

AN INVESTIGATION OF THE PRACTICES, PROBLEMS, AND POTENTIAL
ASSOCIATED WITH COMPUTER GENERATED MASTER SCHEDULING
FOR HIGH SCHOOLS IN NEWFOUNDLAND AND LABRADOR

CENTRE FOR NEWFOUNDLAND STUDIES

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ABSTRACT

The purpose of this study was to investigate the present practices and problems of scheduling high schools in St. John's, Newfoundland. Additionally, this study attempted to determine the potential of computer developed master schedules for Newfoundland high schools. A set of ten research questions was considered to achieve the objectives of this study. The questions dealt with scheduling procedures, scheduling practices, scheduling problems, schedule adequacy, scheduling alternates, schedule experimentation, computer scheduling advantages and computer scheduling disadvantages.

An interview was conducted in each of four St. John's high schools. The interviews dealt with data relevant to existing schedules. The second phase of the study resulted in the production of a computer schedule for Lester Pearson Memorial High School. This schedule was compared with the school's manual schedule. Data from the interviews and schedules were analyzed and reported within the framework of the research questions.

Findings from the analyses of the data were as follows:

1. All schools used the hand mosaic method of schedule construction.

2. No significant differences existed in the scheduling practices of the schools.

3. Several problems such as workload problems, inadequate guidance services, standard periods, unresolved conflicts, and rigid schedules were identified by the school administrators.

4. All principals stated that their schedules were inadequate.

5. Experimentation is practically non-existent in the high schools.

6. Many disadvantages such as a long scheduling period, increased costs, large numbers of unscheduled periods, uniform scheduling, and the clustering of courses were revealed in the computer generated schedule.

The major recommendations arising out of the study were:

1. School districts should provide in-service programs on scheduling for their principals.

2. Memorial University of Newfoundland should provide at least one course in scheduling for graduate students in Administration.

3. The Department of Education should assume a leadership role in the utilization of computers for high

school master scheduling.

4. Computer scheduling should not be implemented in high schools in the near future.

5. This study should be replicated to determine the potential of computers in high schools in the province.

6. School administrators should be conscious of curricular innovations in high schools. Experimentation with these concepts should be conducted with a view to improving instructional patterns in schools.

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by



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To my wife Belle
and daughters Sharon and Susan
without whose understanding and support
this study could not have been completed.

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CHAPTER I

INTRODUCTION

One of the best representatives of any school's philosophy of education is its master schedule. It is more than a mere chart that indicates where students and teachers must be at any given time. In many ways it can be read like a book, one that reveals the type of learning experiences provided and the degree of flexibility within the school. For instance, the schedule will reveal whether or not the school provides equal time periods for all subjects, recognizes that some students need more exposure to certain subjects, and recognizes that some teachers have special interests and abilities in specific subject areas. Murphy emphasizes the importance of the master schedule when she states that:

The master schedule is to the high school principal as the musical score is to the concert director, for in either case a soundly planned program, harmonious and tightly knit in all its component parts, will determine the effectiveness of the individual and his organization.¹

The past decade has seen the creation of many curriculum and organizational innovations in an attempt to

¹Judith Murphy, School Scheduling by Computer; The Story of GASP (New York: Educational Facilities Laboratories, Inc. 1964), p. 1.

improve the educational programs available to students. So extensive have been the changes that one might term the educational climate of schools today as somewhat "explosive". Increased emphasis on changing curriculum and quality of instruction, together with greatly enlarged school enrollments, has created major problems for secondary school administrators. However, major strides have been made in the past two decades to resolve many of these problems.

Of particular interest are the contributions made by secondary school administrators in the area of flexible scheduling, more specifically the concept proposed by Trump in 1961.² These individuals served many important functions in their efforts to cope with the enormous task of scheduling to obtain optimum efficiency. McClure suggests the following as the most pertinent functions performed by secondary school administrators:

First, they were responsible for translating educational theory into practice. Secondly, they served important action research functions essential to intelligent development and refinement of educational theory and practice. Thirdly, they pursued multi-dimensional implementation strategies that yielded invaluable first hand knowledge concerning the practical administrative limitations and possibilities of recently implemented flexible class schedules. Fourthly, administrators contributed significantly in the dissemination of the expanding core of knowledge

²J. Lloyd Trump and Dorsey Baynam, Guide to Better Schools, (Chicago: Rand McNally and Co., 1961), p. 147.

related to the implementation of flexible class schedules. And finally, administrators in exemplary schools openly challenged the comfort and safety enjoyed by those maintaining the status quo.³

It is somewhat of a paradox today that the majority of educators place a great deal of emphasis on individualized instruction but yet very few of them have attempted to reorganize their schools, flexibly or otherwise. Cawelti, in a 1966 study of United States' schools, estimated that only about five to seven percent of the secondary schools were pursuing some form of flexible scheduling.⁴ Clearly, there exists a gap between the philosophy and its application to school organization. One might ask why this difference exists. Many factors could be identified to answer the question but the following seem to stand out as most important. First, though not unique to any one institution, is the resistance to change. Anderson suggests that a time-lag of approximately thirty years is required before innovative ideas in education become assimilated into common practice.⁵ Secondly, there is the insufficiency of

³ Charles T. McClure, "A Study of Problems and Solution Strategies Following Implementation of Flexible Class Schedules in Secondary Schools." (Unpublished Doctoral dissertation, Indiana University, 1970), p. 1.

⁴ Gordon Cawelti, "Innovative Practices in High Schools: Who Does What-and Why-and How," Nation's Schools 79:59, April, 1967.

⁵ E.G. Anderson, "Data Processing: Time Lag for Ideas; 30 Years," Nation's Schools 78:50, December, 1966.

substantive research beyond the implementation phase in effecting educational change.⁶ Thirdly, the flexible schedule is difficult to build and requires a considerable degree of creativity. Davis and Bechard accuse administrators of retaining the typical school schedule as a matter of administrative convenience rather than for enhancing the instructional process.⁷

The master schedule, being the blueprint of activities, might be considered a critical factor in the success of a school and its program. Consequently, the school administrator has the formidable task of ensuring that the schedule does not hinder the learning processes. In organizing his school, the administrator should attempt to:

1. provide for the best possible use of teacher talents, space, time, and equipment to the greatest advantage of the students;
2. provide every opportunity for teachers, individually and as a faculty, to achieve what they are potentially capable of achieving;
3. bring students and teachers together in the best possible combination of circumstances; and
4. reflect recognition of the individual and human

⁶ McClure, op. cit., p. 3.

⁷ Harold S. Davis and Joseph E. Bechard, Flexible Scheduling, Cleveland, Ohio: Educational Research Council of America, 1968.

qualities of every student and teacher.⁸

In other words, the schedule should become the "servant" of the educational process and not its "master" as many educators feel the typical schedule has been in the past. The general view held is that the flexible schedule, along with the application of computers, provides the means for curriculum reform and implementation of the preceding principles. This study attempted to consider scheduling within this framework and determine its implications for Newfoundland schools.

STATEMENT OF THE PROBLEM

The purpose of this study was to investigate the present practices and problems of scheduling high schools in St. John's, Newfoundland. Additionally, this study attempted to determine the potential of computer developed master schedules for Newfoundland high schools. In keeping with these objectives, the following research questions were considered:

1. What procedures are presently being used to schedule high schools in St. John's, Newfoundland?
2. Do the scheduling practices used in the high schools of St. John's differ significantly?

⁸ L.R. Palmer, "The Module - A New Mode for Gaining Flexibility," Minnesota Foreign Language Bulletin, 7:2, January, 1967.

3. What scheduling problems, if any, do high school administrators consider most significant?

4. Are high school administrators satisfied with their present master schedule and scheduling practices?

5. Have high school administrators given any consideration to alternate forms of scheduling and have they experimented with any of these alternate forms?

6. Are the present high school schedules retarding curriculum innovation?

7. What are the advantages of scheduling Newfoundland high schools by computer?

8. Are there any disadvantages of scheduling Newfoundland high schools by computer?

9. What resources are necessary to enable a high school to utilize the computer for scheduling?

10. Are these resources available?

SIGNIFICANCE OF THE STUDY

Since the turn of the century, man's knowledge and the world population have been increasing at an ever accelerating rate. The contemporary demand for quality education for a large and diverse student population has set educators and laymen to examining our school systems in depth to discern whether or not education is adapting to the needs of a changing society.

A product of many of these studies has been the recent attempts to revise the curriculum of schools, particularly that of the high schools. Society, no longer content with mass education for students, is demanding more individualized programs which, in turn, is creating new concepts of flexibility in curriculum. However, "the full potential of the new curriculum cannot be realized within the organizational framework of the conventional school."⁹ Inherent in this statement is the fact that there is little or no possibility of bringing about change for the improvement of high school programs if the scheduling process does not accommodate that change.

Without question, educators in general recognize the need for curriculum innovation. The need to break out of the strait jacket schedule has been expressed by people in education for a long time. Most educators feel that the conventional schedule is a major inhibiting factor for introducing curricular innovation; yet most schools continue to function within the confines of such a schedule. Their attitude has been basically one of: "It can't be scheduled."¹⁰

⁹Donald C. Manlove and David W. Beggs, Flexible Scheduling (Bloomington: Indiana University Press, 1965), p. 19.

¹⁰D.W. Allen and D. Delay, Flexible Scheduling: A Reality. Stanford, Calif: School of Education, Stanford University, in ERIC, EDO27624, p. 1.

Until recently this might have been a legitimate reason but since the early sixties many new scheduling techniques have been developed.¹¹

Perhaps the failure to introduce new scheduling practices to facilitate educational program improvements is an indication of a lack of scheduling knowledge or a reluctance on the part of school administrators to innovate because of a lack of understanding or training. It seems that there are few, if any, formal courses available to deal with the various aspects of scheduling. Again, the amount of actual research available is somewhat limited. Basically, all that one can find is a report of the results of some innovative high school in any one of the professional journals which is questionable with respect to its reliability because of the subjective manner in which it is reported.

Traditionally, then, scheduling procedures have evolved locally and have in common only a lack of uniformity. They have had little more than superficial investigation and, until recently, there has been scant systematic treatment of this topic in the educational literature. Also, although high school scheduling has long been the function of the school principal or vice-principal working in conjunction with his guidance department, the actual master schedule has,

¹¹ H.S. Davis and J.E. Bechard, Flexible Scheduling. Cleveland, Ohio: Educational Research Council of America, 1968.

in most instances, been the product of one man's brains. While the principal or vice-principal may, and often does consult with the teachers, the master schedule, nevertheless, has remained his responsibility. The degree of imagination and flexibility existent in the master schedule has, therefore, depended upon the extent of the imagination and flexibility of the man producing it. Both these factors have contributed to the time lag between curriculum innovation and new scheduling techniques.

Recent literature has shown that ways and means may be found to improve learning that are better than many common practices of today.¹² Indeed, with the advent of computers, schools are now able to incorporate a high degree of flexibility in their master schedules.¹³ It is vital to find an organizational plan that is less destructive of individual initiative and autonomy; and one that will help prepare our young people to keep their individuality, initiative, and creativity. Some students would like to take a pure academic program while others would prefer a program in vocational

¹²J.W. Stegall, "Descriptive Analysis of Class Scheduling Procedures in Selected Secondary Schools in Texas." (Unpublished Doctoral dissertation, Texas A&M University, 1970), p. 8.

¹³R.V. Oakford, The Stanford School Scheduling System (Stanford, California: School of Education and Department of Industrial Engineering, Stanford University, 1968), p. 5.

education. The diverse needs of students require individual options in the curriculum which obviously means more flexible scheduling. Educators are hopeful and have reasons to be optimistic that the computer will give schools the flexibility required. The basic advantage of the computer is that it can explore an unlimited number of alternatives in a short period of time and produce the schedule that provides optimum flexibility within the constraints imposed by the school, its facilities and program.

To put into practice the philosophy that we as educators are continually expounding is a monumental, if not impossible, task without the assistance of the computer.

According to Murphy:

If scheduling construction is a formidable task in the conventional school that changes little from year to year, it looms like a monster to the principal of a school embarked on educational innovation. Consider the potential scheduling difficulties inherent in team teaching, for instance. Or in non-graded plans where individual students progress at their own rate through the school. Or in the redistribution of standard classes into large, medium, and small groups. Or in the provision for independent study and honors work, or wide ranging electives. Or in the strict application of ability grouping, subject by subject. Or in such innovations in the school day as modular scheduling, or flexible periods.¹⁴

¹⁴ Judith Murphy, School Scheduling by Computer: The Story of GASP (New York: Educational Facilities Laboratories, Inc., 1964), p. 6.

Many schools in other provinces and the United States have broken away from the conventional schedule and embarked on a more flexible type of scheduling. As a rule, their innovative type schedules have accommodated modular time units, variable group size learning, independent study and teaching teams. Generally, the result has been greater flexibility and better utilization of staff and facilities. Practically all schools that have adopted a flexible schedule have done so with the aid of a computer.

It is a fair assumption to make that at the present none of the Newfoundland high schools have adopted flexibility scheduling in total or in any significant part. This study attempted to analyze the present scheduling practices of selected high schools in St. John's, Newfoundland and, with the aid of relevant literature and computer technology, provide the means whereby high schools can innovate to improve their educational programs and the utilization of their facilities.

LIMITATIONS AND DELIMITATIONS OF THE STUDY

The study was limited to an investigation of the scheduling practices and problems of selected high schools in St. John's, Newfoundland. No attempt was made to interpret the results in any other context since it was realized that schools may differ greatly from community to community. Any reference to other high schools in the province was made with

caution and only if the researcher felt that it might serve as a useful guideline for those schools.

To generate a master schedule by computer requires a considerable amount of preplanning and reorganization by a school's staff. Because of this the researcher did not expect nor did he ask the teachers of any school in the population to commit themselves to such a major task. The researcher used the Lester Pearson Memorial High School, located at Wesleyville, as the data source for experimentation with the computer scheduling package. This school was chosen because it is under the writer's administration and its enrollment (320 students) is representative of the mean enrollment of the province's high schools. However, any generalizations of the findings relative to smaller or larger high schools were stated with reservations. Any suggestions made will have to be substantiated by research before they can be optimistically acted upon.

FUNDAMENTAL ASSUMPTIONS

This study emanated from and was essentially founded upon the following basic assumptions:

1. The master schedule is vital to the efficient and effective operation of the high school.
2. Some degree of scheduling flexibility is necessary to meet the objectives of a school's program.

3. The need for scheduling innovation is basically the same in Newfoundland high schools as it is in the rest of Canada and the United States.

4. This study could contribute significantly to administrative efforts to achieve further the goal of individualized instruction in Newfoundland high schools.

5. School administrators will not intentionally attempt to conceal their lack of scheduling knowledge if indeed they do have an inadequate understanding of the subject.

DEFINITIONS OF TERMS

For the purposes of this study the following definitions will be used:

High School

A school in which only grades seven through eleven or any combination thereof are found.

Master Schedule

The master schedule is the school's comprehensive plan of the time, the place, and the kind of instruction for each section of each course of study. That is, it is a detailed plan for the opening and closing of each class section during the school day, indicating the teacher(s) assigned, the section, and the room in which it will meet.

Teacher Schedule

A detailed plan assigning class sections, rooms, and planning periods for each teacher on bases such as time, activities, levels, and numbers of students.

Room Schedule

The plan for the use of school rooms by various classes and activities for the different periods of the school day.

Student Schedule

A program designating, by periods or modules, the subjects, activities, teachers, and room assignments for each student.

Flexible Schedule

This term refers to an organization for teaching and learning which:

1. calls for variable class sizes in and between courses;
2. provides for independent study;
3. makes teaching teams possible; and
4. provides for instructional groups which meet at varying frequencies and for varying lengths of time.

(Varying lengths of time may be accomplished by combining the required number of modular time units.)

② Conventional Schedule

The conventional, classical, or traditional schedule is characterized by:

1. standard-length periods of time; each period meets for the same number of minutes (usually from forty-five to sixty minutes) regardless of the subject matter or activity.

2. a high level of control over students. All students are in class from the beginning of the school day to the end with the exceptions of recess and lunch periods.

Manual Schedule

A schedule which is constructed and in which students are assigned to approved courses without assistance from electronic or mechanical data processing machines or other forms of semi-mechanized data processing such as the "needle sort".

Computer Generated Schedule

This term refers to the master schedule that is generated by a computer from the data supplied to it by the school being scheduled. This may also include the assignment of students and teachers to their course sections and provide other relevant details.

Modular Time Unit

The module is a period of time of some predetermined length which becomes the basic unit of instructional time. The module may be of any desired length, but as a rule is thought of as a small unit (ten to thirty minutes).

Teaching Team

A team of teachers which is responsible for the instruction of all students who take a particular course. These teachers make cooperative decisions about course content, assignments, and both student and content evaluation. Usually, each teacher is responsible for those aspects of the subject area in which he is most competent, as well as the type of learning situations in which he functions best.

Variable Size Groups

This concept refers to classes of students of various sizes. The size of the group is actually a function of the requirements of the learning situation. For example, in the lecture or film setting where the student plays mainly a passive role, large groups can function as well as any other size group. However, if students are actively discussing issues or questioning each other, then small groups are best suited for this purpose.

Independent Study

Independent study emphasizes the individual's role in learning. It is that portion of the school day that is not scheduled on a regular basis. It allows the student the opportunity to make some choices about his learning activities without the constant supervision or direction found in the typical classroom. During independent study time, students may carry on various activities either individually, in small groups, or if they so choose, with teachers.

ORGANIZATION OF THE STUDY

Chapter I provides a general introduction to the study including the statement of the problem, the significance of the study, the delimitations and limitations, the basic assumptions, and the definitions of terms and concepts.

The review of the literature presented in Chapter II consists of resource material related to the focus of this study. It contains information on schedule construction, types of schedules, and curricular innovations, as well as research centered around both manual and computer generated master schedules.

The design of the study discussed in Chapter III describes the population used. Also included in the chapter is a discussion of the development of the interview

questionnaire, a detailed description of the Stanford School Scheduling System, and a description of the data collection procedures.

Chapter IV deals with the analysis of the interview data as reported by the high school principals of St. John's, Newfoundland.

A summary of the data which resulted from a comparison of the computer schedule with the present schedule of Lester Pearson Memorial High is presented in Chapter V. This chapter also evaluates the computer scheduling system in terms of cost and labour.

Using the analysis of the data in the previous two chapters, a summary of the study, the findings, some conclusions and some implications of the study for schedule makers are presented in Chapter VI. Recommendations for further research are also listed:

CHAPTER II

REVIEW OF RELATED LITERATURE

Unlike many research areas in education, the amount of research literature available on scheduling is somewhat limited. Fifteen years ago anyone interested in the topic would have had some difficulty locating any information on the problem, researched material or otherwise.

Today, however, it is nearly impossible to review any of the current professional periodicals or new books on curriculum without finding some mention of scheduling, particularly the concept of flexible scheduling. Even now, it is most difficult to find material that is substantially objective in its view of scheduling. Most of the literature is written by superintendents, principals, or teachers of schools that are employing new scheduling techniques, and they are often quite biased in their viewpoints. Nevertheless, the researcher felt that, along with several related research reports, he should include selected topics of this nature in the present chapter.

In reviewing the literature, the writings were organized into the following major categories:

1. Literature as it relates to scheduling in general.
2. Literature as it pertains to recent curricular, instructional, and organizational practices and procedures which affect scheduling.
3. Literature describing several of the types of master schedules used in high schools.
4. Literature discussing data-processing practices and procedures which affect scheduling.

