested particular classes in particular sequences. The purpose was to develop a series of time and course offerings which would adequately serve the needs of the student body within the constraints of faculty availability.

Appendix C, Questionnaire Forms for Mechanized Accounting and Scheduling of Students Through the Use of the Beekley InSite Device, contains the two forms which were utilized in collecting information relevant to <u>specific</u> course and time desires by the student body. The forms were designed to correspond to the matrices used by the Beekley InSite device, so that data could be transposed easily during punching of InSite tapes. The first form (Figure 1, Appendix C) is the Current Student Course-Time Desires Form. The purpose of this form was to elicit specific responses from the student body as to the precise course and time configurations which each would have selected had all courses for that particular term been available at all hours of the day. Across the top of the form are listed those courses which were offered during the term under investigation, commencing with course LS 100 and ending with course LS 382. At the right-hand side of the course matrix appear the potential starting hours. They begin at 9:00 AM and increase by increments of one hour through 7:00 PM. The students were asked to indicate their selections by placing an "x" in the appropriate block(s) at the intersection(s) where the desired courses and the desired starting hours met.

The second form (Figure 2, Appendix C) is the Future Student Course-Time Desires Form. The purpose of this form was to determine the precise classes which the current student body planned to take during the next three trimesters, within the given constraints of three potential time periods. These three time periods were broken down as morning, afternoon, and evening. As with the prior form (Figure 1, Appendix C), potential courses are listed across the top, beginning with course 100 and ending with course 290. At the extreme right-hand edge of the form appear the letters "M", "A", and "E". These stand for "morning", "afternoon", and "evening". At the extreme left of the form appear the words "summer", "fall", and "winter". These represented the next three terms in the GSLIS curriculum. The students were asked to select those courses which they planned to take during the next three terms and mark an "x" at the appropriate intersection where the term, course, and time met. The purpose of this form was twofold. It was used as a check to determine if historical patterns were still holding true for the current student body. Second of all, it was used as an aid in determining what specific courses ought to be offered and at what general times during the day for ensuing trimesters in the Graduate School of Library and Information Sciences.

Appendix D, Summaries of Questionnaire Forms, contains the summaries and data for the preceding forms utilized as data collection devices. The results of the student time selections indicated that, among the current student body in the Graduate School of Library and Information Sciences, the preferred class hours were Monday through Friday from 9:00 AM to 12:00 noon. Second preference was from Monday through Friday from 1:00 PM to 4:00 PM. Third preference was Monday through Friday from 6:00 PM to 9:00 PM, with Saturday from 9:00 AM to 12:00 noon being selected as more preferable than Monday through Friday from 4:00 PM to 6:00 PM, which ended with the lowest rating. As expected, when analyzing the times during which it was impossible for students to attend, there was a high correlation between the most frequently selected "impossible" time period and the least frequently selected "preference" (Monday through Friday from 4:00 PM to 6:00 PM). A summary of the results of the time preference and possibility survey appears in Appendix D (Figure 1).

The second form (Figure 2, Appendix D) is a summary of the Student Interests. It indicates that, of the students who responded to this questionnaire, cataloging and reference were the two most frequently selected areas of library work. At the same time, approximately one sixth of the respondees indicated by selecting "undecided" that they had not yet made a determination as to which area of library science most appealed to them.

The evaluation and reduction of the data accumulated from the Student Course Determination Forms is given in Appendix D, Figure 3. It is interesting that relatively few students were able to predict desired courses more than two terms into the future. Also, it was interesting to note that when both day and night sessions of the same course were offered, the day course was far more popular. When the same classes were offered both at night and on Saturdays, the evening session was usually selected in preference to the Saturday session. From this, it seems reasonable to suggest that student preferences are generally in the order "day", "night", "Saturday", in descending order.

The results of the survey of current and future course time preferences are given in Figures 4 and 5, Appendix D. As their preferred period for attending a course, 126 students selected the earliest morning starting time, 9:00. 52 individuals selected 10:00 AM. There were scattered results throughout the rest of the day, with the 2:00 being the next most popular time for attending classes as far as daytime students were concerned. However, since many students hold daytime jobs, 120 selected 6:00 PM as the optimum time of the day for attending class.

In examining the results for future student requirements (Figure 5, Appendix D), morning classes again proved to be the most favored, with night sessions rating second, and afternoon being selected as the third, or least desirable, time of the day for attending classes.

With the three-term projection into the future, results of this investigation upheld preliminary results developed from earlier questionnaires in which there was a deterioration in the ability (or interest) of students to predict future requirements as a function of time span from the current term. Thus, there were 416 projections for the winter term immediately following, 265 projections for the spring term of the next year, and only 146 projections for the summer term thereafter.

In this connection, it is interesting to note here that, although it had been generally believed that the summer term was attended most heavily by students who were unable to attend at any other time of the year, the results, as cited, negate this contention.

C. Processing of Data Via InSite

While it was a relatively simple task to reduce the data on the previous questionnaire descriptively, it would have been an extremely time-consuming task to attempt to determine how many total student schedules, or how many portions of student schedules (historical, current, and future) would have been fulfilled if the hypothesized round-robin schedule were matched against the desires of the students. In order to perform this task, the Beekley InSite device was utilized. As has been explained, the InSite device works on a peek-a-boo principle through the automatic scanning of sets of punched Mylar tapes. The operating philosophy behind peek-a-boo processing is that, if all the desired criteria are met, a light source will be able to penetrate through holes punched in the storage media (the Mylar tapes) and result in a printout.

In the investigation on class scheduling, a number of tapes were prepared for simultaneous overlaying and processing. One of these tapes contained both the current schedule actually used and the proposed round-robin schedule for future terms. A second tape was prepared from the Current and Future Student Course Time Form. This second tape reflected, on a student-by-student basis, all of the course and time configurations which had been individually selected. A third tape, which was generated for the purpose of this investigation, was a student prerequisite tape. In the consecutive scheduling of students, it is not only necessary to determine what classes are desired during what terms but, also, to assure that the student would take these courses within prescribed constraints. Consequently, use of the prerequisite course tape was necessary to assure that prior requirements would be met in proper sequence.

The master schedule tape was prepared in the following manner. Eight frames of tape (10 x 10 matrix each) were required for one complete recording of the present and future master schedules. Each schedule was repeated ten times along the length of a single tape, involving the use of eighty 10 x 10 matrices, or frames.

In order for the InSite device to compare student desires and master schedules, a second tape was prepared on which the same number of frames was assigned per student as were assigned to each representation of the total master schedule. Consequently, each proposed student schedule required eight 10 x 10 frames of tape and was punched into the second tape.

If a student had developed his proposed schedule and had taken prerequisites into account, then, the position corresponding to the course he wished to take, on a third prerequisite, tape, was punched out. If, however, the proposed student schedule did not take prerequisites into account, then, the position corresponding to the desired course on the prerequisite tape was not notched. The logic behind this is as follows: if prerequisites are met (and the proper hole is punched out on the prerequisite tape), then, matching against the master schedule tape could proceed without interference. If, on the other hand, prerequisites are not met, then the lack of a hole in the prerequisite tape would automatically negate the proposed schedule. As with the school schedule, the prerequisite tape occupied eight 10 x 10 frames per student.