DIMENSIONS TO SCHEDULING

According to Egge, there are at least three dimensions to scheduling.¹ They may be described as the assignment dimension, the function dimension, and the variability dimension of scheduling.

The assignment dimension. The assignment dimension defines the four basic educational resources of time, facilities, students, and staff in terms of their daily placement in the school program. Figure 1, using hypothetical scheduling information, is an illustration of the assignment dimension.

¹D.E. Egge, "Secondary School Program Scheduling Factors and Their Influence on Schedule Flexibility." (Unpublished Doctoral dissertation, Washington State University, 1967), pp. 24-26.

FIGURE 1

THE ASSIGNMENT DIMENSION OF SCHEDULING ILLUSTRATED BY
THE DAILY ASSIGNMENT OF FOUR EDUCATIONAL RESOURCES.

Time Assignment	Facility Assignment	Student Assignment	Staff Assignment
40-Minute 1 Periods	Room 114 Science Lab	Biology	Teacher A Biology
40-Minute 2 Periods	Room 108 Classroom	English	Teacher E English
40-Minute 3 Periods	Library	Independent Study	Teacher B Supervision
40-Minute 4 Periods	Room 147 Gym	Physical Education	Teacher C Physical Education
40-Minute 5 Periods	Room 117 French Room	French	Teacher C French
40-Minute 6 Periods	Room 106 Industrial Arts	Woodworking	Teacher F Woodworking
40-Minute 7 Periods	Rooms 104 & 105 Lecture Hall	History	Teacher G History

The vertical columns illustrate sampling applications of the four resources in the assignment dimension of scheduling. A typical seven-period day using forty-minute periods describes the assignment of time. The variety of facilities in the second column describes the assignment of facilities. The student's daily assignment is found in column III. The final column shows a teacher's tasks for a day.

The function dimension. The function dimension defines the four educational resources of time, facilities, students, and staff in terms of the role played by each in the instructional process. Figure 2 illustrates the function dimension. Hypothetical scheduling information is used to illustrate the functional role of the four resources in the instructional process as they are varied to meet daily or sequential instructional need.

The four horizontal columns illustrate sample applications of the four resources, using a five-day cycle. The five days are coordinated for all four resources for a single school program. The sequence for this cycle includes large-group, small-group, laboratory, and independent study activities.

FIGURE 2

THE FUNCTION DIMENSION OF SCHEDULING ILLUSTRATED BY THE
DAILY AND SEQUENTIAL FUNCTION OF THE
FOUR EDUCATIONAL RESOURCES

Factors	Monday	Tuesday	Wednesday	Thursday	Friday
Time Function	40-Minute Period	20-Minute Period	20-Minute Period	80-Minute Period	40-Minute Period
Facility Function	Lecture Room	Seminar Room	Seminar Room	Laboratory	Library
Student Function	Listens	Discusses	Discusses	Searches Researches	Researches Studies
Staff Function	Lectures	Leads Discussions	Leads Discussion	Directs Laboratory	Supervises

The variability dimension. Scheduling practices, needed to implement the new designs of secondary education, require greater flexibility than has been generally provided in the traditional schedule. The assignment and function dimensions have generally established eight basic scheduling factors in the scheduling matrix in an inflexible manner. In practice, these have been locked into the schedule for the duration of the school term. In order for the schedule maker to provide a flexible schedule, the basic scheduling factors must be tractable.

Variability has been identified as the third dimension of scheduling. This dimension should provide tractability for the eight basic scheduling factors as a way to provide schedule flexibility.

BASIC SCHEDULING FACTORS

The chapter, to this point, has established time, facilities, students, and staff as the basic educational resources necessary for the operation of the school program. Each of these resources has been described according to the way it is assigned and by the instructional function it performs in the master schedule.

Eight basic scheduling factors have resulted from the material presented in the previous section. They are:

(1) time assignment, (2) facility assignment, (3) student assignment, (4) staff assignment, (5) time function, (6) facility function, (7) student function, and (8) staff function. These factors are described in greater detail in the remainder of this section. Each of them is defined and then described to elucidate the ways they may be used in the schedule development process.

Time Assignment

The first basic scheduling factor is defined by adding the designation of time to the master schedule of classes.

Time is assigned in the schedule for day, week, and term or school-year periods. The basic time modules or combinations of time modules used in the assignment of this time are generally called periods. The lengths of any of these time periods have been generally determined by traditional practice and regulations of Departments of Education and/or School Boards. Schools have typically used 187-day school years, 5-day weeks, 7-period days, and 40- to 50-minute periods. Most of these time periods have been determined by administrative needs. Each should be determined, however, by the length of time needed to complete the instructional demands of students, subjects, and teachers.²

²Ibid., p. 27.

Time has often been arbitrarily divided rather than used as a tool in the learning process. Faunce has warned that, "a good schedule cannot be developed on a basis of a uniform time allotment for each period and each class."³ In other words, the time allotted to any group or course must be appropriate to its purpose. The module or combination of modules which use a short fifteen or twenty minute time base promise to break the schedule maker free from the lock step of traditional time periods and enable him to meet the demands of groups and courses.

Facility Assignment

The second scheduling factor has been developed by designating the use of the facilities of the school in relation to the master schedule of classes. Facilities are assigned for the use of students and teachers in the educational process. Facilities must be available when the need for them occurs. They must provide adequate size. They must provide the amenities required for the instructional act, such as appropriate utilities, storage, and space for individual and group work.

Taylor has suggested that a relationship must exist between the educational planning of a program and the

³R.C. Faunce, Secondary School Administration (New York: Harper and Brothers, 1955), p. 309.

facility to which it is assigned.

Change in educational planning is inevitable and desirable, for it reflects the advancing and expanding ideas of our times. School facilities may encourage or hinder progress. Buildings should have the capacity to accommodate any changes in curriculum that will result from economic, social, and technical developments and any changes in school practices that will result from developments in teaching methods and materials.⁴

Facilities provide teachers and students an environment of space and equipment for teaching and learning. The schedule maker is responsible to consider the availability and adequacy of the facilities when he selects them for the instructional program. As the instructional needs assigned to these facilities change, so must the space be pliable, diversified, and easily reshaped by the people that occupy and use that space. Taylor also suggested that:

Schools can be so constructed, by arranging space logically and by providing moveable partitions, that spacious rooms can be created when they are needed without excessive effort and waste of instructional time.⁵

⁴J.L. Taylor, "Flexibility in School Facilities," *School Life*, 43:13, October, 1960, cited by D.E. Egge, "Secondary School Program Scheduling Factors and Their Influence on School Flexibility." (Unpublished Doctoral dissertation, Washington State University, 1967), p. 28.

⁵Ibid., p. 12.

Student Assignment

The third scheduling factor is defined as the appropriate placement of students in the school master schedule. Students are scheduled for individual assignments or to instructional groups according to school grouping procedures. These procedures are developed on the basis of school requirements and elective opportunities designed to meet student need.

Some of the new directions that are being taken in the assignment or placement of students have been described by Anderson and Gruhn.

There is some evidence that education is moving in the direction of organizational patterns that fit best the concept of understanding, knowing, and respecting the child and giving him a choice of opportunities to develop his talents.⁶

Perhaps the flexibility of scheduling a particular pupil's time, depending upon his maturity and progress in independent study skills, will be as characteristic of the future high school as is the familiar pattern of today consisting of four or five periods of classes with one or two periods of study hall.⁷

An important demand on the school today is the development of more precise requirements for the assignment

⁶V.E. Anderson and W.T. Gruhn, Principles and Practices of Secondary Education (New York: The Ronald Press, 1962), p. 486.

⁷Ibid., p. 485.

of students to learning groups. Manlove and Beggs suggested that specifications should be developed for each class group. They pointed out that the primary purpose of any group procedure is to establish an atmosphere in which learning can take place.⁸

Bush and Allen recommended two primary variables in the development of group specifications. They listed ability to grow in particular subject areas and developable interests in the course of study. They recommended that four basic learning groups might be used in a flexible curriculum:

1. A comprehensive low-interest group.
2. Comprehensive with high interest in the subject.
3. Subject talented with little interest.
4. Subject talented with high interest.⁹

Staff Assignment

The fourth scheduling factor has been developed by assigning the use of the instructional staff of a school in relation to the master schedule. Teachers, counselors, administrators, and para-professionals are assigned to meet

⁸D.C. Manlove and D.W. Beggs, Flexible Scheduling (Bloomington: Indiana University Press, 1965), p. 46.

⁹R.N. Bush and D.W. Allen, A New Design for High School Education (San Francisco: McGraw Hill Book Co., 1964), p. 61.

and work individually or as teams with individual students or with student groups. In providing such an assignment in the master schedule, consideration must be given to the staff member as he works individually, as a member of a teaching team, or as a member of a faculty group. The following are some guiding principles of staff assignment:

1. Teachers and pupil loads must be such that they will provide maximum professionalization of teaching and maximum potential of learning opportunities for the students.¹⁰
2. The teacher's assignment, the other educational services in his program, and the devices used to make the teacher load equal and reasonable, are the most important working conditions of the teacher.¹¹
3. Teachers' schedules should allow adequate time for classroom preparation, research, and conferences with parents.¹²
4. Care should be taken to assign sections only to teachers with appropriate subject-matter education.
5. A tentative assignment of sections and activities to the position to be filled should be worked out as an aid in selecting the best qualified teachers for the work to be assigned them.

¹⁰J.L. Trump, "Flexible Scheduling: Fad or Fundamental", Phi Delta Kappan, 44:370, May, 1963.

¹¹M.J. Cohler, "Curriculum: Its Basis in the High School Schedule," American High School Journal, 144:13, April, 1962.

¹²A. Ruffing, "Proper Use of Teacher Time," School and Society, 47:76, February, 1959.

6. Students and teachers should be matched together wherever possible.

7. New teachers need experience under reasonably calm circumstances to gain confidence.

8. Teachers should be provided time to work with other teachers during the school day.¹³

Time Function

The fifth scheduling factor is a description of the use of time to meet instructional need for pattern and sequence in planning and implementing the school program. Courses might take a month, a semester, or a school year to complete. The course might function better with lengthy periods or short periods. In some cases, the periods of time in a course might need to be static or changed according to the needs of the pupils and teachers as they work through a particular course of study. Many questions should be asked about the use of time as the curriculum is planned.

1. How much time is required in a given instructional cycle?

2. How much time is to be utilized and divided?

3. How much time should be allotted for independent study?

4. What materials are needed to guide students in the profitable use of independent study time?

5. How much teacher time will be left unscheduled for work with individuals and small

¹³ Egge, op. cit., pp. 30-31.

groups?

6. How can the teacher best utilize his own unscheduled time?¹⁴

In order to develop the use of time as a function of curriculum and instruction in the master schedule, several principles should guide the schedule maker in his decision-making.

1. The primary consideration in the allotment of time should be the learning of the students. Holidays, and other activities should be secondary.

2. The class schedule should be made daily on the basis of teacher requests.

3. Each student, under competent direction, should make decisions regarding his part in the established schedule.¹⁵

4. The schedule needs to provide time so that students can work as many hours per week in the workshops as professional counselors and teachers may decide.¹⁶

5. Time can be effectively reduced in one subject, without measurable loss in pupil achievement, and can be profitably devoted to another subject.¹⁷

¹⁴D.L. Jessor and R.C. Stuty (ed.), Scheduling for Flexibility in Small Schools (Salt Lake City: Western States Small Schools Project, 1966), p. 7.

¹⁵Trump, op. cit., p. 370.

¹⁶J.L. Trump, "Developing and Evaluating a Class Schedule to Help Each Pupil Learn Better," Journal of Secondary Education, 36:340, October, 1961.

¹⁷S.P. Morland, "Redistribution of Time Allotted to Academic Subjects in Secondary Schools: An Experiment in Increasing Hours of Classroom Work in Certain Subjects and Decreasing the Hours in Certain Other Subjects, with the Objective of Gaining an Increased net Measurable Achievement by the Pupil," Dissertation Abstracts, 16:274, February, 1955.

6. The schedule should allow for longer periods of time as they are needed.

7. The schedule should provide for unequal distribution of time for various courses.

8. The schedule should provide latitude in organizing special groups to meet one, two, three, or four times a week without having to meet five times a week for equal lengths of time.

9. Some courses can have activities which may meet twice during one day or not at all for a particular day.

10. The cycle can be a two-day or three-day arrangement, as well as a single day or week. The longer the cycle, the more opportunity there is for varying the patterns of organization of learning groups.¹⁸

Facility Function

The sixth scheduling factor is defined as determining the function of available facilities which provide assistance to instructional processes. School facilities are designed to serve those instructional needs required by the nature of the subject taught. The function of school facilities should be based on the premise that the physical and psychological environment must be appropriate to the activities of the group.

Bush and Allen have suggested four essential steps that must be considered while planning the combination of school program and facilities:

¹⁸Manlove and Beggs, op. cit., p. 44.

1. The definition and purpose of the facility must be established.
2. The size groups to be served must be determined.
3. The restrictions to instructional methodology that will occur in it must be stated.
4. The specific equipment that competent practice of this methodology requires must be identified.¹⁹

Student Function

The seventh factor is defined as the way students are expected to perform tasks in the learning process. Student function is determined through participation in appropriate learning groups or in an independent capacity. These learning groups may be any defined size which is determined from the instructional mode of the teacher and by student and subject-matter requirements. The group, and each individual in the group, function according to the size of the group, the purpose of the group, and the activity of the group.

The student has several needs which must be considered while developing groups. Trump felt that each student needed opportunities to study in depth in the areas where he had special interests and talents. He also felt that each student needed to progress through the various phases of

¹⁹Bush and Allen, op. cit., p. 103.

the subject according to his own talents and interests.²⁰ Bush and Allen felt that students needed time available for individual study in specialized fields as they progressed toward graduation.²¹

As groups are designed for instructional purposes, special consideration must be made for group operation and potential success. The composition of a group must be appropriate to its purpose. A key element in the performance of groups is size. As function and activities are defined, the size of the group must become appropriate to those needs. In 1938, Manheimer discussed class size in terms which have only recently been strongly considered and implemented by schedule makers. He hypothesized that "the best size of class, should be that number of pupils who will profit most by the instruction given, whose presence will represent the optimum load that the teacher can carry to achieve the purpose of the lesson." He went on to say that "the size of the class must be variable within the subject from time to time." He also suggested that the development of educational objectives and the appropriate change in the nature of methods could create a variety of influences on

²⁰J. I. Trump, "Flexible Scheduling: Fad or Fundamental," Phi Delta Kappan, 44:371, May, 1963.

²¹Bush and Allen, op. cit., p. 67.

class size.²²

In more recent years, Anderson restated this position by declaring that class size is best determined by the nature of the subjects taught, the ability of those being taught, and the ability of those doing the teaching.²³

Staff Function

The eighth and final scheduling factor derives its role in the scheduling process from determining the instructional tasks that staff members must perform. The instructional responsibility of the staff is to choose and present appropriate subject matter necessary to meet instructional objectives. Another function of the staff is to use the instructional media and mode which are most effective and efficient in the teaching and learning process. The teacher, then, is charged with providing content, methods, and materials which are the keys to instruction.

Cohler describes the influence of the teacher upon the curriculum and the individual courses of that curriculum.

²²W.A. Manheimer, "Creating the Functional Class by Continuous Reclassification," The School Review, 66: 764, December, 1938, cited by D.E. Egge, "Secondary School Program Scheduling Factors and Their Influence on Schedule Flexibility." (Unpublished Doctoral dissertation, Washington State University, 1967), p. 34.

²³R.H. Anderson, "Organization Character of Education: Staff Utilization and Development," Review of Educational Research, 34: 460, October, 1964.

Thus the curriculum and its individual courses are made by educational personnel; and the guidance is a joint venture. The individual course content and its level is determined not only by the syllabus and the materials used in implementing that syllabus; the teacher and the class members constitute the major influence in the content. Depending upon which teacher is selected to teach a particular course, there may be an enormous variability in content and method arising from the use of the identical syllabus. Furthermore, the abilities and interests of the pupils in a given class alter the level of sophistication at which a teacher may teach the same course to different groups of pupils.²⁴

GUIDING PRINCIPLES

Prior to the advent of theories and practices concerning flexible scheduling, most administrative texts on secondary education included at least a chapter on the subject. Generally, they covered the following topics:

1. Criteria of a good schedule.
2. The teaching load.
3. Curricular offerings.
4. Pertinent regulations and traditions.
5. Building facilities.
6. Guidance in schedule making.
7. Administrative decisions preliminary to schedule construction.

²⁴ M.J. Cohler, "Curriculum: Its Basis in the High School Schedule," American School Board Journal, 164: 13, April, 1962.

8. Techniques of schedule construction.
9. Use of conflict charts.
10. Class-size policy.
11. Machine scheduling.

Austin and Gividen recognize that in making the schedule, there are certain general principles which will have applicability in most situations:

1. A clear understanding of the business of scheduling is a reasonable right of all who are to be thereby affected.
2. The over all structure of the curriculum, as well as the guiding purposes of the school, must be clearly understood and honestly accepted by a significant majority of the staff.
3. A constant reappraisal of method and results is fundamental to continual successful scheduling.
4. Data gathering need not be a seasonal affair.
5. The custodial staff, the cafeteria crew, and the office help are part of the school.²⁵

Wey presents the following criteria of a good schedule:

1. Allow the student to pursue his needs.
2. Prepare the schedule to take account of the choices of each student.

²⁵ D.B. Austin and N. Gividen, The High School Principal and Staff Develop the Master Schedule (New York: Bureau of Publication, Teachers College, Columbia University, 1960), pp. 48-49.

3. Take the teacher into account; aspects such as age, aptitude, qualifications, likes, and dislikes should be considered.

4. Equalize the teacher load.

5. Consider the appropriate use of space and equipment.

6. Allow the principal time for supervision as well as management.

7. Provide time for teacher planning.²⁶

Edge made a composite list of scheduling considerations, which provides the information schedule makers need to build a schedule:

1. Preliminary registration data.
2. Class size (minimum and maximum).
3. Number of teachers needed.
4. Lunch period.
5. Activities.
6. Number of periods.
7. Room list (number available; size and purpose for which the room may be used).
8. Teacher training.
9. Ability grouping.
10. Courses to be offered (required and elective).
11. Sequential arrangement of class meetings per week.

²⁶ H.E. Wey, Handbook for Principals (New York: Schaum Publishing Co., 1966), pp. 135-136.

12. Teacher-pupil ratio.
13. Scheduling conflicts.
14. Length of school day.
15. Legal requirements of the state.
16. Regulations of the school districts.
17. Standards of accreditation association.
18. Custom and the public opinion of the community.
19. Length of time for class changes.
20. Organization and administration of the curriculum.
21. Special teacher assignments.
22. Number of daily teacher preparations.
23. Availability of teachers.
24. The plan for forming class sections.
25. Availability of part-time instructors.
26. Teacher preference of assignment and duties.²⁷

When each administrator weighs such considerations on the basis of his school's needs, he immediately sees that the schedule must be different every year. Only the most rigid and static school would be able to use the same schedule of classes, teachers, rooms, and students over and over again.

²⁷ Egge, op. cit., pp. 10-11.

As the administrator approaches the construction of the master schedule, he is confronted with the problem of deciding how to accomplish the different tasks associated with it. Adamo suggests that the overall task of scheduling a modern secondary school may be broken down into three phases: (1) making primary decisions, (2) gathering preliminary data, and (3) constructing the master schedule. These three functions are not readily separable in practice. They overlap, combine, and fail to follow in sequence at several points.²⁸ He summarized the actual schedule making process in the following manner:

1. Review the educational purposes of the school.
2. Review the educational offerings in the program of studies.
3. Project enrollments for the coming year.
4. Project staff requirements for the coming year.
5. Project facilities requirements for the coming year.
6. After orientation and guidance, have pupils make their course selections for the coming year.
7. Tally course selections.
8. Group pupils for instruction (those in honors or special sections will have been determined prior to course selections).