> One of the variables under consideration during this investigation was that of the expenditure of time in entering data in machine-processible form. On the average, ten punches could be entered on tapes per minute. Each student in this investigation requested an average of seven courses (scattered throughout the eight possible matrices per student). Consequently, with set-up and initial seeking time, slightly in excess of one minute was required for punching the proposed schedule of each student. With 149 students participating in this phase of the investigation, punching of the student schedule tapes required approximately two hours and forty-five minutes. Preparation of the student prerequisite tapes required one additional hour.
>
> The time required to punch the entire master schedule ten times in eighty frames was approximately three and one half hours. Once the tapes were punched and verified, they were brought to the InSite device for running.
>
> The operation was as follows: master tape, student desired tape and student prerequisite tape were aligned; the counter was set to its starting position and an initial run performed. Once eighty frames had passed by the sensing head, the

tapes were mechanically rewound. Next, both the "student desire" tape and the student prerequisite tape were slipped manually eighty frames in advance, and frame number eighty-one of these tapes was then aligned with frame number one of the master schedule tape. The tapes were again processed and slipped an additional eighty matrices so that, on the third run, frame number 161 of the second student tapes was then aligned with frame number one of the master schedule. This operation was repeated until all the student schedule tapes and student prerequisite tapes had been processed. On the average, ten students were processed in two and one half minutes, so that the entire processing or "searching" consumed only thirty seven and one half minutes of time for the 149 student schedules involved in this portion of the investigation.

The results of the runs were as follows. On the current trimester basis, in which 149 students were given the opportunity to select any normal starting time within the day for any classes being taught during that particular term, 74 students' requirements matched the existing schedule completely. An average of 2.22 course selections were made.

On the other hand, 73 of the 149 student schedules failed to match the existing schedule. For this group, the average number of course selections per student was 3.26. Of these, 1.23 course selections were acceptable, while 2.03 per student did not match the master schedule.

The range of requests for the remaining 46%, on the other hand, is so great as to preclude the possibility of further adjustment.

In addition to evaluating the current term master schedule against unconstrained student course selections, the Beekley InSite device was also utilized in comparing future student demands against the proposed round-robin schedule.

Of the 149 students involved in the investigation, not all made selections in all future terms; 142 indicated schedules for the first term, 127 for the second future term, and 77 for the third future term. If the responses were separated now by terms and success in scheduling was now construed not as meeting the requirements of all courses selected in all future terms, but as meeting the requirements within any given term, 47 student future term schedules matched the proposed schedule at some point. With 346 student schedule selections (142 for the first term, 127 for the second, 77 for the third), the 47 matching schedules represents only a 13.5% success.

Looking at the results from another point of view, the 142 students who made predictions for the first future term selected a total of 420 classes for an average of 2.95 classes per student. The 127 students who made selections for the second future term chose 251 classes for a 1.97 average per student. The 1.83 average class selection per student for the third future term was based upon 77 student schedules and 147 selected classes. A summary of results is given in Appendix D, Figure 6.

It was obvious from these results that some alteration of class schedules for future terms was required. But this rescheduling could now proceed on the basis of an expression of student desires and in sufficient time to permit adequate planning.

V. Discussion

As a result of the class scheduling investigation, information has been gathered regarding the processing of student schedules using the peek-a-boo principle, in general, and the Beekley InSite device, in particular. In its present state of development, the InSite machine conveniently handles only the matching operation. The mechanism for recording information into tapes, because it is physically appended to the searching mechanism and because a convenient keyboard is not yet available, limits the effectiveness of this application. In order to alleviate this problem, consideration should be given to designing a punching mechanism which is both physically removed from the processing instrument and which can be utilized directly by students so that they might prepare their own schedule inputs.

While the numeric printer in the prototype device has the excellent quality of being able to keep pace with the 50,000 items-per-minute processing speed of the Beekley system, the form and content of its output, as currently configured, is difficult to apply directly to problems relative to class scheduling. Consequently, a prerequisite of successful application would be the development of a printing mechanism which would be capable of graphically representing the results of the internal processing. Such a form is given in Appendix E, Figure 1.

In addition to providing printed visual output, it seems reasonable to expect the provision of an interface between the scheduling operation and future processing steps. It is not inconceivable that a machine-readable output of the scheduling operation, whether in punched cards, punched paper tape, or on magnetic tape, might serve directly as the input medium to other student record processing activities, such as grade reporting. In Appendix E, Figure 2, is given a student scheduling machine-readable output form which hypothesizes what a punched card, prepared by the peek-a-boo device for future processing, might look like.

A factor which warrants future investigation is the development of an idealized real-time class scheduling activity. It is possible to hypothesize an operation in which all student advisors will be available to approve and make suggestions relative to a particular student's curriculum. Once approved, the student would approach a remote console through which he would indicate the numbers assigned to the classes which he has selected. If all his selections are available, a form will be generated automatically; and it would list the courses, the hours, and the course locations.

If a student's curriculum fails to be scheduled completely, a message would be printed out on the remote console which would indicate the courses which were no longer available. The student would then be required to discuss alternative selections with his advisors. A simplified flow chart of the hypothesized procedure is given in Appendix E, Figure 3.

VI. Conclusions

This investigation was intended as a preliminary probe into the problems inherent in applying a peek-a-boo approach to class scheduling. Principally because of the design limitations of the prototype Beekley InSite device in its current configuration, the objectives of the class scheduling study were only partially met. While the results have tended to confirm the usefulness of peek-a-boo processing to scheduling, it has neither adequately proven nor disproven the potential applicability of the InSite device.

The preparation of master schedules seems to be feasible if there is adequate interaction between student body and the developers of the schedule and if the master schedule adequately reflects those courses which the students have cited in preliminary investigation. The availability of a long-term master schedule does eliminate much of the need on the part of the faculty advisor for determining the legality of the schedule and places much of that responsibility on the student. By the same token, if students are to assume this responsibility, then it appears necessary that some guidance or instruction be given, perhaps in the form of a short programmed instruction routine, which would provide the students with methods for making alternative choices should their initial selections not be feasible.

This investigation has suggested that there is potential for developing a direct relationship between the scheduling of students and the succeeding procedures of invoicing, development of class lists for instructors, reporting of grades, maintenance of historical student achievement records, etc., through the creation, during the scheduling operation, of machine-readable records.

There seems to be a continuing need for utilizing low cost mechanical peek-a-boo processing in class scheduling and its allied operations. To this end, it appears feasible to suggest that the development of an advanced prototype electro-mechanical peek-a-boo device be encouraged. This system would incorporate the features of remote processing, real time potential, and machine-processible output records.

Appendix A

Curricula Hypothesized for Various Specializations and Functions Related to Librarianship

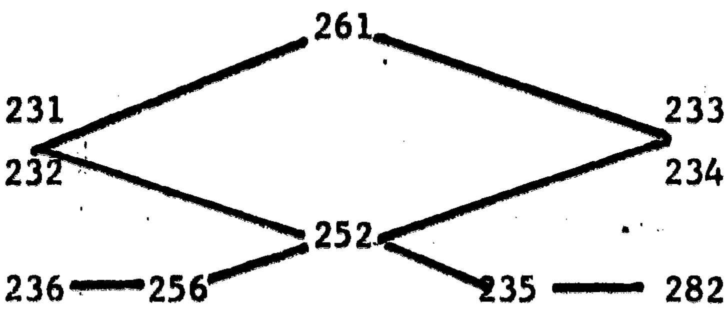
Course Numbers and Titles

LS 100	Introduction to Librarianship
LS 110	Orientation
LS 120	Collections Development and Use
LS 121	Collections Development and Use (Selection)
LS 122	Collections Development and Use (Reference)
LS 150	Organization of Library Materials
LS 180	Principles of Library Administration
LS 185	Instructional Materials Centers
LS 205	History of the Book
LS 206	History of Libraries
LS 211	Methodology of Research
LS 219	Individual Research
LS 222	Materials for Children
LS 223	Materials for Adolescents
LS 224	History of Children's Literature
LS 225	The Materials Based Curriculum
LS 226	Storytelling
LS 231	Collections Building in the Humanities and Social Sciences
LS 232	Reference and Information Services in the Humanities and Social Science
LS 233	Collections Building in Science and Technology
LS 234	Reference and Information Services in Science and Technology
LS 235	Government Publications
LS 236	Serial Publications
LS 237	Medical Literature and Libraries
LS 238	International Library Services and Resources
LS 239	International Education Documentation Services
LS 252	Technical Processes
LS 253	Special Problems in Cataloging and Classification
LS 255	Rare Books
LS 256	Critical Bibliography
LS 261	Mechanized Information Retrieval
LS 262	Specialized Information Centers
LS 263	Mathematics in Information Storage and Retrieval
LS 264	Computers and Information Retrieval
LS 265	Data Processing and the Library
LS 267	Languages for the Library and Information Sciences
LS 280	Library and Information Systems Development and Cooperation
LS 281	Problems and Current Trends in Administration of Library and Information Centers
LS 282	Library Architecture