²⁸E.A. Adamo, "A Study of Scheduling for Team-Teaching and Television in Selected Secondary Schools" (Unpublished doctoral dissertation, Columbia University, 1964), p. 27, cited by S.D. Howell, "A Study of Scheduling Practices, Procedures, and Related Influential Factors in Selected Public High Schools of Pennsylvania". (Unpublished Doctoral dissertation, Temple University, 1971), p. 24.

9. Post all classes to the periods of the week following expeditious priorities.

10. When individual scheduling is employed, place pupils in posted classes.

11. Apply cross-checks to determine accuracy and efficiency of work completed.

12. Publish tentative master schedule.

13. Make necessary adjustments and finalize the schedule.

14. Make subsidiary schedules from the master plan.²⁹

Koos has recommended a set of guiding principles to be observed by the schedule maker:

1. The schedule should afford each pupil the opportunity to pursue studies which his individual needs and interests justify him in desiring.

2. The school schedule must be based on and prepared in the light of the choices of subjects made by the pupils under guidance.

3. Teacher qualifications must be thoughtfully weighed and optimally used.

4. The schedule must make it possible for teachers to know pupils and to know them well enough to individualize educational treatment.

5. The schedule must equalize the load of teachers, giving due consideration to all the factors that contribute to a teaching load.

6. The schedule should equalize class sections according to standards established in advance.

²⁹ Ibid., pp. 40-41.

7. The schedule must be made to give each pupil and teacher as simple and regular an assignment of his class and study-hall engagements as is possible.

8. The schedule should provide for such alternation of the activities of the pupil as will obviate fatigue and respect convenience.

9. The schedule should aim at the most appropriate use of the space, the varied facilities, and equipment of the school.

10. The schedule is the means of assuring the smooth functioning of the school from the very beginning of the year or term for which it was made.³⁰

A Schedule Development Process

The processes used to develop scheduling steps, considerations, and principles have, in most cases, been unique to each schedule maker. As a result of this survey of the literature, the development of a set of steps based upon the experience of school principals in schedule development would appear to be an important aid to scheduling.

In general, the schedule development process can be grouped into six major phases.

Priority phase. The schedule maker and his staff determine scheduling priorities through the evaluation of regulatory, administrative, curricular, and instructional decisions needed to implement the school program.

³⁰ L.V. Koos, Administering the Secondary School (New York: American Book Co., 1940), pp. 287-289.

Scheduling building phase. The master schedule is developed from the priorities that have been established.

Programming phase. Each student is individually assigned to his program of classes.

Enrollment phase. Students enter their classes. This provides feedback to the schedule maker so that he might determine the accuracy of the schedule and changes that must be made.

Transfer phase. Students are transferred to meet individual program needs, to implement organizational techniques, to handle non-graded programs, and to provide methods of changing the schedule when flexible scheduling practices are used in the school.

Evaluation phase. The schedule maker and his staff check for past success or failure as a means to assist future schedule development. This is a most important phase to eliminate weaknesses and prevent the schedule from becoming static.

CRITERIA OF A GOOD SCHEDULE

There are many varied opinions concerning the criteria which have been used and possibly should be used to measure the adequacy of a master school schedule. In 1947, Devilbiss suggested the following four broad criteria for a good master schedule:

1. A good schedule must make it possible to provide and administer the kinds of learning experiences needed to implement the purposes for which schools exist.

2. A good schedule provides for the maximum utilization of all the human resources of the school for the benefit of the greatest number of pupils.

3. A good schedule provides for the maximum utilization of all the physical resources of the school.

4. A good schedule should facilitate an effective program of guidance.³¹

Manlove and Beggs, concerned with scheduling, stated:

"A realistic goal is to develop a schedule which honors all the students' choices of courses and satisfies every recommendation of the staff for group membership."³² Two years prior, Anderson and Van Dyke listed the following twelve criteria:

1. Be sufficiently clear and complete to assist materially in the effective operation of the daily program on opening day.

2. Function with a minimum of confusion and change from the first days of the year.

3. Contain no conflicts between courses for all but a small percentage of students (one or two percent).

³¹W. Devilbiss, "Criteria of a Good Master Schedule," National Association of Secondary School Principals Bulletin, 31: 32, November, 1947.

³²D.C. Manlove and D.W. Beggs, Flexible Scheduling (Bloomington: Indiana University Press, 1965), p. 116.

4. Provide for good balance in the distribution of class sections through the school day.

5. Assign teachers to courses for which they are qualified and, insofar as possible, those for which they have a preference.

6. Provide good balance in section size and in the number of students and class sections assigned to teachers.

7. Provide at least one open period for planning and conferences for each teacher.

8. Provide for optimum utilization of all rooms in relation to the capacity of the building and the enrollment.

9. Meet all minimum standards for time allocation as designated by the state department of education and other accrediting agencies.

10. Serve the characteristics and preferences of the community with respect to time limits for the school day.

11. Provide for some degree of flexibility in the length of certain periods, meeting times for certain sections, and programming of various activities within the school day.

12. Make provisions for ability groups, seminars, remedial sections, and other programs to allow for differences in ability.³³

Faunce, in summarizing the shortcomings of the conventional schedule, stated that a good secondary school schedule should be characterized by:

³³ L.W. Anderson and L.A. Van Dyke, Secondary School Administration (Boston: Houghton Mifflin Co., 1963), p. 167.

1. Flexibility.
2. Provisions for teacher planning.
3. Provisions for guidance as part of instruction.
4. Provisions for integrated learning.³⁴

Courm developed evaluation criteria with which to judge the degree of flexibility of a master schedule. He listed criteria for the following general areas:

1. Students.
2. Instructors.
3. Time
4. Space.
5. Curriculum content and methods.
6. Motion.³⁵

Bush, Coffrey, Oakford, and Allen agreed that the master school schedule must meet the needs of all students. They also held that the schedule should make better use of the instructional staff and permit a more flexible arrangement of meetings of different courses.³⁶ Allen felt that the

³⁴R.C. Faunce, Secondary School Administration (New York: Harper Brothers, 1955), p. 310.

³⁵A.L. Courm, "A Study of Scheduling and Staffing Practices in the Public Schools of Dade County, Florida." (Unpublished Doctoral dissertation, University of Miami, 1968), p. 72.

³⁶R.N. Bush, et al., "Using Machines to Make the High School Schedule," School Review, 64: 48, Spring, 1961.

ultimate aim of a school master schedule must be flexibility in all important dimensions.³⁷

Wright, in comparing the efficiency of computer scheduling with the efficiency of the previous system used in participating schools, used the following criteria:

1. Number of scheduling errors.
2. Building utilization.
3. Staff utilization.
4. Individual attention provided to the student.
5. Greater flexibility in the timetable for the entire scheduling process.³⁸

The literature revealed many varied opinions regarding the criteria utilized in judging the adequacy of master school schedules. Some authorities listed criteria under a few general broad headings, while others were quite specific. Generally, the criteria reviewed were distributed into five major categories: students, planning time, teachers, classes, and facilities.

³⁷ D.W. Allen, "Elements of Scheduling a Flexible Curriculum," The Journal of Secondary Education, 38: 84, November, 1963.

³⁸ R.D. Wright, "Computer Scheduling in Selected Secondary Schools in New Jersey." (Unpublished Doctoral dissertation, Rutgers - The State University, 1965), p. 51.

CONVENTIONAL SCHEDULING PRACTICES AND PROCEDURES

Early Studies

Puckett was one of the earliest investigators to conduct a study in the field of high school scheduling. In 1933 he attempted to determine the difficulties encountered in making a high school schedule of recitations. He selected ten high schools with enrollments between 87 and 344 students in the Iowa area and made six complete schedules for each school. Forty-five and sixty minute periods were used. Only one schedule out of the entire sixty was free of difficulties. He found little relationship between the size of the school and the conflict difficulties. He also concluded that the conflicts per pupil in a given school decrease with an increase in the number of sections of a subject. In his study, the two most outstanding factors resulting in difficulties in schedule making were:

(1) the use of the schedule requiring double periods for some subjects and (2) the prevalence of the irregular pupil programs.³⁹

Prior to Puckett's study, as well as during the years up to the present decade, the twentieth century has

³⁹R.C. Puckett, "The Difficulties of Making a High School Schedule of Recitation". (Unpublished Doctoral dissertation, University of Iowa, 1933), p. 33.

produced phenomenal growth in school resources and sweeping changes in the curriculum, but scheduling philosophy and practice have changed little.⁴⁰

According to Austin and Gividen, the Carnegie Unit was introduced in 1909 to help implement the recommendations of the 1892-'93 NEA Committee of Ten. The NEA Committee of Ten reported that every subject that is taught at all in a secondary school should be taught in the same way and to the same extent to every pupil so long as he pursues that subject, no matter what the destination of the pupil may be.⁴¹

Austin and Gividen recognized that there was little choice but to capitulate to the Carnegie Unit because colleges established the unit as a basis for entrance. High school class periods ranging from forty to fifty-five minutes in length and scheduled four to five times weekly were almost universal after 1910.⁴²

⁴⁰ D.B. Austin and N. Gividen, The High School Principal and Staff Develop the Master Schedule (New York: Bureau of Publication, Teachers College, Columbia University, 1960), p. 5.

⁴¹ Ibid., pp. 5-6.

⁴² Ibid., p. 37.

To illustrate the apparent lack of quality educational planning thirty or forty years ago, Puckett recorded the median time for beginning preliminary registration as being two weeks before the end of June. A number of schools did not consult pupils until the opening week in September.⁴³

Puckett commented that the administrator who tries to do the most satisfactory job of meeting the needs of the students will spend plenty of time planning in the spring, while a small minority of principals will wait until the students have appeared for the first day of school in the fall before they try to work out the schedule.⁴⁴

Ricksecker suggested, in the form of a check list, the steps that have been found helpful in remote and remedial planning of the school's program. He assigned much of the clerical work to the teachers and students.⁴⁵

Puckett's book also deals with the mechanics of constructing the schedule. He reviewed practices, offered suggestions, and gave specific directions on the important

⁴³Puckett, op. cit., p. 53.

⁴⁴Ibid., p. 30.

⁴⁵C.N. Ricksecker, "Check List of Steps used in Scheduling a Modern High School," American School Board Journal, 83: 61, September, 1931.

and often troublesome problem of making schedules which really work to the best advantage. Puckett wrote comprehensively at a time when there were few similar studies. Some examples of the subjects covered in detail include:

1. Forms used.
2. The descriptive booklet.
3. Signatures of parents.
4. Order of subjects on card.
5. Form of card.
6. Practices in listing subjects.
7. Making a schedule without a preliminary registration.
8. Who does the tabulating.
9. Method of tabulating.
10. Form used for tabulating.
11. Long periods make easier scheduling.⁴⁶

Standard Approaches

Newsome and Langfitt discussed the factors involved in program scheduling. There are three approaches in common use which provide for the various factors involved:

(1) the mosaic, (2) the block, and (3) the combination approach.⁴⁷

The mosaic approach ranks first in use with the majority of schools, reported Newsome and Langfitt. It is comprised of a trial-and-error procedure utilized by schedule makers to fit together teachers, rooms, and class sections

⁴⁶ Puckett, op. cit., p. 49.

⁴⁷ N.W. Newsome and R.E. Langfitt, Administrative Practices in Large High Schools (New York: American Book Co., 1940), p. 103.

in a manner that appears most satisfactory and efficient.⁴⁸

Puckett wrote that the most difficult task in completing the mosaic approach is trying to avoid conflicts. Pins, blocks, cards, colored pegs, and various other movable objects have been used to piece together into workable fashion a conflict-free master schedule. He suggested the construction of a conflict sheet on which were listed along the top and along the left hand side all of the subjects that could possibly be in conflict with each other. It was a complete guide for practically every difficult combination which might occur.⁴⁹

The block approach consists of arranging all sections into non-conflicting groups or blocks, with each period generally regarded as a block. Students in each class-year are assigned as units to class sections.⁵⁰

The combination approach consists of simply applying the block approach in required courses for all students and

⁴⁸ Ibid.; p. 104.

⁴⁹ R.C. Puckett, "An Aid in Schedule Making," American School Board Journal, 91: 30, August, 1935.

⁵⁰ Ibid., p. 104.

completing the remainder of the schedule by using the mosaic approach and making adjustments where conflicts exist.⁵¹

RECENT CURRICULAR, INSTRUCTIONAL, AND ORGANIZATIONAL PRACTICES AND PROCEDURES WHICH AFFECT SCHEDULING

A Focus on Change

Trump, the executive director of the National Association of Secondary School Principals' experimental projects in staff utilization, as a result of listening to proposals and discussions by that organization's Commission of the Experimental Study of the Utilization of the Staff in the Secondary School, was able to bring into focus new ideas for improving schools. All of his proposals had a common characteristic - they demanded flexibility in all school arrangements, in scheduling, in facilities, in architecture, in staff use, and in the organization of instruction. They constituted a new plan; a concept of the most adaptable kind for tomorrow's schools.⁵²

Team Teaching

Adamo investigated one of these areas in 1964 when he studied scheduling for team teaching and television in

⁵¹Ibid., p. 105.

⁵²J.L. Trump and D. Baynham, Focus on Change: Guide to Better Schools (Chicago: Rand McNally and Company, 1961), pp. 23-24.

six secondary schools which were heavily engaged with these projects in the northeastern United States.⁵³

As a result of interviews and one to three day visits in each of the schools, he concluded that all study schools were experiencing changes in curriculum with increased tendencies towards enrichment of subject matter. They had increased large-group spaces and instruction, but only two had increased small-group spaces and instruction. All but one school block-scheduled their innovation classes in their master schedule. These innovation classes comprised twenty percent or less of the total number of classes programmed.⁵⁴

Team and television instruction, according to Adamo, caused a wide difference in decision-making power in scheduling. Among his recommendations he included the encouragement of block time master scheduling for team-teaching and a wide variety of team arrangements with preference for the two or three-teacher teams composed of professionals with co-equal status.⁵⁵

⁵³ E.A. Adamo, "A Study of Scheduling for Team-Teaching and Television in Selected Secondary Schools". (Unpublished Doctoral dissertation, Columbia University, 1964.

⁵⁴ Ibid., p. 204.

⁵⁵ Ibid., p. 210.

According to the Trump plan, teaching teams fit no single pattern. They are of various sizes and compositions and are usually concerned with one subject field. Trump quoted some teachers from Evanston, Illinois, who commented that there is a different spirit in team teaching and team classes. They claimed that team teaching is more demanding for students and more stimulating for teachers.⁵⁶

Wey listed four points that should be considered when approaching team teaching:

1. Team teaching can be approached by a school from a very limited scale to complete reorganization. As a general rule, the limited approach is almost mandatory in a conventional school.
2. A beginning approach would be the assignment of two teachers in subject-related areas to a block of time. For example, a senior math teacher and an advanced science teacher could be assigned sixty pupils and a two-hour block of time.
3. Another limited approach could be the combination of classes and teachers of one subject, allowing the best qualified teacher to handle the area of team teaching he is best suited for. Three English I teachers could be combined to handle a group of ninety pupils; this group could be involved in large-group, small-group, and individual instruction by means of this combination.
4. Complete reorganization involves complicated problems in scheduling, training of teachers, change in facilities, and having proper equipment. It should not be attempted without

⁵⁶Trump and Baynham, op. cit., pp. 83-85.

several months of planning. Though it cannot be claimed that team-teaching improves instruction, it does provide an environment that encourages improvement.⁵⁷

Variable Size Groups

Advocates of flexible scheduling claim that the size of a class should be determined by the function it performs. The classroom of twenty-five to thirty-five students being the most effective method of achieving mass education has been labeled a myth by many educators. It was at best a compromise solution and one that did not fit many patterns of teaching exceptionally well. It was too small for large group instruction and too large for discussion groups.⁵⁸

Probably the easiest type of grouping for a school to initiate is the large group. Its primary functions are: (1) introducing new units of work; (2) audio-visual presentations; (3) using outside resource persons; (4) content presentations; (5) explaining new concepts; and (6) group testing.⁵⁹

The class size can range from sixty to three hundred students, or even more if the facilities are available. The size of the group is determined by the nature of the

⁵⁷ H.W. Wey, Handbook for Principals (New York: Schaum Publishing Co., 1966), p. 38.

⁵⁸ J.L. Trump, "Images of the Future," National Association of Secondary School Principals Bulletin, 25: 11, October, 1959.

⁵⁹ Trump and Baynham, op. cit., pp. 29-32.

presentation. Usually there would not be as many students in attendance for a lecture as there would be for the showing of a film.

The small or discussion group usually involves from seven to fifteen students. Any more than fifteen students in the small group would reduce its primary feature which is to enable the teacher to involve every student within the group. It is in this small sized group that the student is given the opportunity to discuss, question, clarify, and propose the ideas and knowledge he had presented to him in large groups or had discovered for himself in independent study.⁶⁰

Small groups give the teacher the opportunity to observe how the student applies information and concepts to problem solving. Because the size of the class is limited, the skilled teacher can involve each student in discussion and debate. When the students are grouped by activity, they can react to problems and take an active part in discussions without the fear of displaying their lack of knowledge on the subject. The quiet and unobtrusive students who often drift through school never being noticed or challenged have an opportunity to develop self-confidence in a situation that is not as threatening to them as the traditional classroom.

⁶⁰D.C. Manlove and D.W. Beggs, Flexible Scheduling (Bloomington: Indiana University Press, 1965), p. 23.

Trump and Baynham state four important purposes of the small group that are valuable in understanding the contribution that could be made by them. They are:

1. Provide opportunities for teachers to measure individual students' growth and development and to try a variety of teaching techniques which will be suited to the students' needs.
2. Offer the therapy of the group process, whereby students are induced to examine previously held concepts and ideas, and to alter rigid, sometimes mistaken, approaches to issues and people. Students will learn, in other words, how to become better group members.
3. Permit all of the students to discover the significance of the subject matter involved and to discuss its potential uses, rather than just to receive it passively and return it in tests, as happens all too often in today's classrooms.
4. Provide students with opportunities to know their teachers, on a personal, individual basis.⁶¹

When properly used, students in discussion groups learn how to ask questions instead of just answering those asked by the teacher. Students are led to discuss concepts, make generalizations, listen intelligently, and develop a critical tolerance for ideas that differ from their own.

⁶¹Trump and Baynham, op. cit., pp. 24-25.

Independent Study

Independent study is a very significant activity for many students operating under a flexible schedule. This activity does much to provide for the individual interest and abilities of the student. Much of the time the students are working alone, under the supervision of the teacher, but there are times when it is profitable for two or three students to work together.⁶²

Independent study should not be confused with homework. When a teacher assigns a pupil a certain number of pages to read, or a certain number of problems to work, then he is giving homework. Independent study differs from homework in that the students undertake projects that have been selected by themselves, under the guidance of a teacher, to "clarify, add to, or enrich subject matter presented in large classes and further explored by discussion in small classes."⁶³

Manlove and Beggs saw individual study as performing the following purposes and functions:

⁶²W.A. Keefe, "A Review of Recent Literature Concerning Flexible Scheduling and Team Teaching." (Unpublished Master's thesis, Redlands University, 1966), p. 17.

⁶³Trump and Baynham, op. cit., p. 27.

1. Develop skill or assimilate content.
2. Reinforce processes and understandings.
3. Expand areas of interest.
4. Broaden background.
5. Formulate interests and learning objectives.
6. Enlarge capacity for self-development.
7. Increase knowledge independent of formal instruction.
8. Refine skills.
9. Engage in creative thought.⁶⁴

Bishop has described an Independent Study Program which operates at three distinct phases of independence, depending upon the student responsibility, and the recommendations of his counselor, teachers, and parents. The first, total independent study, is designed for select students, since this is the highest phase of the program. At this level, mature, responsible students are allowed to use their unscheduled time without restriction. These students may study at their own discretion in any available areas of the school when they are not scheduled into class.

Phase two, limited independent study, is the one in which the majority of high school students will participate. At this level students are given initially some guidance in

⁶⁴Manlove and Beggs, op. cit., pp. 25-26.

planning constructive use of their unscheduled time. Most of these students are given only a limited, planned amount of completely unscheduled time. Specific amounts of this time may be assigned as supervised study.

The final phase is a plan which may be considered a part of the Independent Study Program only because it is designed to prepare students for the other two phases. Directed study provides close supervision for students who have demonstrated that they need help in developing basic, responsible study habits. For some of this time, they work with teachers in supervised study areas; for other periods of time they meet with a teacher in groups of seven or eight to discuss study problems, to learn techniques of general study, and to be introduced to ways of using the resource centers, library, or labs.⁶⁵

Flexible Scheduling

In the school years 1958-1959, Gividen studied ways of improving the design and implementation, with emphasis of flexibility, of small high school master schedules. He assisted a study group on flexible scheduling formed by the twenty-two member schools of the New York State Catskill

⁶⁵L.K. Bishop, "Independent Study," Clearing House, 42: 10-12, September, 1967.

Area Project in Small School Design. He helped to plan the study group's monthly meetings, investigated teacher and student attitudes towards schedules, conducted independent schedule study and redesign, and helped prepare a scheduling guidebook to be used by member schools.

Gividen's study group adhered to three scheduling principles as they developed their recommendations:

1. Comprehensive Offerings: Schedule design must make it possible for students to have a greater variety of educational experiences than is usually available in the small high school.
2. Longer Periods: In order to enhance increased personal interaction between the teacher and the individual student, schedule design must provide that most periods be longer than the forty-five minute periods customary in small schools.
3. Variability: From time to time, schedule design and implementation must facilitate changes in the organization of school days or weeks if learning advantages are to accrue.⁶⁶

The study group recommended that most Catskill Area Project Schools give careful consideration to the adoption of a floating-period schedule and a six-period day. Also, it was recommended that schools make a particular effort to study rotations and the modular schedule, and to exchange

⁶⁶N.J. Gividen, "Improving the Design and Implementation of Small High School Master Schedules with Emphasis on Flexibility," (unpublished Doctoral report of a type A project, Columbia University, 1959), pp. 5-8.

"punch card" experiences. A computer consultant was also invited to study their scheduling problems and derive whatever assistance he could from the computer.⁶⁷

As the years passed, Trump's group gained support for their original proposals. In 1965 the publications of Bush and Allen⁶⁸ and Manlove and Beggs⁶⁹ encouraged the need for new designs in secondary education. Earlier articles by Bush and Allen had helped in this respect, too.^{70, 71} Both sets of authors developed flexible scheduling models.

Bush and Allen recognized the need for a new design that is open and which can be outlined with sufficient precision to be amenable to adoption and experimentation in a variety of situations. They based their model on seven

⁶⁷ Ibid., pp. 85-87.

⁶⁸ R.N. Bush and D.W. Allen, A New Design for High School Education Assuming a Flexible Schedule (New York: McGraw-Hill Book Co., 1964).

⁶⁹ D.C. Manlove and D.W. Beggs, Flexible Scheduling (Bloomington: Indiana University Press, 1965).

⁷⁰ D.W. Allen, "First Steps in Developing a More Flexible Schedule," National Association of Secondary School Principals Bulletin, 46: 34-36, May, 1962.

⁷¹ R.N. Bush and D.W. Allen, "Flexible Scheduling," The National Association of Secondary School Principals Bulletin, 47: 73-98, May, 1963.

basic curriculum assumptions, three of which are pertinent to the specifics of scheduling:

1. Each subject, when properly taught, will include four basic types of instruction:
 - (a) Independent and individual study.
 - (b) Small-group instruction.
 - (c) Laboratory instruction.
 - (d) Large-group instruction.
2. Class size, length of class meeting, and the number and spacing of classes ought to vary according to the nature of the subject, the type of instruction, and the level of ability and interest of the pupils.
3. It is possible to obtain scheduling assistance through the use of data-processing equipment in order to implement a large degree of schedule flexibility.⁷²

Manlove and Beggs called their model of flexible scheduling "IndiFlexS," the Indiana Flexible Schedule. Their premise is that if the schools are given a flexible organization for teaching and good teachers, they will be able to do a better job than they can with a traditional schedule.⁷³ The procedures and administrative steps suggested to construct IndiFlexS are based both on solid theory and practical experience.

The IndiFlexS concept calls for the following organization of instruction:

⁷²R.N. Bush and D.W. Allen, A New Design for High School Education Assuming a Flexible Schedule (New York: McGraw-Hill Book Co., 1964), p. 8.

⁷³Manlove and Beggs, op. cit., p. ii.

1. Classes of varying size within and between courses.
2. Instruction groups which meet at varying frequencies and for varying lengths of time.
3. The possibility of team teaching in any contact area or for any group of students in the school.
4. Countless professional decisions by teachers about students, content, and teaching methods.⁷⁴

The Bush and Allen proposal called for specific content study, suggested specific teaching procedures, and insisted on varying class sizes. The Manlove and Beggs proposal provided for, but did not require, team teaching.

Building Flexibility

There is no question that a school adopting flexible scheduling would find it a distinct advantage to be able to design its facilities to fit the curriculum rather than trying to fit the curriculum to the buildings. However, schools that have used flexible scheduling in traditional buildings have stated that by careful remodeling and adequate planning it has proven to be quite workable.⁷⁵

The large groups usually meet in auditoriums, multi-purpose rooms, or in some cases two connected classrooms where a wall has been removed. If a school has a building

⁷⁴Ibid., p. 23.

⁷⁵Manlove and Beggs, op. cit., p. 81.

designed for team-teaching where two or more classrooms could be opened into one larger room, this arrangement can be used for large groups. In large areas the installation of amplifying equipment would be desirable. The number of large group areas in the school will depend upon the enrollment and the extent to which large group instruction is being practised.

The traditional school should have little difficulty with small group areas. Although classrooms were probably designed to accommodate up to forty students, they could be divided easily into smaller areas by constructing partitions or by using portable screens. Schools that have used screens to separate two or more small groups in one classroom reported the noise level was entirely tolerable; teachers and students adapted quickly to the situation.⁷⁶

Providing space for independent study in the traditional school can be a problem. If a student is permitted, to a certain extent, to determine his own destiny in the learning process, then the appropriate facilities must be available. The installation of carrels in the library and/or unused classrooms will serve as independent study areas. In the over-crowded school where a library

⁷⁶Keefe, op. cit., p. 20.

might not be available, expansion may be the only solution.

In the flexible school, probably the most vital area is the resource center. In many cases this center is located in the library. The well equipped resource center should provide for individual study, storage of audio-visual materials, listening posts for tapes and records, small conference areas, and teacher work areas. With the library and resource center combined, teachers and students are able to find and use books, periodicals, pamphlets, pictures, models, slides, films, tapes, records, maps, charts, audio-visual equipment, programmed materials, and possibly television.⁷⁷

Implementing a Flexible Schedule

In 1965, Beggs completed a major study in which he attempted to describe the procedures used in eleven secondary schools to implement a new form of organization, the flexible class schedule. Eleven schools using a flexible schedule for at least three years constituted the sample. One additional school which was in the early stages of developing a flexible scheduling program was added to the sample. Upon examination, no significant differences were found between the responses of the latter

⁷⁷ Ibid., pp. 21-22.

school and the other eleven schools.⁷⁸

The schools studied by Beggs had used either six or seven period school days before using a flexible schedule. The number of modules per day used by each school ranged from twelve to twenty-four.⁷⁹

The following conclusions of Beggs are noteworthy:

1. The motive for flexible scheduling, in each case, was related to visions of improving instruction.
2. A set of activities and a positive disposition toward this form of school organization can result in the successful implementation of the flexible schedule.
3. Sustained administrative leadership is a prerequisite for, and a continuing companion to, the faculty's study and eventual use of flexible scheduling.
4. Flexible scheduling is a satisfactory, operationally successful arrangement in the sample schools in which this organization was introduced.
5. Teachers need to be a part of a long-term faculty study carried on within the school building.
6. A building unit can identify instructional problems, propose solutions, and implement an action program.

⁷⁸ D.W. Beggs, "A study of the Implementation Strategy Employed by Selected Schools Using a Flexible Class Schedule". (Unpublished Doctoral dissertation, Indiana University, 1965), p. 57.

⁷⁹ Ibid., p. 58.

7. The conclusion evident from this study is that the strategy used to introduce the flexible schedule is aimed at altering the teachers' traditional classroom performance to accommodate the purpose of the large and small groups with independent study.⁸⁰

A review of the literature has revealed several references to the Trump Plan in operation at Ridgewood High School in Norridge, Illinois.⁸¹ Ridgewood High, which enrolled its first students in 1960, is a school designed both architecturally and organizationally to embody many of the Trump recommendations. In Ridgewood, large group classes are usually scheduled for morning periods. They schedule large classes in the first half of the week and small classes in the latter half so that the subject matter presented in large classes and further discussed in small classes before the week ends has a better chance of being retained by students.⁸²

In 1966, Thayer conducted a survey of current practices in fifty-six secondary schools of California which incorporated the concept of flexible scheduling or which used other unique and varying patterns of time modules for scheduling. He evaluated practices on the basis of

⁸⁰Ibid., pp. 120-122.

⁸¹Wey, op. cit., pp. 21-27.

⁸²Trump and Baynham, op. cit., pp. 87-89.

local objectives. Interviews were held with twelve principals, their teachers, counselors, and students.

Thayer developed a set of clear, succinct conclusions, most of which apply to flexible scheduling implementation:

1. Unique and varying patterns of time arrangements are useful tools for implementing instructional innovations.
2. There is a broadening interest in, and a trend towards, schedule modification, which is affecting the basic structure of instruction.
3. The length of time intervals assigned to academic subject areas is becoming more dependent on the topics considered, the instructional techniques utilized, and the maturation and ability levels of the students involved.
4. Staff roles are affected by the types of schedules used in a school.
5. With proper orientation, students adjust quickly to scheduling innovations and can be expected to indicate their support of well-planned experiments with sincere effort.
6. There appears to be a communications problem, which is in direct proportion to the complexity of the schedule, between the school and the parents regarding unusual scheduling procedures.
7. There is a concern among educators, students, and parents regarding readiness for independent study.
8. Planned evaluations of scheduling experiments are seldom employed. There is evidence, however, that there is a significant relationship between program success and evaluation procedures.

9. There is a trend toward the use of computers for scheduling students, particularly in the more complex schedule types.
10. The most important element controlling the success of unusual scheduling plans is the teacher. His understanding and support of the plan is essential to the achievement of objectives.⁸³

Thayer reported that only one of the sixty involved staff interviewees expressed a desire to return to a traditional schedule. In relation to item ten (above), the twelve interviewed principals all recommended that the selection and assignment of teachers and the staff involvement be given top priority in the development of scheduling plans.⁸⁴

Beggs developed a common strategy for introducing a flexible schedule:

1. Administrative judgement, familiarity with the faculty, and understanding the concept of flexible scheduling are necessary to consider before the decision is made to employ a flexible schedule.
2. The employment of a flexible schedule calls for different expenditures of funds than the traditional schedule demands.
3. An in-service program was considered vital to the introduction of the flexible schedule.

⁸³ G.E. Thayer, "The Use of Unusual Time Modules for Scheduling Secondary School Students." (Unpublished Doctoral dissertation, University of Southern California, 1966), pp. 278-279.

⁸⁴ Ibid., p. 279.

4. A workshop should be planned for the faculty during the summer before the new schedule is to be implemented.
5. Visits by teachers who expect to use a flexible schedule should be made to schools already using such an organization.
6. There is a need to develop written bulletins about critical aspects of flexible scheduling.
7. There should be a planned program of community information.
8. External approach for the concept should be sought from the board of education, the regional accrediting association, and the state department of public instruction.
9. There must be a focus on activities which will yield maximum changes in teaching performances within the context of large-group instruction with independent study.⁸⁵

Beggs's common strategy, or set of activities, is similar to a set of guidelines developed by Thayer for the same purpose. Thayer, in addition to Beggs's strategies, would bring in consultants and possibly computers to assist in scheduling the variable modules.⁸⁶ Wiley and Bishop describe the most recent account of the flexibly scheduled high school which involves the three distinct phases of independent study.⁸⁷ Instead of a modular flexible program,

⁸⁵Beggs, op. cit., pp. 116-119.

⁸⁶Thayer, op. cit., p. 281.

⁸⁷Wiley and Bishop, op. cit.

Bishop calls it the Variable Class Scheduling Program.⁸⁸

Flexible Scheduling Problems

Beggs, in his study, identified at least seven potential scheduling problems:

1. Difficulties were encountered in attempting to alter traditional methods of instruction to those required in flexible schedules.
2. Developing a concise understanding of the unique purpose of varying class size became essential before the flexible organization resulted in different instruction.
3. Perplexities were common in attempting to secure full participation of the faculty in the study of flexible scheduling.
4. Gaining sustained faculty and community support for flexible scheduling appear to represent a significant problem.
5. Students in adjusting to a flexible plan of organization often needed extensive assistance from the professional staff.
6. Routines involving pupil accounting and other administrative matters were frequently complicated.
7. The additional demands of flexible class schedules did not allow enough time for principals to work cooperatively with teachers and other staff members.⁸⁹

Duncan conducted a study in three secondary schools to determine whether teacher-resistance was a significant

⁸⁸Bishop, op. cit., pp. 9-14.

⁸⁹Beggs, op. cit., pp. 114-119.

factor in flexible scheduling. An identical questionnaire was submitted to faculty members in each of the schools before and after one semester's exposure to a flexible class schedule. The questionnaire solicited responses of teachers' expectations regarding flexible scheduling in the following eight areas: (1) the teaching-learning process, (2) utilization of teacher's time, (3) faculty interpersonal relations, (4) satisfaction with teaching tasks, (5) classroom management, (6) student achievement, (7) positive accomplishments, and (8) serious disadvantages.

Among conclusions drawn from the study, the following seemed especially pertinent: (1) teachers responded favorably to flexible scheduling and indicated that it was a satisfactory organizational arrangement for teaching and learning; (2) financial resources available to a school had no bearing on whether it was organized on a traditional or flexible basis; (3) flexible scheduling placed more exhausting demands on teachers' time than did a traditional organization for teaching and learning; (4) flexible scheduling aided in bringing about a change in the role of teachers; and (5) students accepted more responsibility for their own learning.⁹⁰ The study concluded that, with only

⁹⁰ J. R. Duncan, "A Study of Teachers' Expectations of Flexible Scheduling in Three Selected Secondary Schools." (Unpublished Doctoral dissertation, Indiana University, 1967), pp. 217-219.

a few exceptions, teachers' attitudes were more positive after one semester's exposure to flexible class schedules and teacher-resistance, therefore, appeared to be an unsubstantiated myth.

Leigh reported six important problems encountered in the implementation and administration of a flexible class schedule: (1) some students demonstrated irresponsible behavior as a result of additional freedom; (2) college requirements were restrictive of exploratory courses; (3) the school board, parents, and public were very critical of unassigned time; (4) state requirements concerning graduation credits; and (5) legal requirements of teacher supervision of students at all times.⁹¹

One secondary school reported seven major problems as a result of implementing a flexible class schedule. They were: (1) the facility, designed for traditional organization of instruction, was not conducive to finding rooms for independent study, or large and small study groups; (2) the library was too noisy and inadequate; (3) the staff could not keep track of those students unable to handle extra freedom; (4) noisy and aimless wandering in the school's halls; (5) difficulties in providing adequate

⁹¹T.G. Leigh, "Big Opportunities in Small Schools Through Flexible-Modular Scheduling," Journal of Secondary Education, 42: 77, April, 1967.

teacher planning time; (6) coordinating and scheduling students for extra curricular activities became a constant source of confusion and irritation; and (7) a pronounced increase in the size of the staff.⁹²

Once the flexible schedule had been implemented, Sleight contended that a number of problems continued to arise just as they did in traditional organization patterns. The new organization led to constant change because faculty and community attitudes tend continually to demand innovative processes.⁹³

Sleight identified numerous post-implementation problems in administering a flexible class schedule and indicated that many of them were common to the administration of traditional or flexible organizations. These problems included:

1. Difficulties are encountered in logically developing and setting subject designs.
2. Establishing schedules for final examinations, assemblies, and extra-curricular activities becomes more complex.
3. The administrative load is increased in nearly every perspective.
4. Determination of how many minutes of class time and number of credits applicable for each

⁹²"Five Flexible Schedules that Work," Nations Schools, 82: 28-29, August, 1968.

⁹³R.H. Sleight, "Administrative Problems as a Result of Flexible Scheduling and Team Teaching," Journal of Secondary Education, 42: 360, December, 1967.

course offered in the program of studies becomes complicated.

5. Lunch periods must be established and in so doing, considerations such as split or universal lunch periods, what is to be done with non-scheduled students during lunch periods, and working such students into the schedule deserve extensive administrative deliberation.
6. Length of the school day becomes a problem, especially when deciding what is a reasonable day for students and faculty.
7. Remodeling for large and small group instruction and independent study presents problems in administrative decisions related to the selection of materials, areas, and design.
8. Decisions related to audio-visual equipment especially in regard to portability, quantity, and location becomes especially difficult.
9. Problems related to the purchase of proper materials, supplies, and equipment become pronounced.
10. Providing for teachers' planning time is a major problem. It includes aspects such as a time when all teachers can meet, places where they can meet, and personality conflicts between members of teaching teams.
11. Analyzing and adjusting administrative tasks and assignments in a flexible organization is more difficult and time consuming than in a traditional organization.
12. Attendance procedures are complicated and consume more administrative and clerical time than in a conventional organization.
13. In-service teacher education programs become more pressing in a flexible schedule and thus additional financial expenditures required of the school become significant.

14. The problem of how much to involve students and parents in planning and yet not inhibit the school staff is aggravated in the pursuance of a flexible schedule.
15. Problems in staffing become pronounced. Teacher load, minutes per week they teach, adding new teachers, substitutes, unanticipated enrollments at the beginning of the school year, assigning new staff members to teaching teams, are significant problems and tend to complicate staffing logic.
16. Difficulties in locating students and teachers are considerably greater and more complicated in a flexible organization than they are under a traditional organization for instruction.⁹⁴

Research has provided little help in determining whether a flexible schedule is better than a traditional schedule. In fact, proponents of flexible scheduling were well aware that their support of it was based upon empirical observation, theoretical soundness, and/or opinion.⁹⁵ In view of the foregoing, it is obvious that program evaluation could become a major problem for administrators in schools pursuing flexible class schedules. The future must see some rigorous evaluation of educational innovations such as flexible scheduling.⁹⁶

⁹⁴ Ibid., pp. 361-363.

⁹⁵ Manlove and Beggs, op. cit., pp. 90-98.

⁹⁶ "National Association of Secondary School Principals set for 5-Year Innovations," Education News 2: 7, May 1968.