Suggested Course Number Configurations

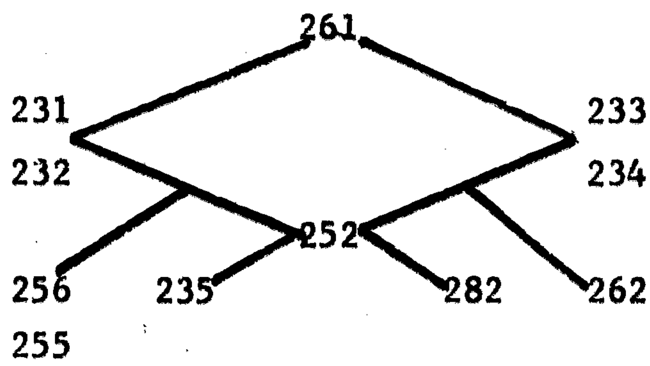
Public Librarian

110
120
150
180



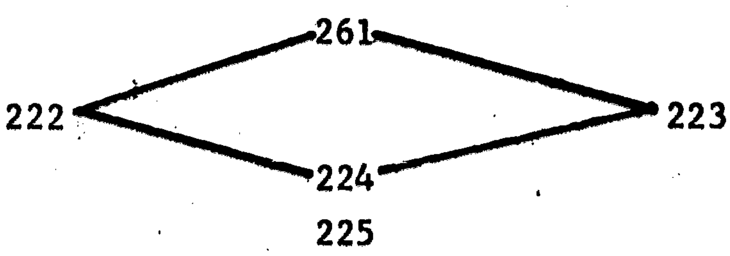
College and University

110
120
150
180



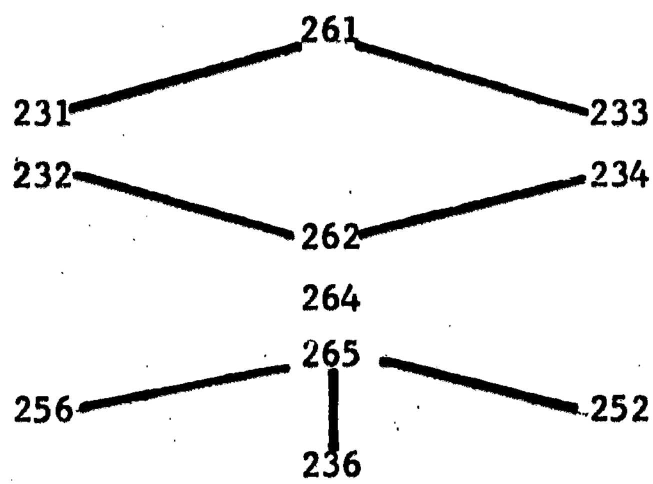
School Librarian

110
120
150
185



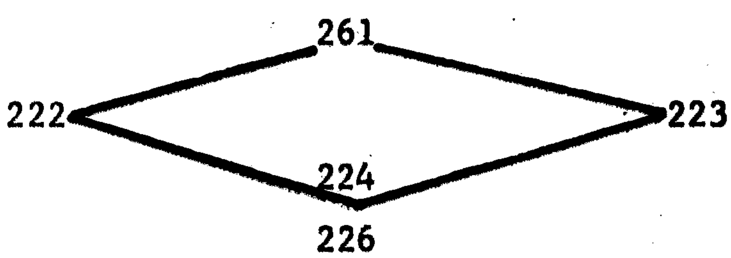
Special Library

110
120
150
180



Children's Librarian

110
120
150
185



Functions

Acquisitions

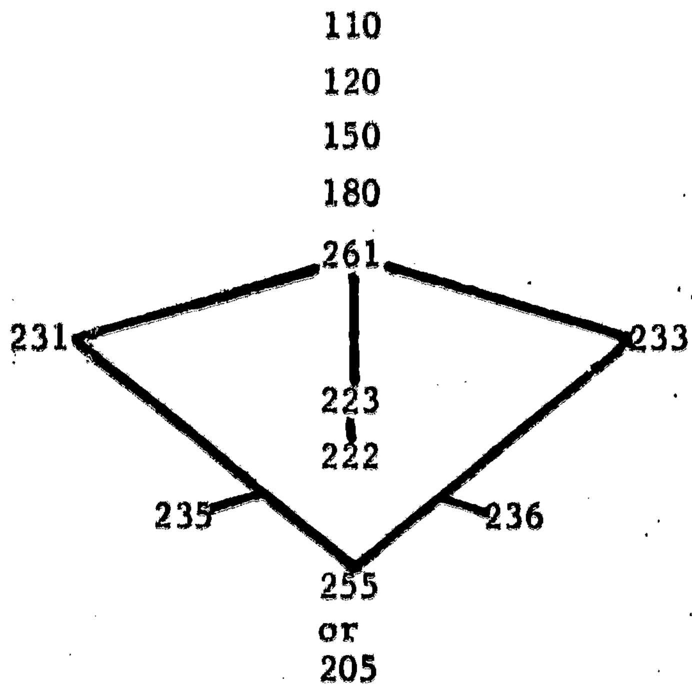
Cataloging

Reference

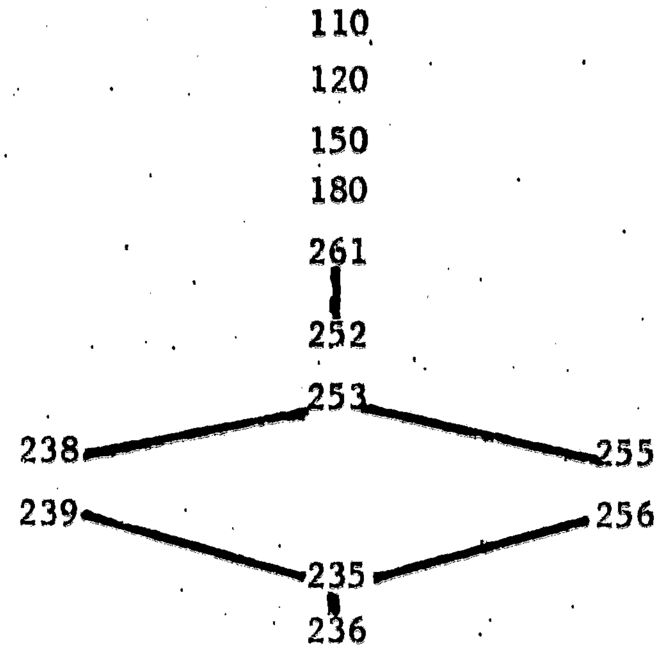
Administration

Suggested Course Numbers and Configurations

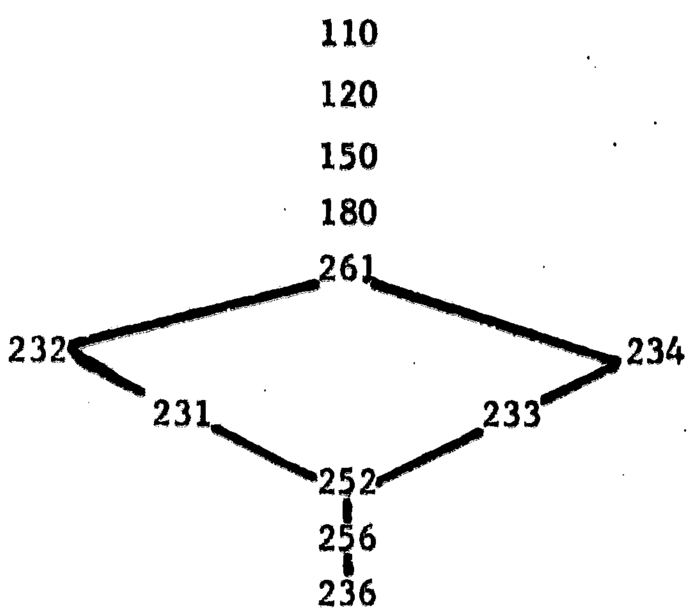
Acquisitions



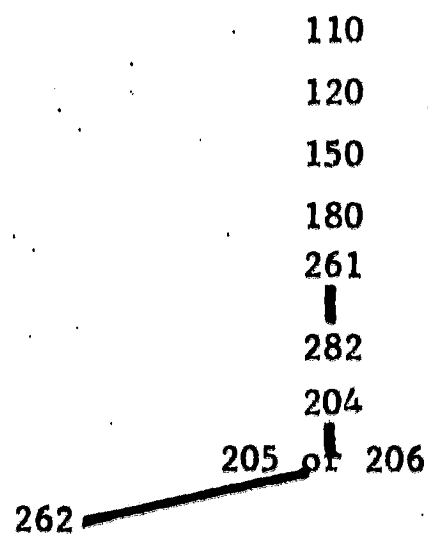
Cataloguing



Reference



Administration



NAME ______________________ AREA OF INTEREST ______________________

Please circle the courses you have taken or plan to take until the awarding of the M.L.S. degree, observing the time codes an tutorial credits.

Fall, 1965-66	Winter, 1965-66	Spring, 1965-66	Summer, 1966	Fall, 1966-67	Winter, 1966-67	Spring, 1966-67	Summer, 19
100 N	100 N	100 N	110 D	100 N	100 N	100 N	110 D
110 D	121 N	120 N	150 D	110 D	120 N	150 N	120 D
120 (I) B	122 B	180 B	185 D	120 D	180 D	180 N	211 LA
120 (II) N	150 N	*206 D	219	150 D	*205 D	185 S	219
120 D	180 D	211 LA	222 D	180 N	219	*206 D	222 D
150 D	185 S	219	223 D	185 S	222 D	219	223 D
180 D	219	222 N	*224 D	*206 D	223 N	222 N	*224 D
*206 D	222 LA	223 D	225 D	211 D	*224 D	223 D	225 D
219	*224 D	225 S	*226 D	219	225 S	*226 LA	*226 D
222 LA	*226 N	231 N	232 N	222 N	231 D	232 D	232 N
223 D	231 D	232 D	236 N	223 LA	232 N	234 N	*236 D
225 S	232 D	*236 N	237 N	*226 D	233 N	*236 N	237 N
*226 N	233 D	*238 D	239 D	231 N	234 D	*238 D	239 D
231 D	233 N	*239 LA	*253 D	233 D	*236 D	*252 D	*253 D
232 D	234 S	*253 N	262 N	234 N	237 N	261 N	261 D
234 N	234 N	256 D	*282 D	*236 N	239 D	263 N	*282 N
*238 D	237 N	261 N		*238 D	*253 D	265 D	
*253 D	*252 D	263 N		*252 N	261 D	*280 D	
256 D	255 D	265 D		261 N	262 N		
261 N	261 D	*281 D		265 N	264 N		
265 N	262 N			*267 N	*267 D		
	264 N				*281 D		
	*267 D				*282 D		
	*280 D						

Figure 3. STUDENT COURSE DETERMINATION FORM

APPENDIX B

GENERAL QUESTIONNAIRE FORMS FOR DETERMINING BROAD PARAMETERS OF STUDENT COURSE AND TIME SELECTIONS

Student's name ______________________

Check the times when it is impossible for you to attend classes:

	Fall	Winter	Spring	Summer
Mon.-Fri. 9-12				
Mon.-Fri. 1-4				
Mon.-Fri. 4-6				
Mon.-Fri. 6-9				
Saturday 9-12				

Reasons: ______________________

____

Check the times when you would prefer to take classes:

	Fall	Winter	Spring	Summer
Mon.-Fri. 9-12				
Mon.-Fri. 1-4				
Mon.-Fri. 4-6				
Mon.-Fri. 6-9				
Saturday 9-12				

What is your major area of interest at this time? ______________________

____

Figure 1. STUDENT TIME SELECTION CHART

NAME: ____

Please check the <u>one</u> area of library work in which you are most interested.