TYPES OF SCHEDULES

As difficult as it may seem, innovative principals have proven that the master schedule can be made the servant of the educational program. This section illustrates several ways in which this may be done.

Simple Block Schedule

In departing from traditional scheduling patterns, the simple block schedule might be considered as an easy first step. Although such a schedule restricts teachers to a relatively short block of time, it does allow them to share students, facilities, and equipment. It also encourages cooperative planning, eliminates duplication of effort, and creates an opportunity for professional growth. The student benefits from more varied learning experiences such as large-group instruction, small-group instruction and independent study.

To accommodate teaching teams, one merely gives each member of a team an identical schedule. For example, if two teachers form a team to teach English, each should be scheduled to meet different sections of the same course during the same period, as indicated in Figure 3. Notice that this is a portion of the daily schedule and that somewhere during the day it is essential that teachers A and B share a common planning period. Figures 4 and 5 show two

FIGURE 3

SIMPLE BLOCK SCHEDULE

Period

I

Teacher A
Eng. VIII
Sect. I
(30 students)

Teacher B
Eng. VIII
Sect. 2
(30 students)

Planning Period Teachers A & B

FIGURE 4

SIMPLE BLOCK SCHEDULE: PATTERN ONE

Period

I

Teacher A
Eng. VIII
Sect. 1a
(15 students)

Teacher B
Eng. VIII
Sect. 2a
(15 students)

Independent Study
Sect. 1b and 2b
(30 students)

FIGURE 5

SIMPLE BLOCK SCHEDULE: PATTERN TWO

Period

I

Teacher A
Eng. VIII
Tutorial
(10 students)

Teacher B
Eng. VIII
Independent Study
(50 students)

of the possible patterns that may be formed from this type schedule.⁹⁷

Back-to-Back Schedule

Working within the framework of a traditional schedule, an administrator may introduce considerable flexibility by increasing the number of time blocks from one to two. Shown in the following figures are variations of structure involving two English teachers, two social science teachers, and 120 students scheduled "back-to-back" in a two-period allocation.⁹⁸

FIGURE 6

BACK-TO-BACK SCHEDULE

Period	Teacher A	Teacher B	Teacher C	Teacher D
I	Eng. VIII Sect. 3 (30 pupils)	Eng. VIII Sect. 4 (30 pupils)	S.S. VIII Sect. 1 (30 pupils)	S.S. VIII Sect. 2 (30 pupils)
II	Teacher A Eng. VIII Sect. 3 (30 pupils)	Teacher B Eng. VIII Sect. 4 (30 pupils)	Teacher C S.S. VIII Sect. 1 (30 pupils)	Teacher D S.S. VIII Sect. 2 (30 pupils)

⁹⁷ H.S. Davis and J.E. Bechard, Flexible Scheduling (Cleveland, Ohio: Educational Research Council of America, 1968), p. 2.

⁹⁸ Ibid., p. 4.


FIGURE 7

BACK-TO-BACK SCHEDULE: PATTERN ONE

Period

I

Teachers A & B
 Eng. VIII
 Sect. 1, 2, 3, & 4
 (120 students)

Teachers C & D
 Planning
 Period 

II

Teachers A & B
 Planning
 Period

Teachers C & D
 S.S. VIII
 Sect. 1, 2, 3, & 4
 (120 students)

FIGURE 8

BACK-TO-BACK SCHEDULE: PATTERN TWO

Period

I

First Day	Second Day					Third Day				
Large Group Sect. 1, 2, 3, & 4 Teachers A & B or C & D Eng. VIII or S.S. VIII	Independent Study	Small group				Independent Study	Small group			
		A	B	C	D		A	B	C	D
	Sect. 3 & 4	1a	1b	2a	2b	Sect. 1 & 2	3a	3b	4a	4b
		Eng. VIII	Eng. VIII	S.S. VIII	S.S. VIII		Eng. VIII	Eng. VIII	S.S. VIII	S.S. VIII

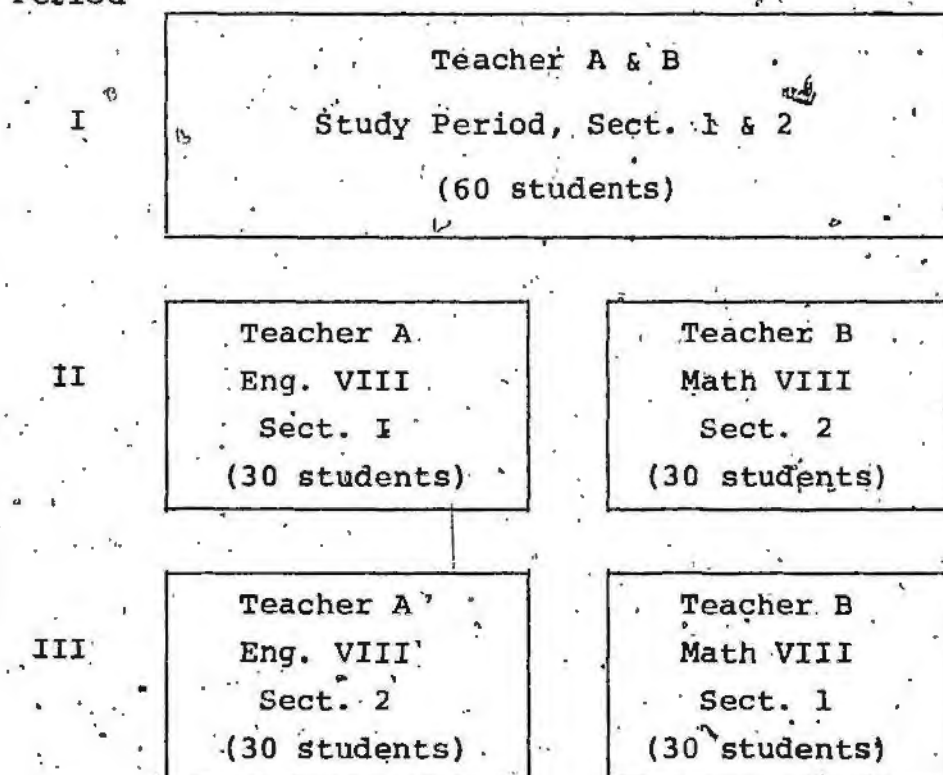
Inter-Disciplinary Schedule

The inter-disciplinary schedule is a variation of the block schedule used for teaching teams. This method of scheduling is appropriate for small schools where there is usually only one teacher for each subject. A team can be composed of two or more teachers of different disciplines. Figure 9 illustrates a block of three periods that allows the team the option of using them as they see fit.⁹⁹

FIGURE 9

INTER-DISCIPLINARY SCHEDULE

Period



⁹⁹ Ibid., p. 8.

School-Wide Block Schedule

When a school decides to make a school-wide scheduling commitment to take better advantage of time, talent, and space, one of the easiest to implement is the block schedule. Figure 10 shows one type which makes use of team teaching.

Looking at the mathematics-science team, we find that team members have four modules of time allotted for both subjects. Some teams may correlate content, and work together at all times. Others may prefer to work as separate math and science teams. In any case, these teachers are responsible for pupils in different grades in three of the four academic blocks of time. The remaining time block is free for planning. Note the use of a 20 minute module here.¹⁰⁰

School-Wide Block Schedule (Variation)

In contrast to the Block schedule shown in Figure 10, most teams in the second type of block schedule (Figure 11) teach only one grade level. This schedule is designed to allow cross-discipline teams to function with groups of students within generally longer blocks of time. For example, the Unified Studies Team 7 teaches English, social studies, mathematics, and science to only 7th grade

¹⁰⁰ Ibid., p. 10.

FIGURE 10

SCHOOL-WIDE BLOCK SCHEDULE

Module	Grade 7	Grade 8	Grade 9
1-4	Mathematics Science	Language Arts Social Science	Humanities Foreign Language
5-8	Industrial Arts Physical Education	Mathematics Science	Language Arts Social Science
9-12	Humanities Foreign Language	Industrial Arts Physical Education	Mathematics Science
13-16	Lunch, Band, Club Meetings, Independent Study		
17-20	Language Arts Social Science	Humanities Foreign Language	Industrial Arts Physical Education

FIGURE 11

SCHOOL-WIDE BLOCK SCHEDULE (VARIATION)

Module	Grade 7	Grade 8	Grade 9
1 2	Fine Arts Team F	Unified Studies Team 8	Unified Studies Team 9
3 4	Physical Education Team P		
5 6	Unified Studies Team 7		
7 8		Physical Education Team P	
9 10		Lunch	
		Lunch	Physical Education Team P
11 12	Lunch	Fine Arts Team F	
13 14	Unified Studies Team 7	Unified Studies Team 8	
15 16			
17 18			Fine Arts Team F

students. The team makes its own decision as to the amount of time to be spent in the various subject areas. These decisions are based upon the educational needs of their students. In this schedule, the academic teams remain within their grade levels while the physical education and fine arts teams travel through the grade levels at different times during the day. While these special teams operate, the unified studies team is free for planning.¹⁰¹

Rotating Schedule

Figures 12, 13, 14 and 15 demonstrate how a conventional schedule may be re-arranged without changing the basic design. These schedule arrangements are ideal as initial steps to make a staff aware of the advantages of a flexible schedule.

Figure 12 is an alteration aimed at relieving monotony and fatigue. Last-hour classes, when teachers and students are most tired, are rotated. Note the fourth or lunch period remains constant.

Figure 13 introduces another dimension. This is the inclusion of a seventh period into a six period day. Provision of x and y periods opens up many possibilities. These periods can be placed anywhere in the schedule and

¹⁰¹ Ibid., p. 12.

FIGURE 12

ROTATING SCHEDULE I

Period	M	T	W	T	F
I	1	2	3	5	6
II	2	3	5	6	1
III	3	5	6	1	2
IV	4	4	4	4	4
V	5	6	1	2	3
VI	6	1	2	3	5

FIGURE 13

ROTATING SCHEDULE II

Period	M	T	W	T	F
I	1	7	6	5	4
II	2	x	7	6	5
III	3	2	1	7	6
IV	4	3	2	1	7
V	5	4	3	y	1
VI	6	5	4	3	2

FIGURE 14

ROTATING SCHEDULE III

Minutes Per Period	M	T	W	T	F
45	1	6	5	4	1
45	2	1	6	5	3
60	3	2	1	6	4
60	4	3	2	1	5
90	5	4	3	2	6

FIGURE 15

ROTATING SCHEDULE IV

Periods	M	T	W	T	F
I	1	1	1	1	2
II		2	2	2	
III	3	3	3	4	3
IV	4		4		4
V	5	5	6	5	5
VI	6	6		6	

may be used for any purpose.

Figure 14 uses the rotating schedule as a base and adds variable period lengths. The rotation allows each teacher to experience a variety of time blocks and to plan appropriate activities such as 90-minute lab periods, etc.

Figure 15 further illustrates how a traditional schedule can be made more flexible by combining class periods on various days instead of rotating. Where teachers are already scheduled back-to-back this offers further flexibility.¹⁰²

Flexible-Modular Schedule

The flexible schedule has been discussed in detail in an earlier section of this chapter, however, Figures 16 and 17 are presented here to illustrate the nature of both the student and teacher schedule. Note the variable time periods, frequency of subject meetings per cycle, size of groups and room assignments.

No schedule guarantees better education. Before "changing for the sake of change" a responsible staff will determine whether or not the present schedule enhances the attainment of sound educational objectives. If not, then the schedule should be changed to fit the program, rather than forcing the program to fit the schedule.

¹⁰²Ibid., p. 16.

FIGURE 16

FLEXIBLE-MODULAR SCHEDULE: STUDENT SAMPLE

Module	Monday	Tuesday	Wednesday	Thursday	Friday
1	Geography	Geography	Biology	Geography	English
2	Small group	Small Group	Small Group	Small Group	Small Group
3	Room 110	Room 110	or Laboratory Room 126	Room 110	Room 111
4	I.S. (pupil option)	I.S.	I.S.	I.S.	I.S.
5	Open Lab	Art	Physical Science	Art	Phys. Science
6	I.M.C.	Room 118	Large Group	Room 118	Small Group
7	Lounge		Room 203		or Lab
8	Art etc.				Room 206
9			I.S.	I.S.	
10	Lunch	I.S.	Lunch	Lunch	Lunch
11					
12	I.S.	Lunch	I.S.	Language	
13	Math		Math	Lab	I.S.
14	Large Group		Large Group		
15	Room 119	I.S.	Room 119	English	Math
16	I.S.	English		Small Group	Small Group
17	Physical Science	Large Group			
18	Small Group	Room 121	I.S.	I.S.	
19	or	Biology			I.S.
20	Lab	Small Group		Biology	
21	I.S.	or		Large Group	
22	French	Lab	French	Room 126	
23	Room 109	Room 126	Room 109		French
24		Math		Math	Room 109
		Small Group			
		Room 201			

FIGURE 17

FLEXIBLE-MODULAR SCHEDULE: TEACHER SAMPLE

Module	Monday	Tuesday	Wednesday	Thursday	Friday
1	Team Planning	Math I Large Gp., Sect.		Math 1, Lg. Gp. Sec. 1,2	Team Planning
2		1,2,3,4,5,6		3, 4, 5, 6,	Math 2
3		Room 119		Room 119	
4	Math I, Sm. Group, Sect.		Math I, Sm. Group, Sect.		Small Group
5	I, Room 203		I, Room 203		Sec. 1
6					Room 203
7	Math I, Sm. Group, Sect.	Math I, Sm. Group, Sect.		Math I, Sm. Group, Sect.	
8	2, Room 203	2, Room 203		2, Room 203	
9	Math I, Sm. Group, Sect		Math I, Sm. Group, Sect		Math I, Sm.
10	3, Room 203		3, Room 203		Group, Sect.
11	Lunch	Lunch	Lunch	Lunch	3, Room 203
12					
13	Math 2, Lg. Gp., Sect. 1,	Team Planning	Math 2 Lg. Group,		Math 2, Sm.
14	2,3,4, Rm. 119	General Math	Sec. 1,2,3,4,		Group, Sect.
15			Room 119		4
16					Room 201
17					
18	Gen. Math, Lg. Gp. Sect. 1,2,		Gen. Math. Small Group		Gen. Math
19	3,4,5,6, Rm. 119		Sect. 6		Small Group
20			Room 201		Sect. 6
21					Room 201
22		Math 2, Sm. Group, Sect.		Math 2, Sm. Group,	
23		4		Sect. 4	
24		Room 201		Room 201	6

DATA-PROCESSING PRACTICES AND PROCEDURES
WHICH AFFECT SCHEDULING

General Effects of Data-Processing on Scheduling

The area of student registration and scheduling is where the most extensive pupil personnel service is performed by data processing. Prior to the use of data processing for these purposes, many administrators and assistants lost countless days of the summer making sure that students' schedules were ready for the first day of school.

Dombrow completed a study of manual and unit-record techniques for processing clerical data in Plymouth-Whitemarsh High School, Plymouth Meeting, Pennsylvania, a school of 1,000 students. His primary purpose was to determine the possibility of more effectively utilizing the time of a school's professional staff. He analyzed existing clerical duties of personnel, determined which unit-record techniques could help to produce a more simplified and economical approach to data processing, and compared present clerical procedures with the unit-record techniques developed through the use of a service bureau.

Two advising groups assisted Dombrow in his study. Both educators and data-processing personnel made recommendations that unit-record procedures be investigated for taking over clerical duties in the areas of attendance, budget, course selection and scheduling, grading,

standardized testing, and textbook accounting.

Dombrow's study indicated that the overall costs of scheduling were reduced by over 50 per cent. In addition to the economy factor of both time and money saved, all documents produced by the machines showed greater legibility than documents produced by hand. He also found that schools of smaller size could investigate the advantages of data-processing techniques available to assist the scheduling process from a service bureau.¹⁰³

Murphy used International Business Machines equipment for his 600-student high school through the help of the Service Bureau Corporation, a data-processing subsidiary of International Business Machines. The service is contracted for on an annual basis at a per pupil rate. The results of this service again provide for vital economy of professional time.¹⁰⁴

The chief obstacle to the use of unit-record equipment in 1950 was its lack of availability. Later,

¹⁰³ R.T. Dombrow, "A Study of Manual and Machine Techniques for Processing Clerical Data in a Secondary School of 1,000 students." (Unpublished Doctoral dissertation, Temple University, 1960), pp. 268-270.

¹⁰⁴ R.M. Murphy, "Data Processing System for the Small High School," National Association of Secondary School Principals Bulletin, 46: 19-21, April, 1962.

Templeton had no problem in that respect. He described a scheduling plan using International Business Machines' punch cards, sorting machines, and tabulating machines with the assistance of the unit-record machines at neighbouring Indiana University.¹⁰⁵

Educators were concerned that mechanical devices not be permitted to take the place of sound, constructive thinking. Manley and Holt wrote in 1959 that there is a strong tendency to make the daily time program, student programs, teacher programs, and other factors which enter into schedule making conform to the mechanical system used. They stated that secondary school administrators who use mechanical aids must constantly be on guard against this danger.¹⁰⁶

In 1968, G. Ernest Anderson reported the existence of the Data Processing Project of the New England School Development Council. This project was concerned with the entire range of student record processing, including scheduling. Anderson stated that this has grown into an example of regional cooperation in the establishment of

¹⁰⁵ E.L. Templeton, "The Use of IBM Techniques in Program Making and Class Scheduling," National Association of Secondary School Principals Bulletin, 34: 15-22, October, 1962.

¹⁰⁶ C.B. Manley and C.C. Holt, "What is the Case For and Against Machine Techniques for School Scheduling," National Association of Secondary School Principals Bulletin, 63: 196, April, 1959.

New England Data Systems (NEEDS), a nonprofit organization which now serves 80,000 students in more than fifty school districts and six state departments of education. Associated with Harvard Graduate School of Education, NEEDS receives financial support from the Ford Foundation and the United States Office of Education as well as from its members.¹⁰⁷

In 1965, Brummitt conducted an analysis of the impact of automated data processing on public education in another region, the Central Schools of New York State. A study of the eight schools revealed a unique data-processing technique in relation to scheduling at Messina High School. High school pupils were registered and scheduled for class by the use of a collator. This method is more complicated than some other sorting methods but much faster in terms of the lapsed time used in processing the data.¹⁰⁸

Brummitt recognized that the punch card or unit-record system more closely fitted the needs of most school systems than did the so-called computer hardware. The ten percent of the Central Schools of New York State which were committed to the process of automation of data processing

¹⁰⁷G.E. Anderson, "New Computer Programs Help Flexible Schedules," Nation's Schools, 81: 20, June, 1968.

¹⁰⁸B.R. Brummitt, "The Impact of Machine Data Processing Systems on the Central Schools of New York State." (Unpublished Doctoral dissertation, Syracuse University, 1965), p. 26.

were, on the whole, enthusiastic about its advantages. One of the greatest effects was the manner in which student scheduling was accomplished.¹⁰⁹

According to Grossman, today's able administrator is being challenged by the increasing complexity of the challenges of new school programs. The most successful decision makers will be those who can best plan, process, interpret, and implement these new designs, using automated techniques.¹¹⁰ However, despite the potential of data-processing, a carefully drawn up and systematized approach to implementation is required before any step towards the automation of an aspect of school operations is taken. Bushnell and Allen¹¹¹ reported that automation demands systematic planning and thinking, for therein lies its promise and the solution to complexities.¹¹¹

Computer Scheduling

In this day of computerized capability, the time-consuming and laborious manipulation of colored bits of paper is no longer necessary to build the master schedule.

¹⁰⁹ Ibid., pp. 123-124.