__________ Acquisitions

Administration
__________ College library
__________ Public library
__________ Special library

__________ Cataloging

College or university library
__________ Science
__________ Humanities
__________ Science <u>and</u> humanities

__________ Information sciences

__________ International librarianship

Public library
__________ Science
__________ Humanities
__________ Science <u>and</u> humanities
__________ Children's

__________ Reference

School library
__________ Elementary
__________ Secondary

Special library
__________ Science
__________ Humanities
__________ Science <u>and</u> humanities

__________ Undecided

Figure 2. <u>STUDENT LIBRARY INTEREST FORM</u>

APPENDIX C

QUESTIONNAIRE FORMS FOR MECHANIZED ACCOUNTING AND SCHEDULING OF STUDENTS THROUGH THE USE OF THE BEEKLEY INSITE DEVICE

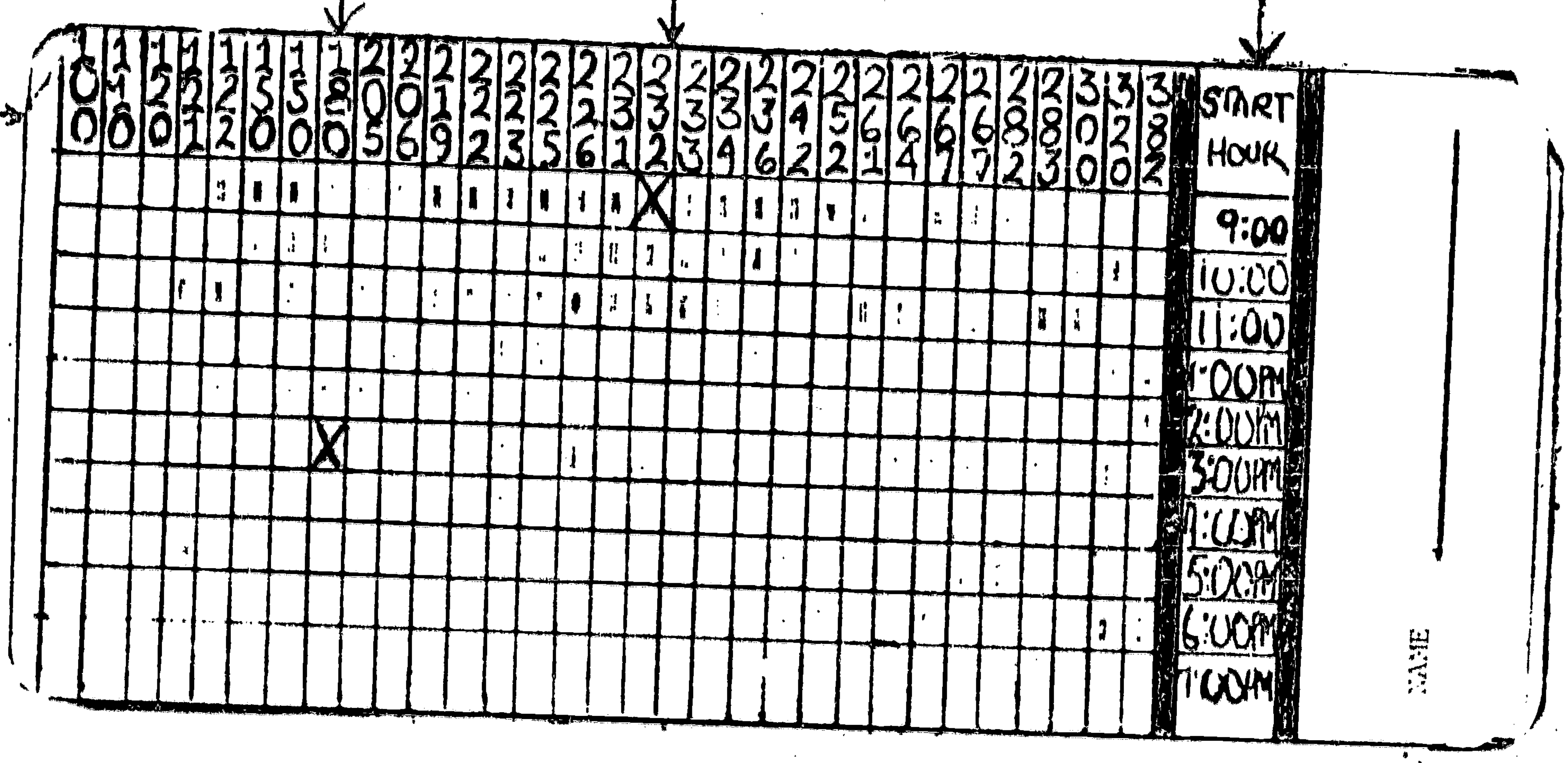
~~In~~ ~~conjunction~~ with an overall plan to better fulfill the needs of the student body of the Graduate School of Library and Information Sciences, the University of Pittsburgh's Knowledge Availability Systems Center is examining the scheduling of both course offerings and times scheduled for the various classes.

In order to aid in this investigation, will you kindly fill out the form below in accordance with the following instructions.

(1) From the courses listed across the top of the card, select those which you would have taken this term had they all been available at the hours you desired.

(2) From the "starting hour" column to the right of the card, determine what would have been the optimum starting time for the courses you would have selected.

(3) Mark the block where the desired course number and the desired starting time intersect. For example, if you wished to take course number 180 at 3:00 p.m. in the afternoon, you would find course number 180 at the top of the card, and 3:00 p.m. at the right of the card, and mark the block where the two intersect.
By the same token, if you wished to take course number 232 at 9:00 a.m., you would find 232 at the top of the card and 9:00 a.m. to the right of the card, and mark the block where these two intersect.



Would you now kindly fill out the form on the following page in accordance with the suggested course configurations for your particular "major" area.

Figure 1. CURRENT STUDENT COURSE-TIME DESIRES FORM

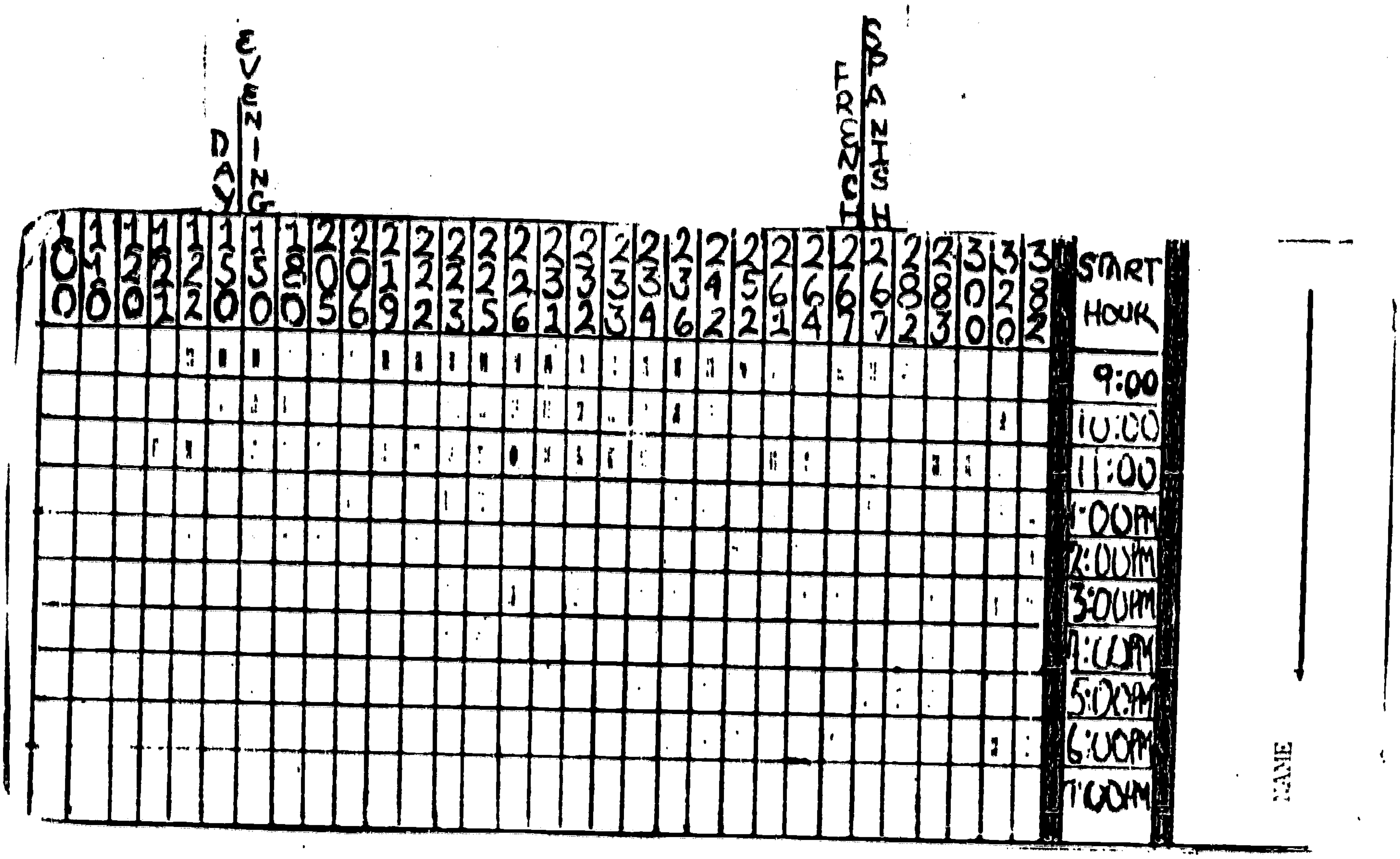


Figure 1. (continued)

Now that you have developed an optimum schedule for the current term, you are being asked to help design future schedules for the Graduate School of Library and Information Sciences.

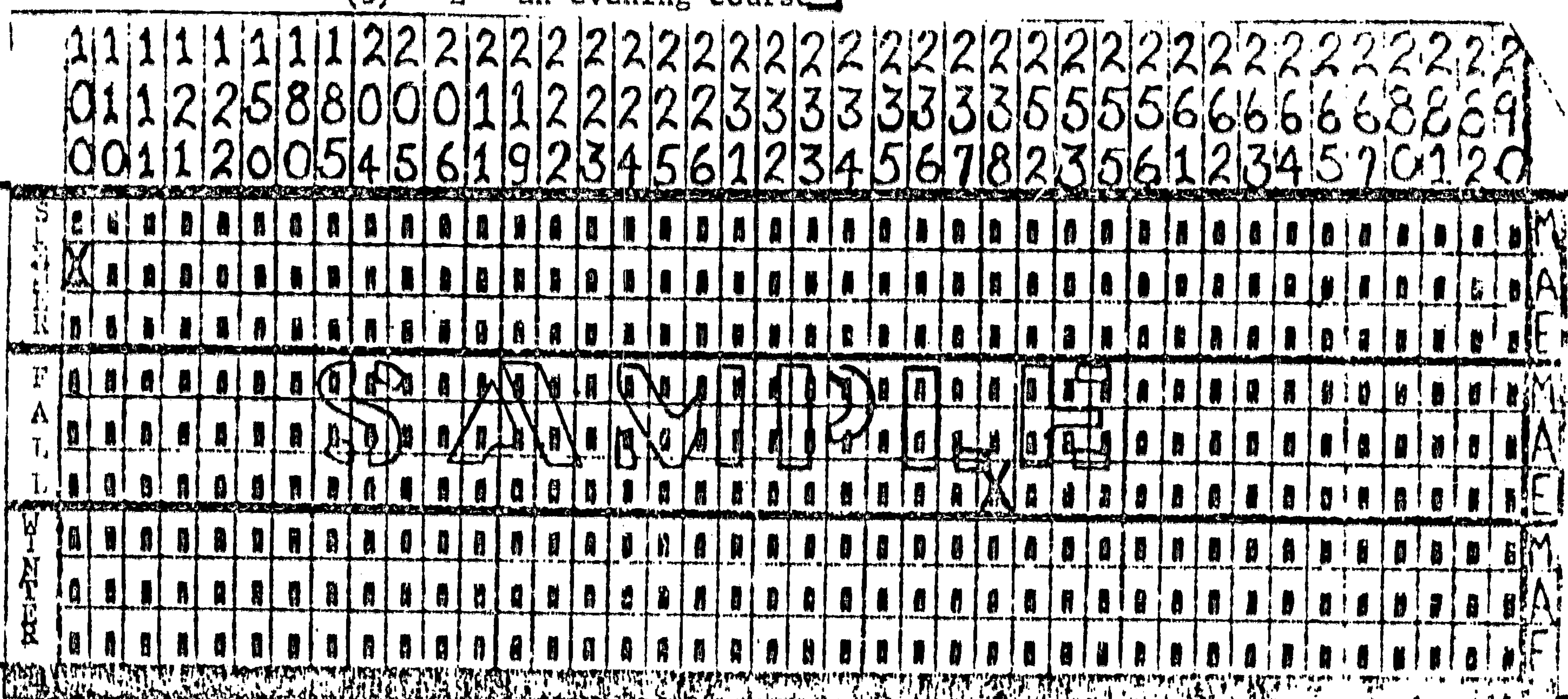
On the form below are listed all the fifth year courses which are available in the Graduate School. These courses are listed across the top of the card.

To the left of the card are listed the next three terms during which courses will be offered in the Graduate School of Library and Information Sciences.

(1) the first is for the summer session, 1966
(2) the second is for the fall semester, 1966
(3) third is for the winter semester, 1966-67

To the right of the card, there are three time period breakdowns for each semester.

(1) M = a morning class
(2) A = an afternoon class
(3) E = an evening course



In order to fill out the form, first determine the courses you are planning to take in these next three semesters (provided you will not have been graduated at an earlier date). If, for example, you wish to take course number 100 in the summer half term in the afternoon, you would locate course number 100 across the top of the card. You would then find the section for the summer half term, 1966, and within that section the afternoon time period. Where the afternoon session for course 100 in the summer half term lines coincide, you would mark the appropriate box with an X.

If, in addition, you plan to take course number 238 in the fall term in the evening, you would find 238 at the top of the card, the fall term in the middle band of the card and then, finally, the evening hour for that term. You would then X this block. The same criteria holds true for the winter term.

In accordance with the above instructions, will you please select the courses you desired to attend for the next three terms, and X your desired choices on the form located on the following page. We will endeavor to develop a long range

Figure 2. FUTURE STUDENT COURSE-TIME DESIRES FORM

schedule of courses which will reflect your expressed needs.

Thank-you for your cooperation.