¹¹⁰ A. Grossman, "Data Processing: An Answer to the Shackles of Paperwork and Decision Making," National Association of Secondary School Principals Bulletin, 46: 18, April, 1962.

¹¹¹ D. Bushnell and D.W. Allen, The Computer in American Education (New York: John Wiley and Sons, Inc., 1967), p. xiv.

Even the modest size high school, some distance from a large city and possessing no computer of its own, can have computer assistance at a reasonable cost.¹¹²

Initial experiments in computer scheduling were applied to college scheduling. One of the earliest was Blakesly's at Purdue University in 1956, which aimed at devising a computer system for registering and scheduling. When Purdue University changed over to a computerized class-scheduling system, students got their first choice of professors about 78 per cent of the time, compared to 22 per cent under the old manual system.¹¹³

In 1963, Boyles saw the need to set forth theoretical rules which would direct the efforts of the programmer in developing a program for the utilization of a computer in the secondary school schedule construction process. This was accomplished by establishing the criteria by which secondary school schedule construction factors could be identified, classified, and rated. Then, Boyles identified, classified, and rated these factors and attempted to differentiate between those which could or could not be manipulated by an electronic computer.

¹¹² J.J. Janes, C.J. Salisbury, and R.L. Spencer, Secondary School Administration (New York: McGraw-Hill Book Company, 1969), p. 282.

¹¹³ J.I. Goodlad, J.F. O'Toole, and L.L. Tyler, Computers and Information Systems in Education (New York: Harcourt, Brace, and World, Inc., 1966), pp. 76-77.

Boyles worked with six selected high schools in identifying the factors. The factors were then submitted to a group of principals and to a group of computer experts to decide the feasibility of handling them on an electronic computer. The rules projected in his study were as follows:

1. Schedule classes so that the subject code and the room code are equal as far as the first digit of the identification code number.
2. Place single-section subjects into the schedule matrix after the fixed-time activities and before multiple-sectioned subjects; place all conflicting single-section subjects in the matrix at a time period other than the opposing conflicting single-section subject.
3. Schedule fixed-time activities prior to the scheduling of single-section subjects.
4. Schedule a single-section subject opposite a subject being offered in multiple sections or opposite a subject which has not been chosen by any of the students choosing the original single-section subject.
5. Do not schedule a two-section subject opposite two single-section subjects.
6. Do not schedule a three-section subject opposite three single-section subjects.
7. Schedule a subject with four or more sections opposite any subject regardless of the number of sections in the opposing subject. However, do not schedule multiple sections of the same subject at the same time.
8. Schedule classes only within predetermined time limits of the school day.
9. Code subjects in such manner that they will be scheduled in the time period represented by the code.

10. Code any double period subjects in such manner that two consecutive periods will be allowed for its time period.
11. Limit all teachers except those coded for fewer periods to five periods of teaching.
12. Rate teachers by a code in relation to the subjects they can or should teach. Assign subjects to teachers according to this rating.¹¹⁴

The success of a program as complicated as the automatic scheduling of students into classes demands good organization and management. Most administrators have read descriptions in the newspapers about a few schools which have not been scheduled successfully by a computer. In many cases, these schools had missing links in their organization and management of the computer scheduling process.¹¹⁵

Prance completed a doctoral study in 1964, at which time she developed a handbook of procedures for personnel involved in computer scheduling. It was to be used in the secondary schools of Dade County, Florida. As a result of developing this handbook and testing its use with the schools, Prance made the following conclusions:

¹¹⁴N.L. Boyles, "Theoretical Rules for the Construction of a Secondary School Master Schedule Utilizing an Electronic Computer." (Unpublished Doctoral dissertation, University of Tennessee, 1963), pp. 98-101.

¹¹⁵S.D. Howell, "A Study of Scheduling Practices, Procedures and Related Influential Factors in Selected Public High Schools of Pennsylvania." (Unpublished Doctoral dissertation, Temple University, 1970), p. 65.

1. A complete, detailed, clear set of instructions is necessary for the success of a program as complicated as the automatic scheduling of students into classes. The construction of the Handbook was necessary.
2. Automatic scheduling of students into classes can provide additional time for educational counseling in the event of irresolvable conflicts.
3. Accurate data furnished to principals can result in better master schedules.
4. The process of computer scheduling provides desirable by-products in the form of class rosters, attendance cards, and grade reporting cards, which become automatically available and are of considerable convenience.¹¹⁶

Prance recommended that every secondary school in the county proceed toward computer scheduling and that in-service training scheduling procedures be provided for all teachers, counselors, and principals. The latter recommendation came as a result of finding a failure to follow instructions in some schools, which resulted in delay of time, unnecessary clerical work by teachers and counselors, and avoidable errors.¹¹⁷

A study of the extent of computer scheduling systems used in the state of New Jersey was conducted by Wright for the year 1963-1964. Wright investigated the eleven systems

¹¹⁶H.T. Prance, "The Application of Automation to the Scheduling of High School Students into Class." (Unpublished Doctoral dissertation, University of Miami, 1964), p. 3.

¹¹⁷Ibid., p. 58.

then in use, compared them with previous scheduling systems used in the schools identified, and examined the effects and advantages of computer scheduling. The investigation included the reasons that prompted secondary school administrators to use computer scheduling and the steps involved in its introduction.

Wright wrote that computer scheduling represents a refinement of the machine data processing or bin method. In computer scheduling, the computer assigns students to classes on the basis of the master schedule and the students' course selections. The computer is programmed to balance classes and to avoid student schedule conflicts. Printed students' schedules and class lists are an output of the computer.¹¹⁸

Wright found that the schools using a paid consultant successfully scheduled 95.2 per cent of the students as compared to the 86.9 per cent successfully scheduled, in schools not using a paid consultant. The computer costs ranged from zero to 600 dollars, and the per student cost tended to decrease as the student population increased.¹¹⁹

¹¹⁸R.D. Wright, "Computer Scheduling in Selected Secondary Schools in New Jersey." (Unpublished Doctoral dissertation, Rutgers - The State University, 1965), p. 24.

¹¹⁹Ibid., pp. 74-79.

An analysis of the data collected by Wright led him to the following conclusions:

1. Previous data-processing experience is not necessary in order for school administrators to successfully introduce computer scheduling.
2. It is possible for computer scheduling to be introduced and used successfully in a school even though data-processing equipment is not available within the school district.
3. Computer scheduling systems can be introduced without delegating administrative decisions to non-professional personnel or to machines.
4. A computer scheduling system can be introduced without forfeiting any educational objectives that were obtainable with the previous scheduling system.
5. Computer scheduling is inexpensive when the reduction in professional and nonprofessional labor is considered.
6. The computer scheduling system can be of assistance in determining staff needs earlier than was possible with previous systems.
7. Computer scheduling can be of assistance in the development of new schedule patterns and techniques.¹²⁰

COMPARISONS OF SCHEDULING PRACTICES

In 1966, Marjory Jacobson's study compared seven large Michigan high schools' scheduling by computer with five other Michigan schools of the same size which scheduled manually. She interviewed administrators, counselors, teachers

¹²⁰ Ibid., pp. 107-108.

and students. Three areas of the educational program were selected as the bases for comparison: (1) involvement in curriculum innovation, revision, and change, (2) efficiency of the scheduling system in individualizing the student schedules, and (3) satisfaction with the scheduling system as expressed by the respondents.

Jacobson concluded that computer scheduling had little, if any, impact on any one of these areas. However, interest in the automation of scheduling systems is growing rapidly, and many of the large secondary schools either have or are planning computerized systems for assigning students to classes.

Jacobson's findings revealed that

1. Administrators in the automated schools believed that scheduling is more important than their other administrative duties; administrators in the manual schools did not have this conviction.
2. The administrators and counselors in the automated schools registered greater satisfaction with their scheduling systems and believed that their systems provided more individualized student schedules.
3. Student responses revealed that a significantly higher percent of the administrators in the automated schools assisted students in scheduling.¹²¹

¹²¹M.E.L. Jacobson, "A Study of Scheduling Practices in High Schools which Employ and Do Not Employ Data Processing," (Unpublished Doctoral dissertation, University of Michigan, 1966), pp. 249-258.

In relation to curriculum, Jacobson commented that interrelationships between curriculum innovation, or curriculum change, and scheduling methods play an important role in the operation of the educational program of a school as it endeavors to upgrade the curriculum through innovation, or change, and schedule modification.¹²²

James J. Fast compiled a listing of some advantages of student scheduling by computer. He said that computer-assisted scheduling makes it possible for schools to improve the educational experiences of students by:

1. Providing more time for counselors to work with individual pupils in the selection of courses to be scheduled;
2. Providing more time for principals to prepare the master schedules;
3. Providing better class placement for pupils through the preparation of schedules after summer school or immediately before the beginning of the school year.
4. Providing teachers with prelisted rolls for classes and, in many instances, by using scheduling output for additional pupil personnel applications;
5. Providing printed schedules either prior to or at the opening of school;
6. Facilitating educational planning through the availability of enrollment, assignment, class size, and related information immediately following the scheduling;

¹²² Ibid., p. 253.

7. Simplifying accreditation reports through the availability of data-processing information of school characteristics, which may be used in place of the usual report forms;
8. Balancing the size and composition of classes;
9. Permitting repeated revisions of the master schedule in order to try various configurations on unlimited passes; and
10. Permitting unlimited attempts to schedule a student, which will result in a program of studies preferred by the student.¹²³

Essentially, the success of computer scheduling depends upon the proper selection of the people, the machine, and the computer program involved in the situation. The principal's thorough understanding as to how he must describe his master schedule to the computer is a key facet of successful scheduling. Ideally, the computers must be reliable, fast and relatively inexpensive; the computer program must be flexible so that a school principal need not compromise in his efforts to satisfy an individual student's educational needs.

The various computer programs vary in some basic qualities as they schedule students. They differ in the following eight ways:

¹²³ J.J. Fast, "Advantages of Student Scheduling by Computer." National Association of Secondary School Principals Bulletin, 53: 30, January 1969.

1. Speed.
2. Program size that can be handled.
3. Effectiveness, especially in unusual situations.
4. Analysis of problems.
5. Cost.
6. Specific Features.
7. Ability to monitor and, if necessary, override computer assignments before producing student schedules and class lists.
8. Ease of use.¹²⁴

Allen states that two groups first succeeded in devising relatively successful master scheduling systems for computers. (They were used for the first time during the 1964-1965 school year). The Stanford group, comprising R.V. Oakford, R.W. Bush, and D.W. Allen, developed the Stanford School Scheduling System (SSSS). The M.I.T. group, under the direction of Robert Holz, produced the Generalized Academic Simulation Program (GASP). Both of these programs generate master schedules that allow and even encourage, curricular innovation.¹²⁵

¹²⁴G.E. Anderson, "How Computers Assign Students," Nation's Schools, 75: 70, February, 1965.

¹²⁵Bushnell and Allen, op. cit., p. 52.

Bushnell and Allen stated that the real mission of these computer scheduling systems is not just to weave the curriculum, staff, students, and facilities into a whole, but to challenge old patterns and methods by providing alternatives that can range over a far greater curricular, methodological, and administrative spectrum.¹²⁶

Oakford commented that the computer logic required for flexible scheduling is more complicated than that used by the Air Force to track the altitude, speed, and direction of every airplane flying over the United States at any given time.¹²⁷

Other Developments

The Anaheim, California school system and the Brigham Young University Laboratory School are researching ways to implement Daily Demand Scheduling, which allows schedule variations as desired within the traditionally scheduled school term. Here the schedule is changed by teacher request each day, and students are rescheduled.¹²⁸

Allen suggested that there is now an opportunity for educators to use computer-scheduling technology for innovation. One of the most promising approaches is the

¹²⁶ Ibid.

¹²⁷ D.W. Allen and R. Oakford, "Flexible Class Scheduling by Computer," *School and Society*, 92: 220, Summer, 1964.

¹²⁸ Anderson, loc. cit.

development of curriculum-simulation studies.. Simulation allows the rapid examination of key theoretical and functional questions; therefore, it may well be more important than the basic service of real schedule construction.¹²⁹

Curriculum-simulation study techniques allow the local staff to manipulate the variables involved in the design of a school, stated Allen. If a new curriculum and the changes it entails could be pretested before final commitment by a school, much anxiety and resistance to change might be alleviated.¹³⁰

Technology is still ahead of human beings in school scheduling, according to Anderson. Administrators are, however, beginning to pay increasing attention to the problems of generating genuine behavioral changes in both faculty and students. Obviously, the computer alone does not solve such problems.¹³¹

RECENT STUDIES

In this study, conducted in 1970, Howell attempted to determine the manner in which selected Pennsylvania high school administrators, representing second, third and fourth

¹²⁹ Bushnell and Allen, op. cit., p. 57.

¹³⁰ Ibid.

¹³¹ Anderson, loc. cit.

class districts, proceed with the scheduling of classes. By means of (1) questionnaires to 357 high school principals; and (2) interviews with thirty-six persons, mostly principals, data were collected covering the following areas of scheduling: unique scheduling practices; the advantage and disadvantage of the existing practices and procedures; changes in practices in the three year period, 1965-1968, and the reasons for these changes; course selection practices; and the principal's evaluation of his scheduling responsibilities and practice.

From his findings, Howell concluded that:

1. There were four basic scheduling practices in use for the 1968-1969 school year:
(1) scheduling by hand, (2) scheduling through the use of unit-record equipment, (3) scheduling through the use of edge-punch cards, and (4) scheduling with the assistance of computers.
2. No matter which scheduling practice was employed, a majority of schedulers indicated that the most important advantage of their scheduling practice was that it furnished the best selection of courses for the student.
3. There were some disadvantages involved no matter which scheduling practices were used. However, there appeared to be more disadvantages in the use of hand scheduling than in any of the other three methods.
4. Data processing, as it affects the scheduling of students, is effective and saves time according to a majority of respondents. One-third of them would use it in most high schools.

5. The responsibility of scheduling was among the several important responsibilities of the principals, although a small number of them claimed that it was the most important one.¹³²

Scheduling methods used in the larger high schools of Texas were investigated by Stegall in 1970. An attempt was made to compare the traditional with the more innovative or variable techniques of scheduling. To achieve this end, an instrument for measuring curricular flexibility was constructed to evaluate scheduling techniques and overall program flexibility. Schools involved scored mostly in the lower half of the flexibility scale. The fact that accepted authorities in the field devised the scale within the framework of existing flexible patterns, indicated that much can be done to improve flexibility within philosophical and physical limitations.¹³³

Wax studied both the manual and computer method of schedule making to determine which would be more desirable

¹³²S.D. Howell, "A Study of Scheduling Practices, Procedures, and Related Influential Factors in Selected Public High Schools of Pennsylvania." (Unpublished Doctoral dissertation, Temple University, 1970), pp. 205-212.

¹³³J.W. Stegall, "Descriptive Analysis of Class Scheduling Procedures in Selected Secondary Schools in Texas." (Unpublished Doctoral dissertation, Texas A & M University, 1970), pp. 68-71.

for use in an innovative junior high school. The project involved the actual generation of two schedules; one by the hand mosaic method, the other by computer using the GASP program. The comparison was made by utilizing weights assigned to six selected criteria by a panel of five judges.

Wax presented the following conclusions from the data analysis:

1. From the standpoint of cost alone, the more efficient method of schedule construction was the manual method.
2. From the standpoint of adequacy, the hand schedule was more desirable than the computer schedule.
3. In the actual generation of the schedules, the computer was more efficient than the hand method.
4. In the actual generation of the schedules, the hand method cost less than the computer method.
5. Preparation of the input data was less time consuming for the computer method than the hand method.
6. The cost of preparing the input data was higher for the computer method than the hand method.
7. From the standpoint of cost and adequacy, the more efficient method of generating the master schedule was the hand method.¹³⁴

¹³⁴I. Wax, "A Study of the Hand Mosaic and GASP Methods of Master Scheduling to Determine the More Desirable for use at an Innovation Junior High School." (Unpublished Doctoral dissertation, University of Miami, 1968), p. 88.

Wax also recommended that the junior high school generate its master schedules by hand until such time that computer services can be provided more economically and efficiently.¹³⁵

A study done by Fawcett in 1970, attempted to determine whether schedules generated through the use of EDP (electronic data processing) equipment: (1) save clerical and administrative time, and (2) are more effective according to established criteria as to what constitutes an effective schedule. Fawcett used twenty-one similar high schools in Connecticut and held structured interviews with the personnel of each.

From an analysis of the data, Fawcett concluded that:

1. Since EDP assisted scheduling is frequently a means of perpetuating the existing school schedule, a gap exists between the potential usefulness to be realized from EDP assisted scheduling and the actual utilization of this scheduling aid.
2. A flexible EDP assisted secondary school schedule requires a school administrator knowledgeable in EDP operations.
3. With the exception of the complex modular schedule developed with the use of high speed computers, scheduling flexibility continues to be only slightly affected by differences in scheduling procedures.

¹³⁵ibid

4. The cost of EDP scheduling services is not excessive when compared with the personnel costs required to produce a comparable hand schedule.
5. The production of a school master schedule by EDP results in increased scheduling costs. The results obtained may justify the additional charges.¹³⁶

In 1968, Lawson studied flexible scheduling, to determine whether it would serve students better than traditional scheduling, regardless of their achievement level, interest, or ability. He concluded that (1) individualized instruction becomes more of a reality; (2) flexible scheduling makes better use of the professional competencies of teachers; and (3) course work becomes more meaningful and students assume a greater responsibility for their own education.¹³⁷

An investigation to determine the various flexible plans in operation, the implementation procedures, and effectiveness of each plan in thirteen high schools was done by Beacom in 1969. Included in his findings are the

¹³⁶ R.H. Fawcett, "A Comparative Study of Electronic Data Processing Schedule Making and Other Current High School Schedule-Making Practices in Connecticut." (Unpublished Doctoral dissertation, University of Connecticut, 1970), pp. 195-196.

¹³⁷ I.R. Lawson, "Flexible Scheduling in Secondary Schools." (Unpublished Master's thesis, East Tennessee State University, 1968), pp. 72-73.

following observations:

1. Few schools indicated that a flexible schedule improved instruction.
2. The teacher who has knowledge of the student's needs can tailor his program to those needs.
3. Education can be more efficient under flexible scheduling because the appropriate facility, time, and method of instruction are used.
4. Increased numbers of elective offerings can be added to the program without the expense of making the school day longer.
5. Flexible schedules can create better relationships between teachers and students.
6. Students are more responsible for their own education in a flexible plan.
7. Teachers are more effective because of the flexible schedule.¹³⁸

Studies with basically the same theme have been done by Parker,¹³⁹ Fugate,¹⁴⁰ McClure,¹⁴¹ Egge,¹⁴²

¹³⁸J.F. Beacom, "A Survey of Administrative Problems of Flexible Scheduling," (unpublished Master's thesis, California State College, 1969), pp. 103-106.

¹³⁹J.J. Parker, "A Study of Master Schedules in Secondary Schools," (unpublished Doctoral dissertation, Columbia University, 1971).

¹⁴⁰J.P. Fugate, "An Analysis of the Implementation Year of a Junior High School Modular Schedule as it Relates to Teachers, Students, Parents, Achievement, and Grades," (unpublished Doctoral dissertation, University of Idaho, 1970).

¹⁴¹C.T. McClure, "A Study of Problems and Solution Strategies Following Implementation of Flexible Class Schedules in Secondary Schools," (unpublished Doctoral dissertation, Indiana University, 1970).

¹⁴²D.E. Egge, "Secondary School Program Scheduling Factors and Their Influence on Schedule Flexibility," (unpublished Doctoral dissertation, Washington State University, 1967).

Giuliano,¹⁴³ Vogt¹⁴⁴ Wright,¹⁴⁵ Keefe,¹⁴⁶ Parent,¹⁴⁷ Heath,¹⁴⁸
 Schramm,¹⁴⁹ LaPray,¹⁵⁰ Onweller,¹⁵¹ Rogers,¹⁵² Evans,¹⁵³
 Brandt,¹⁵⁴ Ball,¹⁵⁵ Fleming,¹⁵⁶ and Kilgore.¹⁵⁷ All of these

¹⁴³F.J. Giuliano, "Implementation of Certain Flexible Scheduling Concepts with the Aid of Computer Programs in Selected Secondary Schools," (unpublished Doctoral dissertation, Boston University School of Education, 1970).

¹⁴⁴R.L. Vogt, "A Computerized Modular Schedule Model for The Florida State University School," (unpublished Doctoral dissertation, Florida State University, 1967).

¹⁴⁵R.D. Wright, "Computer Scheduling in Selected Secondary Schools in New Jersey," (unpublished Doctoral dissertation, Rutgers-The State University, 1965).

¹⁴⁶W.A. Keefe, "A Review of Recent Literature Concerning Flexible Scheduling and Team Teaching," (unpublished Master's thesis, Redlands University, 1966).

¹⁴⁷G.A. Parent, "Specific Theories of Scheduling for the Secondary Schools of Ontario," (unpublished Master's thesis, Niagara University, 1968).

¹⁴⁸J.C. Heath, "An Investigation of the Economic Feasibility of Scheduling Certain Small High Schools by Means of Electronic Computers," (unpublished Master's thesis, Southwest Texas State College, 1966).

¹⁴⁹G.E. Schramm, "Modular Scheduling: Implementation into a Small School," (unpublished Master's thesis, Mankato State College, 1969).

¹⁵⁰J.J. LaPray, "Flexible Scheduling in the Junior High School," (unpublished Master's thesis, Utah State University, 1968).

¹⁵¹M.J. Onweller, "An Appraisal of Flexible Scheduling as a New Design for High School Education," (unpublished Master's thesis, University of Toledo, 1967).

¹⁵²H.K. Rogers, "An Investigation of Concepts in Automated Scheduling for the Secondary School," (unpublished Master's thesis, East Tennessee State University, 1967).

¹⁵³R.L. Evans, "The Creation of a Flexible Schedule,"

researchers centered their study around flexible scheduling dealing with implementation, problems, procedures and the advantages or disadvantages of various scheduling techniques.

(unpublished Master's thesis, California State College, 1966).

154 A. Brandt, "Two Types of Flexible Scheduling," (unpublished Master's thesis, California State College, 1966).

155 D.D. Ball, "A Traditional School's Approach to Implementing Modular-Flexible Scheduling," (unpublished Master's thesis, Drake University, 1969).

156 J.O. Fleming, "Flexible Scheduling in the Junior and Senior High Schools," (unpublished Master's thesis, Pepperdine College, 1968).

157 J.R. Kilgorè, "An Investigation of the Practicality of the Flexible Schedule in Secondary Schools," (unpublished Master's thesis, Chapman College, 1968).

CHAPTER III

DESIGN OF THE STUDY

The previous chapter reviewed the literature related to scheduling and, more particularly, literature relative to the focus of this study. These sources provided a wealth of information pertinent to the concerns of this study and aided in the design and organization of this research effort. The present chapter describes the instruments and the procedures used to complete this study successfully.

POPULATION

This study dealt with two major issues: (1) the practices and problems associated with scheduling, and (2) the potential of computer generated master schedules for Newfoundland high schools. The latter represents the primary focus of the research; however, it was felt that the present practices of scheduling should be surveyed before any attempt would be made to investigate computer potential relative to the generation of high school master schedules.

In this respect, the high school principals of St. John's, Newfoundland were asked to participate in the study.

The Newfoundland and Labrador Schools Directory indicated that there were six schools to be contacted.¹ A telephone call was made to the principal of each of the schools, and their help was solicited. Four of the six principals agreed to participate. These Principals were:

Mr. G. Compton
Booth Memorial Regional High School

Mr. J. Parsons
Prince of Wales Regional High School

Bro. J. McHugh
Brother Rice Regional High School

Sr. M.J. Young
Holy Heart of Mary Regional High School

Each principal of the four schools consented to an interview at a predetermined time.

The objective of the computer investigation was to work with a school that would represent, in size, the majority of high schools in the province. Since the average high school has an enrollment of approximately 250 to 300 students, it was apparent that the large schools in St. John's would not achieve this objective. Additionally, the researcher felt that a thorough and detailed knowledge of the selected school's program and facilities would be an

¹Province of Newfoundland and Labrador, The Newfoundland and Labrador Schools Directory (Department of Education, St. John's: Government of Newfoundland and Labrador, 1971).

asset. For these reasons, Lester Pearson Memorial High School, Wesleyville, Newfoundland, was chosen as the participating school. (The researcher was principal of this school during the period of the study.)

The school has an enrollment of 320 students with a staff of fourteen teachers. The program consists of three levels: (1) a college preparatory or academic level; (2) a vocational or general program, and (3) a senior special education program. With guidance, each student is given the opportunity to select his appropriate course of study. The school has a total of nineteen learning centers including provisions for large-group, small-group, and individual learning experiences. Since the writer was principal of the school while conducting this study, advantages accrued that hopefully made the results more meaningful to both the researcher and the readers. The conclusions and recommendations were made on the basis of the results of the research and considerable understanding of the scheduling difficulties of Lester Pearson Memorial High.

THE INTERVIEW QUESTIONNAIRE

To collect data pertinent to the present practices and problems of scheduling high schools, it was felt that a mailed questionnaire would not provide enough information or understanding to answer the questions posed by this survey.

Therefore, a two-hour structured interview was decided upon.

The interview questionnaire was constructed by the researcher. A detailed review of relevant literature provided the framework for the construction of the instrument. Basically, the questionnaire was designed to gather information of two types. First of all, the instrument contained items to collect factual data concerning the school, its facilities, present schedule, program, and personnel. Secondly, the questionnaire consisted of several items that did not require factual information. Generally, they were designed so as to reflect the views of each of the principals with respect to scheduling concepts, problems, and factors, both technical and non-technical, that affect scheduling in any way. The major thrust of many of these items was to reveal such subjects' views concerning innovative organizational techniques such as flexible scheduling.

Before the instrument was used, it was distributed to the staff and graduate students of the Department of Educational Administration, Memorial University of Newfoundland, for an evaluation. All suggested changes and criticisms were considered and the necessary changes were made. The researcher conducted the interviews personally. Statements appearing ambiguous during the interview were resolved by the researcher during administration. A copy of the interview questionnaire is included in the appendices of this report.

THE STANFORD SCHOOL SCHEDULING SYSTEM (SSSS)

To develop from the very beginning a new computer program necessary to generate a master schedule would have been very complex, and would have required a tremendous knowledge of computer technology, several years of testing, and large financial resources. Since much substantial and pioneering work had previously been done to develop school scheduling computer systems, the researcher elected to choose one from the two most sophisticated systems, or packages, available. These were the General Academic Scheduling Package (GASP) and the Stanford School Scheduling System (SSSS). After investigating these computer scheduling packages, the Stanford School Scheduling System was selected as the instrument for this phase of the study. This package was chosen because of its flexibility and adaptability to unique school situations.

Background and Development of SSSS

A school schedule specifies the places and times that each class will meet, the students who constitute the class, and the teacher or teachers that are to meet with the class. The first step in the construction of a school schedule involves a set of policy decisions by the school's faculty, administrators, and students; decisions in which the faculty and administrators determine the content and

structure of the courses to be offered and in which each student, in consultation with the counsellor, identifies the course in which he wants to be scheduled.

The problem, then, is to schedule class meetings in time and space, observing the restrictions imposed by the course structure and content specified and satisfying as many of the students' requests for course enrollment as possible.

Traditionally all courses have been structured almost identically. Each course has had just one phase (one instructional pattern), and the meeting pattern has been the same for all classes. Great emphasis has been placed on holding class size below some specified limit. Within this structure, the teacher would allocate time to the various instructional phases as he saw fit. The introduction of multiphase course structures does not change, but it does greatly increase the complicity of the scheduling problem.

High school administrators were able to construct manually usable high school schedules when virtually all classes conformed to the traditional meeting pattern of one period per day, four to five days per week. It was the desire for the elimination of this obstacle to important educational objectives that motivated educational program developers to study the school scheduling problem and to develop the Stanford School Scheduling System. The system has demonstrated a practical capability of coping with the

scheduling problems presented by the educational objectives of Trump and Bush and Allen. It is a set of computer programs that will perform the difficult and onerous task of computing a school schedule meeting the new requirements.

Description

The Stanford School Scheduling System consists of nine major computer programs and several supplementary programs written in FORTRAN IV for use on the IBM 360-40 or larger computer. The following are brief descriptions of the major components of the system:

1. The data collection component of the system provides forms for recording a school's policy decisions as they are reflected by course structure specifications and the students' course requests. The data from these forms are punched on IBM cards which serve as input to the scheduling system. Sample forms are provided in the appendices at the end of this report.

2. The INCA (Input Card Audit) program reads the punched cards and records the card images in a magnetic file. The program checks the card records for detectable errors and logical inconsistencies. A message is written for each error or inconsistency detected. The program can update the data set to reflect insertions, deletions, or changes in the file. Such corrections are specified by punched cards after the error messages have been studied.

When the detectable errors and inconsistencies have been eliminated from the data, the INCA program prepares a file that serves as input to the SSP (School Scheduling Program). The INCA program assigns a code number to each course, course-phase, section, teacher, room, and student. Within the total scheduling system (SSSS) these entities are identified by code number only.

The file prepared by the INCA for the SSP contains a sequence of data packets. For each course-phase there is one data packet containing the essential elements that describe the structure of that course-phase and its inter-phase dependencies. The packets are ordered basically according to the potential value of scheduling a section of the course-phase, where the value of scheduling a section is defined in terms of the total student periods of class time per section. There are exceptions that are observed in ordering the data packets. For example, all course-phases for which meeting times are prespecified in the data are placed at the head of the sequence. Furthermore, the educator can arbitrarily specify changes in the ordering.

3. The SSP (School Scheduling Program) actually constructs the schedule of class meetings by processing the sequence of course-phase data packets prepared in INCA. The objective of the SSP is to schedule classes so as to maximize the number of student course requests that are accommodated.

Where a section of a course-phase is scheduled, the following events occur:

a. The teaching assignments for the course-phase are observed, and a teacher (or teaching team) is selected.

b. The meetings-per-week and periods-per-meeting specifications for the course-phase are observed. A time pattern is generated at which the teacher (or teaching team) is available. The time pattern is a combination of periods that satisfies the meetings-per-week and periods-per-meeting specifications and further provides that no two meetings of this section fall on the same day.

c. If a room assignment is specified, a test is made to determine whether or not the assigned room is available. If not, a new time pattern is generated as described in (b).

d. The list of students eligible to be scheduled into this section is observed, and the students from this list who are available at this time pattern are identified. To be on the list, a student must have requested the course to which the current course-phase belongs.

However, the list may be further restricted by

an interphase student grouping restriction. If an adequate number of students is available, a section is scheduled, and the teacher and room availability records are updated to reflect this action. Otherwise, a new time pattern is generated at event (b).

e. The number of sections to which the teacher (team) is assignable is observed. When the teacher has been assigned the specified number of sections or when all time patterns at which the teacher is available have been considered, the next teacher (team) in the assignment list is identified at event (a) and the foregoing process is repeated.

f. When all sections of the course-phase have been scheduled, or when it becomes apparent that no more can be scheduled, the students are assigned to sections in a way that balances section sizes insofar as student availability permits. The student availability records are updated to reflect the scheduling of students to sections.

All the foregoing processes are repeated for successive course-phases. In the scheduling of individual sections, exhaustive searching will be performed to find a time pattern

at which the teacher and room assignments can be honoured and at which an adequate number of students are available. A central point is that extensive but not exhaustive searching is performed in an attempt to schedule as many eligible students as possible, given the scheduling decisions that have been made previously. To this extent, the SSP tends to satisfy as many student requests as it is possible to satisfy. However, the SSP does not provide for descheduling and rescheduling of sections, nor does it provide for descheduling or rescheduling of students. It is emphasized that the SSP, in this respect, departs from ideal scheduling theory.

The results of the SSP consists of class lists for individual sections. Each class list specifies the teacher (team), the room (if any requested), the students scheduled in the section, and the times at which the class is to meet. The class lists are recorded in a magnetic file.

4. The PTWS (Program To Write Schedules) section of the UDL (UpDate Lists) program performs a large-scale sorting operation to convert the class lists prepared by SSP into teacher, room, and student schedules. A schedule as prepared by PTWS is actually a list of the code numbers of the sections into which the resources have been scheduled as reflected by its appearance on the class list of that section. The results of the PTWS program are recorded in a magnetic file.

Any student whose course requests have not been completely satisfied by the SSP scheduling is identified as a Status I student.

5. In many cases the school administrator may want to specify certain changes in a schedule generated by SSP even though he regards the schedule as acceptable. Sometimes these changes do not affect the schedule of classes or the schedules of resources. For example, it may be necessary to correct the spelling of, or change the name of, a teacher or room. Frequently the changes may affect the schedule of classes and/or the schedule of resources. For example, changes in teacher assignments or room assignments occur. Sometimes the administrator may even reschedule or modify the scheduled meeting time of one or more sections. These changes are accommodated by the UDAMC (UpDate After Manual Changes) program.

6. It is inevitable that changes in course requests will occur. The plans of returning students sometimes change; new students register in the school after the schedule is fixed; or some students do not return to school. The UDCREQ (UpDate Course REquests) program provides for modification of SSSS records to reflect these changes. Whenever a student's course-request list is modified, his existing schedule is automatically invalidated and he becomes a status I student.

7. The SAP (Student Assignment Program) is used after the class schedule has been fixed for scheduling a Status I student into sections of courses that he has requested. It provides for consideration of alternative courses specified by the student in his course-request form in the event he cannot be scheduled satisfactorily into all the courses requested. In making substitutions, the SAP considers the preference of the individual as indicated by his course-request list and tries to avoid substitutions for those courses for which the student has indicated a high preference.

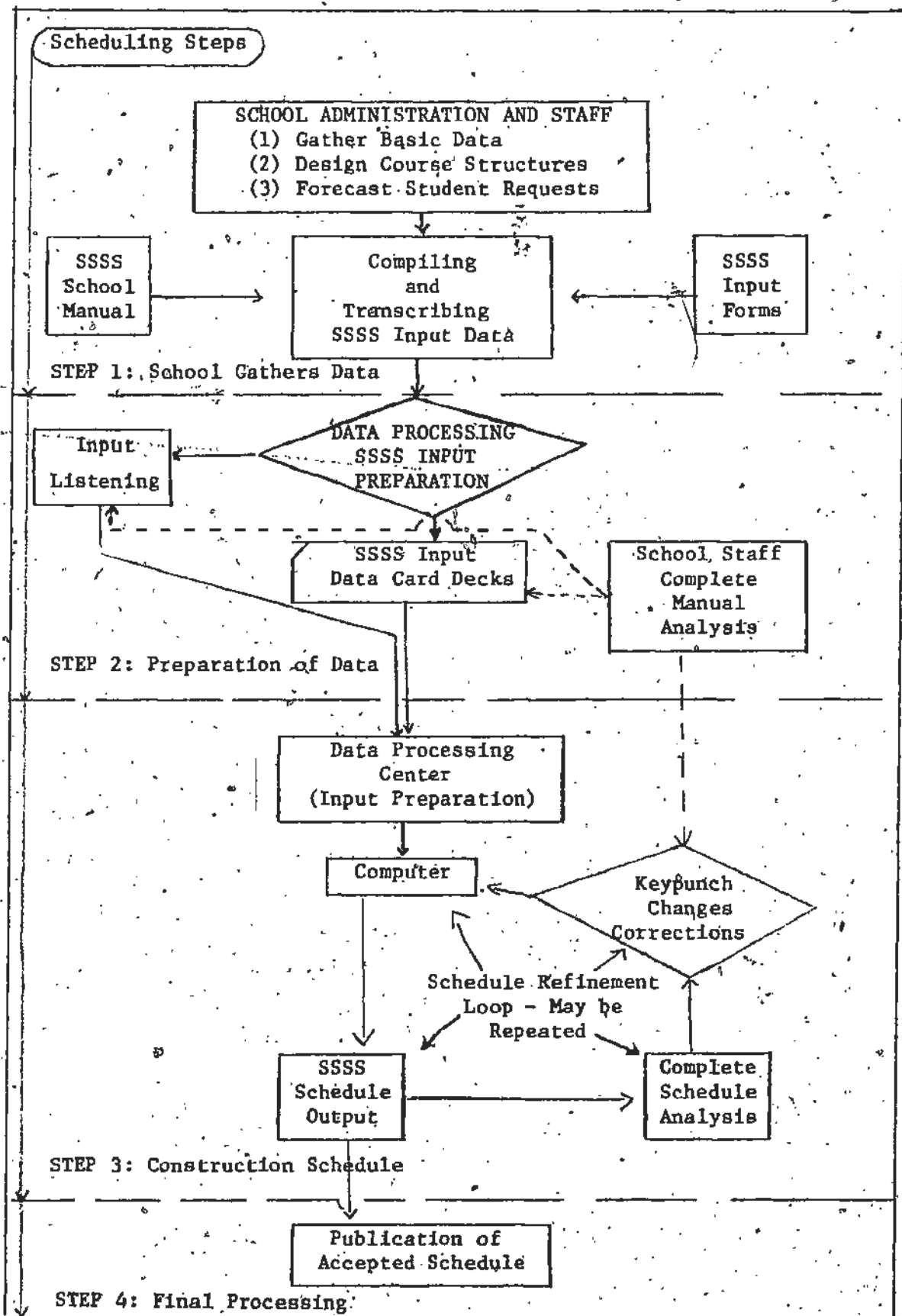
8. The RAP (Room Assignment Program) provides for the automatic assignment of rooms after the schedule is fixed. It requires the school to work out a classification of rooms; the class of room required by each course phase must be identified; the room preferences for each teacher must be specified; and, finally, the staff must be ranked to indicate the individual teacher priority for having his preferences observed in making room assignments. The net effect is that teachers with high priority will have their preferences honoured, whereas those with low priority may not do so well. Some administrators prefer, however, to make the room assignments manually after the schedule is fixed because they can best satisfy the individual preferences and needs of their school's staff.

9. As a consequence of the changes in student schedules that result from execution of the SAP program, the class lists prepared by SSP become obsolete. The UDCL (UpDate Class Lists) section of the UDL (UpDate Lists) program performs a sorting job that prepares new class lists based on the existing schedules of students.

10. The TRANSLATE program provides for decoding class lists and teacher, room, and student schedules and printing them in a form that is directly usable by the school. The user has a choice of either the line or block format for the printed schedules. In the process of preparing a student's schedule, it makes lunch-period assignments for the individual student. It also prepares a master schedule for the school. For each section offered, there is a line in the master schedule that identifies the course, the phase, the section, the teacher, the room, the meeting times, and the number of students enrolled.

There are nine more programs in the SSSS. Most of these are used primarily for diagnostic purposes and will not be described. Some of these programs allow the administrator to control parts of the scheduling process. For example, the SHUFFLE program allows the user to specify the order in which course-phases will be processed for scheduling. Figure 18 describes in flowchart form the schedule construction using SSSS.