	100	110	111	121	122	150	180	185	204	205	206	211	219	222	223	224	225	226	231	232	233	234	235	236	237	238	252	253	255	256	261	262	263	264	265	267	280	281	282	290	
SUMMER																																									M
																																									A
																																									E
FALL																																									M
																																									A
																																									E
WINTER																																									M
																																									A
																																									E

Figure 2. (continued)

APPENDIX D

SUMMARIES OF QUESTIONNAIRE FORMS

Check the times when it is impossible for you to attend classes:

	Fall	Winter	Spring	Summer
Mon.-Fri. 9-12	62 (36.4%)	58 (34.1%)	56 (33.0%)	32 (18.8%)
Mon.-Fri. 1-4	64 (37.7%)	60 (35.2%)	60 (35.2%)	34 (20.0%)
Mon.-Fri. 4-6	78 (45.8%)	70 (41.1%)	60 (35.2%)	42 (24.7%)
Mon.-Fri. 6-9	44 (25.8%)	46 (27.0%)	38 (22.4%)	32 (18.8%)
Saturday 9-12	54 (31.7%)	54 (31.7%)	52 (30.5%)	42 (24.7%)

Check the times when you would prefer to take classes:

	Fall	Winter	Spring	Summer
Mon.-Fri. 9-12	160 (94.1%)	168 (98.8%)	170 (100%)	156 (91.7%)
Mon.-Fri. 1-4	92 (54.1%)	86 (50.5%)	80 (47.0%)	58 (34.1%)
Mon.-Fri. 4-6	24 (14.1%)	24 (14.1%)	18 (10.5%)	10 (5.8%)
Mon.-Fri. 6-9	72 (42.4%)	70 (41.1%)	74 (43.6%)	54 (31.7%)
Saturday 9-12	40 (23.6%)	36 (21.1%)	38 (22.4%)	24 (14.1%)

Figure 1.
SUMMARY: STUDENT TIME SELECTION CHART--NUMBERS AND PERCENTAGES

NAME: ______________________________

Please check the one area of library work in which you are most interested.

(0) Acquisitions

Administration
(2) College library
______ Public library
______ Special library

(13) Cataloging

College or university library
(3) Science
(7) Humanities
(3) Science and humanities

(12) Information sciences

(1) International librarianship

Public library
______ Science
(5) Humanities
______ Science and humanities
(3) Children's

(24) Reference

School library
(5) Elementary
(1) Secondary

Special library
(9) Science
(16) Humanities
(3) Science and humanities

25 Undecided

Figure 2. SUMMARY: STUDENT INTERESTS

ME ______________________ AREA OF INTEREST ______________________

Please circle the courses you have taken or plan to take until the awarding of the M.L.S. degree, observing the time codes and tutorial credits.

Fall, 1965-66	Winter, 1965-66	Spring, 1965-66	Summer, 1966	Fall, 1966-67	Winter, 1966-67	Spring, 1966-67	Summer, 196
(96) 100 N	(1) 100 N	100 N	110 D	100 N	100 N	100 N	110 D
(93) 110 D	(13) 121 N	(10) 120 N	(3) 150 D	110 D	120 N	(8) 150 N	(2) 120 D
(14) 120 (I) B	(18) 122 B	(27) 180 B	(4) 185 D	(1) 120 D	180 D	180 N	211 LA
(13) 120 (II) N	(18) 150 N	(24) *206 D	(1) 219	(1) 150 D	*205 D	(4) 185 S	219
(92) 120 D	180 D	(4) 211 LA	(9) 222 D	(6) 180 N	219	(3) *206 D	222 D
(102) 150 D	(96) 185 S	(2) 219	223 D	185 S	222 D	219	223 D
(1) 180 D	(1) 219	(7) 222 N	(3) *224 D	(3) *206 D	(4) 223 N	222 N	(1) *224 D
*206 D	(8) 222 LA	(8) 223 D	(7) 225 D	211 D	(2) *224 D	223 D	(1) 225 D
(1) 219	(4) *224 D	(6) 225 S	(9) *226 D	219	(1) 225 S	*226 LA	(1) *226 D
222 LA	(1) *226 N	(33) 231 N	(4) 232 N	(2) 222 N	(1) 231 D	232 D	232 N
223 D	(46) 231 D	(27) 232 D	(35) 236 N	(4) 223 LA	(12) 232 N	(4) 234 N	(3) *236 D
(3) 225 S	(43) 232 D	(42) *236 N	(6) 237 N	(5) *226 D	(13) 233 N	(3) *236 N	237 N
*226 N	(14) 233 D	(10) *238 D	(40) 239 D	(4) 231 N	234 D	*238 D	239 D
(4) 231 D	(9) 233 N	*239 LA	(19) *253 D	233 D	*236 D	(2) *252 D	*253 D
(1) 232 D	(8) 234 S	(1) *253 N	(26) 262 N	(6) 234 N	237 N	(3) 261 N	(2) 261 D
234 N	(17) 234 N	(19) 256 D	*282 D	(3) *236 N	239 D	263 N	(2) *282 N
*238 D	(6) 237 N	(3) 261 N		(4) *238 D	*253 D	(2) 265 D	
(2) *253 D	(31) *252 D	(2) 263 N		*252 N	261 D	(1) *280 D	
256 D	(19) 255 D	(16) 265 D		(12) 261 N	(2) 262 X		
(6) 261 N	(89) 261 D	(3) *281 D		(5) 265 X	(5) 264 X		
(2) 265 N	(2) 262 N			(11) *267 X	(4) *267 D		
	(6) 264 N				(2) *281 D		
	(49) *267 D				*282 D		
	(1) *280 D						

Figure 3. SUMMARY: STUDENT COURSE DETERMINATIONS

Figure 4. SUMMARY: CURRENT STUDENT COURSE-TIME DESIRES

100	110	120	121	122	150 DAY	150 EVENING	180	205	206	219	222	223	225	226	231	232	233	234	236	242	252	261	264	267 FRENCH	267 SPANISH	282	283	300	302	382	START HOUR
6	50	51	2	2	1	0	1	1	1	0	1	0	0	1	3	0	0	0	0	0	1	3	0	2	0	0	0	0	0	0	9:00
3	10	15	0	2	3	1	0	1	1	0	1	1	1	0	1	1	0	0	1	1	2	0	1	1	0	1	1	1	1	1	10:00
0	3	4	1	0	3	0	0	3	1	1	0	0	0	0	2	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	11:00
1	1	4	0	1	10	2	1	0	0	0	0	0	0	0	1	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1:00PM
1	3	1	2	0	29	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	0	0	0	0	0	0	0	0	2:00PM
0	1	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3:00PM
1	1	0	0	2	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	4:00PM
1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5:00PM
57	4	5	17	15	1	3	1	1	0	0	1	0	2	3	1	0	0	0	0	0	0	8	0	0	1	0	0	0	0	0	6:00PM
4	1	2	3	4	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	7:00PM

Figure 5. SUMMARY: FUTURE STUDENT COURSE-TIME DESIRES

	100	110	111	121	122	150	180	185	204	205	206	211	219	222	223	224	225	226	231	232	
WINTER	0	1	0	4	2	12	31	5	0	5	3	0	0	6	4	0	5	1	12	12	M
	0	0	0	1	0	2	11	3	1	5	4	0	1	2	3	1	1	1	4	1	A
	1	0	0	15	14	24	12	6	1	1	1	1	0	6	1	2	6	3	1	2	E
SPRING	0	0	0	0	1	2	13	2	2	0	1	2	1	1	3	3	3	0	9	10	M
	0	0	0	0	1	0	5	1	0	0	0	0	0	1	1	0	4	2	3	4	A
	0	1	1	7	10	13	8	6	2	1	1	0	0	0	2	2	4	4	5	0	E
SUMMER	0	0	0	1	2	4	2	4	1	2	0	1	0	3	2	4	3	4	3	3	M
	0	0	0	0	0	2	1	0	0	0	0	0	0	2	0	0	0	0	3	3	A
	0	0	1	1	1	4	7	2	0	3	0	1	0	1	1	1	1	2	1	1	E

	233	234	235	236	237	238	252	253	255	256	261	262	263	264	265	267	280	281	282	290	
WINTER	5	3	2	6	1	1	6	0	1	1	19	1	0	1	0	3	1	0	1	0	M
	1	5	4	7	1	1	6	3	2	1	11	0	0	2	1	12	2	2	2	1	A
	4	5	0	2	0	1	0	0	1	1	12	0	1	2	3	10	1	1	1	1	E
SPRING	3	3	1	3	3	3	4	5	0	2	9	2	3	5	4	7	0	0	1	0	M
	1	0	1	2	1	0	6	3	2	1	3	1	0	2	2	6	0	0	0	1	A
	3	0	1	0	0	1	2	0	0	0	8	2	3	1	0	2	1	1	1	1	E
SUMMER	2	6	2	4	1	0	2	2	1	2	1	0	2	3	2	7	1	0	3	2	M
	2	0	0	4	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	2	A
	0	1	1	4	0	1	2	1	0	0	2	1	1	0	0	4	2	0	0	0	E

Figure 6. SUMMARY OF STUDENT-TO-MASTER SCHEDULE MATCHES

Number of Students Participating	149
Number of Current Schedules Matching Master Schedule	74
Number of Current Schedules not Matching Master Schedule	73
Number of Students not Responding	2
Average Number of Classes Requested per Student which Matched Schedules	2.22
Average Number of Classes Requested per Student which did not Match Schedules	3.26
Number of Students Providing Future Course Requirements	142 for first future term 127 for second future term 77 for third future term
Number of Future Schedules Matching Proposed Future Master Schedule During at least One Term	47 - 14 matching first term 25 matching second term 8 matching third term
Average Number of Classes Requested per Student which Matched Schedules	3.00 for first future term 1.32 for second future term 1.75 for third future term
Average Number of Classes Requested per Student which did not Match Schedules	2.95 for first future term 1.97 for second future term 1.83 for third future term

APPENDIX E

FORMS AND PROCEDURES

FOR HYPOTHESIZED SYSTEM

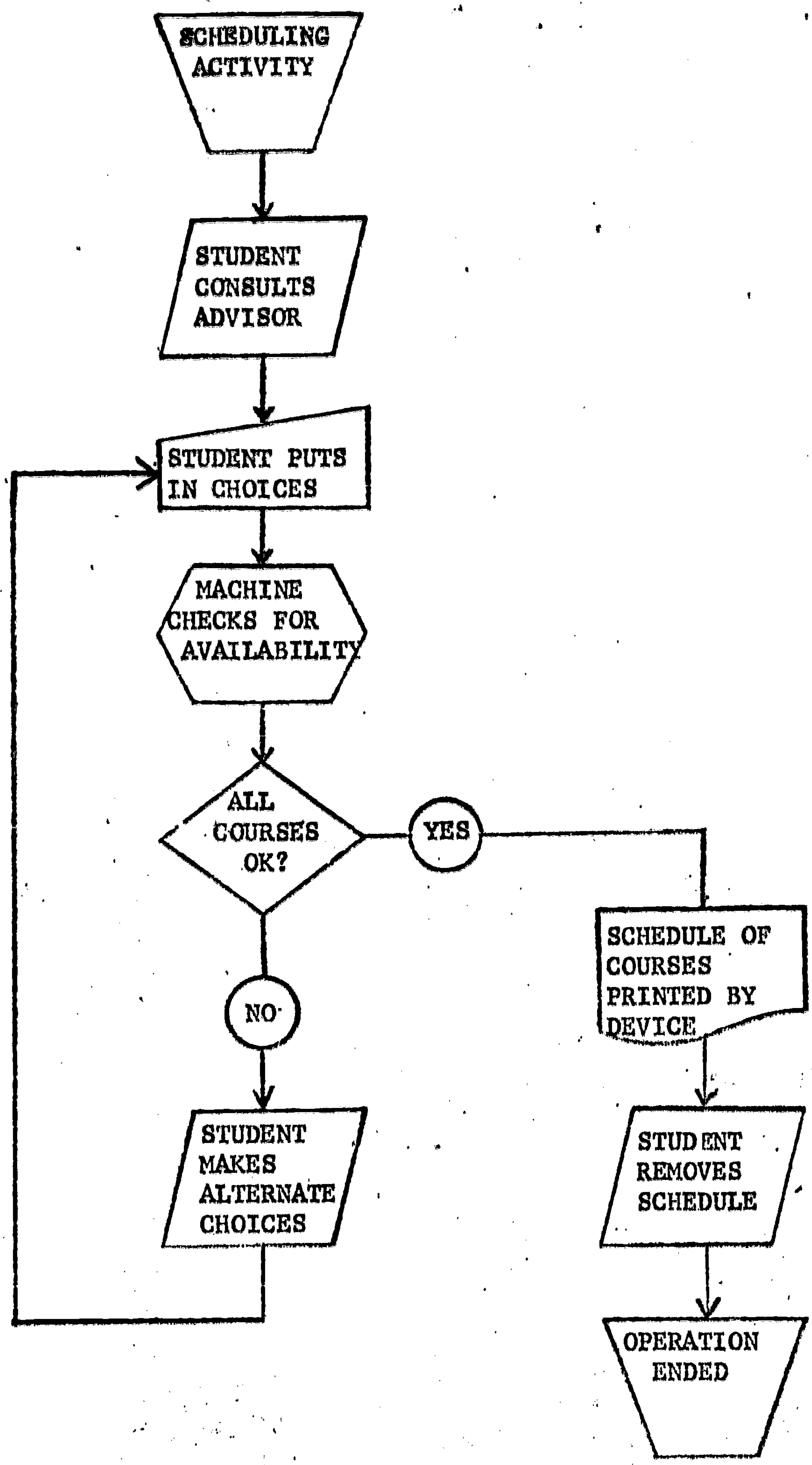


Figure 3.

REAL-TIME CLASS SCHEDULING SYSTEMS DESIGN

STUDENT NUMBER 1-10
DATE 11-16
COURSE NUMBER ONE 17-21
COURSE NUMBER TWO 22-26
COURSE NUMBER THREE 27-31
COURSE NUMBER FOUR 32-36
COURSE NUMBER FIVE 37-41
COURSE NUMBER SIX 42-46
COURSE NUMBER SEVEN 47-51
COURSE NUMBER EIGHT 52-56
COURSE NUMBER NINE 57-61
COURSE NUMBER TEN 62-66
COURSE NUMBER ELEVEN 67-71
TOTAL CREDITS 72-73
SCHOOL OR DEPARTMENT 74-79
CARD CODE 80

Figure 2.

STUDENT SCHEDULING MACHINE READABLE OUTPUT FORM

STUDENT NUMBER:________________ TERM:________________

UNIVERSITY STUDENT SCHEDULE

COURSE NUMBER	DESCRIPTION	MEETING DAYS	MEETING HOURS	LOCATION	CRDT

Figure 3.
STUDENT SCHEDULING PRINTER OUTPUT FORM