STANFORD SCHOOL SCHEDULE CONSTRUCTION PROCESS



Capabilities

The Stanford School Scheduling System was developed as a general purpose scheduling system to serve a wide variety of schools. The following is a list of parameters whose values define the maximum size of any one variable.

1. The courses in a student's program must not be greater than seventeen.
2. The course-phases to be scheduled are limited to 750.
3. The maximum days per schedule cycle equals ten.
4. The total number of modules or periods per day must be less than or equal to thirty-two.
5. The total number of modules or periods per schedule cycle is restricted to 160.
6. The greatest number of sections allowed in a course-phase is thirty-five.
7. The maximum number of students in a course is 750.
8. The number of phases in a course must not be greater than five.
9. The periods per meeting of a class must not exceed nine.
10. The system cannot schedule any more than 255 rooms for a school or five rooms to a room team.
11. The maximum number of sections that can be scheduled is 2,000.

12. A maximum of 3,500 students can be scheduled. However, if a school has access to a computer system with at least a 275,000 byte core partition, then the number of students can be increased to 6,400.

13. Three hundred teachers is the greatest number that can be handled by the SSSS.

14. The system cannot schedule any more than nine teachers to a teaching team.

School Data Requirements

The SSSS begins construction of the master schedule by executing the INCA program. This program and all other programs of the system requires from one to four program control cards. The SSSS Data Processor's Manual describes the format of these cards. In addition to the program control cards, the INCA program requires seven decks of IBM cards containing scheduling information from the school. The information on these cards includes:

1. Deck one, the school parameters, usually consist of one card. However, if there are any time restrictions for scheduling, then a second card is inserted to indicate those restrictions. Included on the school parameters card are the school name, school identification number, number of days in the schedule cycle, the number of modules in a day, lunch period specifications, and the number of course requests of students.

2. The course enrollment transfers constitute deck two of the data. This deck of cards permits the school to reassign students or transfer students from a course that has been dropped.

3. The cards in deck three specify the combinations of courses required by the school. For example, a course in Grade Ten English can be linked to a Grade Eleven English course for "x" number of periods a week for grammar instruction.

4. Deck four consists of the teachers available and their identification numbers.

5. The rooms available and their identification numbers make up deck five.

6. Deck six is called the course data packet. It contains information relative to the course name and identification, the number of phases in the course, the number of sections, number of meetings per cycle, number of teachers required, number of rooms required, the maximum enrollment per section allowed, the teachers available, and the rooms available. Deck six requires three cards per course-phase.

7. The final and seventh deck of cards contains information about each student. Each student will have from two to four cards submitted. Card one contains the student's identification number and name. Card two contains the

student's priority course requests. The first alternate course request is placed on card three and if the student is permitted two alternate choices, then card four will contain the second set of alternates. The last two cards are only permitted if the school requires the student to make second and third choices.

In all cases, the last ten columns of data cards contain sorting information which include the student (course, room, teacher) sort number, card packet sequence number, the deck number, and the three-letter school's alphabetic identification.

Machine Requirements

The SSSS has been used for schedule computation on the IBM System 360, models 40, 50 and 67. The following are the minimal computer system requirement. Caution should be exercised if SSSS is to be used on a system barely meeting these specifications!

1. Central processing unit model 40, 50 or 65 with:
 - a. Standard instruction set.
 - b. Decimal feature instructions.
 - c. Floating point feature instructions.
 - d. Protection feature instructions.
 - e. Clock.

2. Core: O.S. implementation with a partition of at least 228K bytes. In most instances, a 262K byte core with a small operating nucleus is sufficient.

3. I/O devices:

- a. Card reader
- b. Card punch
- c. Printer
- d. Sequential access storage device (nine track magnetic tape drive and two disk storage drives).
- e. Direct access storage device on which the OS load modules and the FORTRAN H direct access data sets reside.

4. Software: If the SSSS programs are to be compiled, the FORTRAN IV level H compiler is required.

Success of SSSS

The SSSS has been subjected to a rather thorough test, which began in the summer of 1963 and is continuing through the present. From 1963 to 1968, some 315 schedules were constructed for more than 100 different schools. Having once tried the system, most schools have continued to use it.

Schedules have been constructed for schools ranging in size from 113 students to 4,618 students and ranging in geographical location from Pennsylvania to Yamato, Japan. A few of these schedules have involved only traditional

single-phase course structures, but most of them have involved multiphase course structures, incorporating many of the educational objectives fostered by flexible scheduling.

The scheduling effectiveness of the SSSS depends to a large extent upon the expectations of the individual user. However, when compared to alternative scheduling systems, the SSSS ranks very favourably. In terms of the number of course requests satisfied, it has proven its capabilities although it still falls short of the theoretical ideal.

DATA COLLECTION

As indicated earlier in this chapter, the nature of the study required the collection of two sets of data. This section describes the procedures following during the acquisition of this data.

Interview Questionnaire

A telephone call was made to each of the principals of the high schools in St. John's, Newfoundland. The purpose of the call was to solicit their cooperation and arrange a convenient time for an interview. Two of the six principals decided not to participate in the research effort and, after follow up procedures, still maintained their original decision. The remaining principals consented to take part in the study and a two-hour interview was arranged with each subject.

Each of the interviews, with the exception of one, was taped by the researcher. One individual was ill-at-ease with the tape recorder, therefore, the conversation was recorded on paper. The interviews centered around the interview questionnaire, with the researcher directing the questions along with any requested explanations. The interviews were conducted in a relaxed, informal manner and many of the principals took advantage of some time at the end of the session to discuss views on scheduling issues not covered by the questionnaire. Consequently, some interviews lasted beyond the two-hour time limit. A total of four interviews were recorded, representing 67 percent of the city's high schools.

Computerized Scheduling

Lester Pearson Memorial High School, Wesleyville, Newfoundland provided the data for the computer generated master schedule. The school has an enrollment of 320 students with a staff of fourteen teachers.

The researcher, also being the principal, together with the staff, organized the school to provide the data necessary for the schedule construction process. It was felt that the school should not depart too greatly from its regular program. In this respect, the results would be more realistic when the comparison with the manual schedule was made. During the organization period, the required seven

groups of data were collected. These data included:

(1) student course requests, (2) teacher assignment information, (3) room assignment specifications, (4) course specifications, (5) student transfers, (6) course combinations, and (7) school schedule parameters. These data were coded in the appropriate INCA forms, samples of which are included in the appendices.

TREATMENT OF THE DATA

Since the data were collected from two different sources and for different purposes, they were dealt with in two separate chapters. The interview data are discussed in Chapter IV and the computer results are reported in Chapter V.

Interview Data

The interview data are reported for each of the items in the questionnaire within the framework of the research questions. No statistical treatment was applied to the responses because the size of the sample and the nature of the questions did not lend themselves to such an analysis. The responses are presented both collectively where agreement occurs and individually where differences of opinion are apparent.

Computerized Scheduling Data

Prior to the computer run, the school scheduling data contained on the coding forms were key punched on IBM cards to be used as input data for the Stanford School Scheduling System. The SSSS involves the running of as many as twenty-five job steps. After each job step is completed, it is necessary to analyse the output for error corrections and to eliminate weaknesses in the schedule. Small modifications in the course specifications, time restrictions, etc., can result in a much improved schedule. For this reason it is most important that the schedule maker be familiar with the school, its program, and resources. The SSSS program guide recommends that the school administrator monitor the scheduling process so that he will be in a position to make the necessary changes. The researcher, with extensive technical advice, controlled the schedule development process.

The schedule provided by the SSSS was compared to the manually constructed schedule. Each schedule was evaluated on the basis of: (1) teacher satisfaction, (2) student satisfaction, (3) number of student requests honoured, (4) preparation time, (5) cost of scheduling, (6) flexibility, and (7) overall functioning of the school and its program.

CHAPTER IV

ANALYSIS OF INTERVIEW DATA

The data presented in this chapter were extracted from the responses of the principals to the items on the interview questionnaire. In section one each item is reported under the research area to which it most appropriately applies. Section two reports the findings as they are revealed by the data.

The schools in which the interviews were conducted are all located in St. John's, Newfoundland, Canada. They are:

Prince of Wales Regional High School

Brother Rice Regional High School

Holy Heart of Mary Regional High School

Booth Memorial Regional High School

Table 1 presents some of the relevant characteristics of each of these schools. Note that the enrollments do not correlate very well with the number of classes in the school. Also, it can be noted that a public high school education closes at the end of Grade Eleven in Newfoundland and Labrador.

TABLE 1

SCHOOL CHARACTERISTICS

School	Enrollment				Instructional Spaces	Teachers		Classes			
	IX	X	XI	Total		Full Time	Part Time	IX	X	XI	Total
Prince of Wales	-	449	355	804	34	33	-	-	12	10	22
Brother Rice	-	423	300	723	25	30	-	-	15	9	24
Holy Heart of Mary	-	673	625	1298	45	52	4	-	17	15	32
Booth Memorial	100	115	127	342	16	14	1	3	3	4	10

REPORTING THE DATA

Scheduling Procedures

Items 13, 14, 15 and 16 of the interview questionnaire were designed to provide information pertaining to the scheduling procedures used in the high schools of St. John's, Newfoundland. (The complete interview document is found in the appendices.)

Item 13: "Are you solely responsible for the construction of the master schedule?" In response to this item, only one of the four principals stated that he constructed the master schedule by himself. Three principals were involved to various degrees but did not assume total responsibility for the schedule.

Item 14: "Do you delegate the responsibility for schedule construction to others? If so, please specify." Two of the principals reported that the vice-principal was involved in schedule construction. One of these vice-principals was totally responsible for the schedule. Two schools used a committee to help build the schedule; however, only one of the committees was involved in schedule construction. The primary purpose of the other was to review the previous year's schedule, make preliminary enquiries, and provide information to the principal for the construction phase.

Item 15: "How much time is involved in schedule construction in your school?" Each school differed in the length of time required to build the schedule. One school indicated that the schedule was completed in two weeks; however, this was the equivalent of one month since two people were working full time. Another principal reported that it took one month to construct the schedule, but that a more realistic period was one and a half months since he worked two weeks in addition to the vice-principal's full month of work. The school using a committee stated that it took one month to complete the schedule, but it represented three months' work since three people devoted their time to it. Finally, the fourth respondent indicated that it took him one month to build the schedule himself.

Item 16: "Comment briefly upon the methodology employed in the construction of the master schedule for your school." All schools were scheduled manually using the trial-and-error or hand-mosaic method. All principals stated that they took into consideration the strengths of last year's schedule, the preferences of teachers, strengths of teachers, and the requests of the students. One principal reported using double periods in physical education, team teaching in Grade 10 mathematics, and back-to-back scheduling in the sciences. Another principal stated that he planned to use the McBee system next year.

Differences in Scheduling Practices

In addition to the items reported in the previous section, items 19 and 26 of the interview questionnaire were included to solicit information relevant to the variations in the scheduling practices of the high schools.

Item 19: "Briefly describe the master schedule presently in use in your school." All principals described what could be classified as a conventional schedule. Each schedule had seven periods per day, operating on a five day cycle. All students were scheduled the full time in class, with few exceptions. The only exceptions were those students doing less than a full term's work with respect to the number of subjects taken. However, one school departed from this procedure slightly. Although all students were scheduled in classes, a student could make a request not to attend classes for his history. Based upon the student's maturity and academic ability, the teacher could permit the student to work independently. The student was allowed to continue to work in this manner as long as he maintained his appropriate level of achievement. Two principals admitted that their schedules were quite rigid. Another principal reported team teaching with large group instruction, in mathematics. Finally, back-to-back scheduling in the sciences and physical education were implemented by another school to create more flexibility.

Item 26: "To what extent does your schedule change from year to year?" All principals stated that their schedules changed very little. They did, however, mention that last year's schedule was not the model for the present schedule. The scheduling strengths of previous years were incorporated into the existing schedule. One principal stated that unless there is a change in staffing, the information supplied by the teachers will not change much. All principals agreed that changes resulted only when there was a change of courses, teachers or facilities. Minor changes such as double periods and back-to-back schedules have been introduced in recent years.

Scheduling Problems

Items 17 and 18 deal specifically with problems imposed by the scheduling procedures of each of the schools.

Item 17: "Please outline any problems that you feel are posed by your present methodology." The following problems, considered most important by the high school principals, are summarized as follows:

1. Some teachers are involved in more than one subject area. Consequently, the teacher becomes spread over too large a subject area and this creates a workload problem.
2. With the present pupil-teacher ratio it is most difficult to offer a diversified program. It is very

difficult to construct a timetable to give the students the desired flexibility.

3. There was inadequate guidance resulting in students being streamed into courses that they are not capable of doing.

4. With its different time lengths, team teaching in mathematics is very difficult to schedule.

5. Sometimes, many students are not timetabled for certain periods because of unresolved conflicts. This presents an injustice to the student.

6. All subjects cannot get the amount of class time required because of conflicts. That is, time adjustments have to be made for some subjects at the expense of the student in terms of getting adequate exposure to the course.

7. It is very difficult to schedule students involved in subject promotion. Therefore, subject promotion has to be kept to a minimum.

Item 18: "What kinds of problems, if any, does your present schedule cause during the school year (educational, operational, etc.)?" In response to this question the principals indicated the following problems:

1. The schedule is too rigid. We must follow its format at all times. It is most difficult to accommodate any activity requiring special arrangements.

2. Inadequate guidance resources result in students finding themselves in the wrong courses. Thus, when they request transfers, there are times when they cannot be properly scheduled because of the course groupings required during the schedule building phase.

3. If a student cannot be given the subject of his choice, he sometimes has to make a second or third choice. Consequently, the student is taking a course in which he has no interest. He then either sits in class, unproductive, or presents a discipline problem, thus affecting the other students.

Adequacy of Present Master Schedules

To provide information on the adequacy of the present master schedules, items 20 and 35 were included on the interview questionnaire.

Item 20: "Is your present schedule adequately fulfilling the needs of your school?" Different degrees of satisfaction were expressed by each of the principals. The most frequent responses are summarized as:

1. The present schedule is too academically oriented. There is not enough time available for work in the non-academic areas of study.

2. There is a lack of fulfillment of student course requests. (With the introduction of the McBee cards, one

principal expressed hope that this situation will improve in the next year.)

3. The schedule does not allow the students the flexibility needed to select their courses. After the timetable is made up, it is almost impossible to make even a minor change because it usually results in a multiple number of changes.

4. The day is not long enough to allow a student to take all the courses he would like to experience. Thus, he has to choose between what he needs and those courses that he would like to take. To add more courses to the student's present list would only result in less exposure in other subjects. (One principal indicated that this problem was solved in typing by allowing interested students to take the course after school hours.)

Item 35: "Do you feel that much of the time teachers spend presenting course material to the students could be utilized by students themselves to obtain this information? Please comment." All principals agreed that up to a certain point some students would benefit more from independent study. However, each individual pointed out that this applies to the more mature students and possibly some others given adequate supervision and proper guidance. Another issue discussed was that of resources. It was stated that without

proper library facilities to carry on research, adequate study areas, or necessary audio-visual equipment and supplies, a program of independent study could not work.

All principals favoured the idea of independent study, but felt that their resources were too limited. One principal, in response to a teacher complaining about not completing the course, stated, "Why are you so interested in covering the course; you've covered it every year for several years. Let the kids cover it. Stop talking and let them learn; help them out if they are in difficulty."

Consideration of Alternate Forms of Scheduling

This section of the questionnaire dealt with both the consideration of alternate forms of schedule building and the amount of experimentation being done by the school with respect to other forms of scheduling. Several items were designed to reveal information pertinent to this area of concern.

Item 24: "Have you given serious consideration to a method of scheduling different from your present one?"

Two schools indicated that they were seriously considering the McBee method for the next year. One of these schools was definite about its implementation the following year. One of these schools was also considering a longer cycle, a rotating schedule and individual scheduling. Two other

schools have talked about computer scheduling but have not studied it in any detail.

Item 27: "Flexible scheduling, for purposes of this study, is defined as a form of scheduling that utilizes the concepts of variable group sizes, modular time units, teaching teams, and independent study. Have you been exposed to any of these concepts either through formal course work or through your own investigations?". All principals reported a limited knowledge of the concepts. One principal indicated that he did receive some exposure in one of his formal training courses. The remaining subjects had only read about flexible scheduling in some professional journals. One principal had no knowledge of modular scheduling and was very hazy about the whole concept of flexible scheduling.

Item 28: "The flexibly scheduled school gives teachers a better opportunity to interact with students and each other. Comment." All agreed with the principle involved; however, they stated they had had no experience with flexible scheduling and could not make a definite statement. One principal stated that any type of schedule will not impede the good teacher.

Item 29: "A flexibly scheduled school provides students with a better learning environment and an opportunity to profit more from the learning experiences provided. Comment." Again there were no disagreements, but, perhaps because of a lack of experience, principals would not comment further.

Item 31: "Do you feel that a flexible schedule would provide opportunities to add new elements to your existing program without increasing the number of teachers and learning spaces? Comment." One principal felt that the program could be expanded with the present resources. Another did not think that flexible scheduling would help in any way. The remaining two respondents were not sure but felt that it might have some potential.

Item 33: "Would you consider implementing flexible scheduling in your school in the near future? Comment." All principals said yes; however, three of them would only consider implementation after it had proved itself. One principal was very concerned over the possible detrimental effects on students.

Item 34: "Are you and your staff studying the concept of flexible scheduling with the intention of adopting such a schedule or various aspects of it? Comment."

In response to this question, one principal referred to the McBee card sort and another indicated their testing of a teaching team of mathematics teachers. The other principals answered that it was not under consideration and there were no plans for it for the future.

Item 36: "Are you in favour of independent study for students? Comment." All principals were in favour of granting independent study. One principal felt that all students could benefit from some degree of independent study. The others thought that only certain students would profit from such an organization. They stated that the other students would have to be closely supervised and under constant guidance.

Item 38: "Would you be willing to grant the students of your school independent study? Comment." Because of a lack of resources, one principal said no for the immediate future. However, within the framework reported in Item 36, the other respondents answered in the affirmative.

Item 39: "Have you considered scheduling your school with the aid of a computer? Comment." All four principals reported that they have given it some consideration. One respondent felt that the growing complexity of the school will force the usage of computerized scheduling.

Item 40: "If you are in favour of computer scheduling but have not taken advantage of this facility, then what are your reasons for not doing so?" Included among the reasons reported are the following:

1. A lack of computer facilities.
2. Computer costs.
3. A lack of leadership from the Department of Education.
4. At present, it doesn't cost the School Board anything to schedule the school because it is done by the principal and/or vice-principal during the summer.

One principal indicated his attitude towards computer scheduling when he quoted J.R. Smallwood, former Premier of Newfoundland: "I'd use the devil himself if I thought he could help me."

Effects of Present Schedules on Curricular Innovation

Items 21, 22, and 23 of the interview questionnaire were included to solicit information relative to the effects of the present schedules on curricular innovation in each of the high schools.

Item 21: "Do you see your present schedule as an inhibiting factor relative to organizational innovations? Comment." One of the four principals stated that he did not think it would inhibit re-organization when the need

arose, although he felt that his schedule was a bit too rigid to allow any extensive innovation. Another principal indicated that if you want something badly enough you will find a way around the timetable. The other principals thought that their schedules were too stereotyped and only reinforced the teacher's resistance to change.

Item 22: "Do you see your present schedule as an inhibiting factor relative to curricular innovation? Comment." One principal felt that his schedule allowed innovation only within the individual classroom. Another principal stated that his schedule could only adequately accommodate academic subject areas. Time innovation is practically impossible. Two of the principals felt that innovation was possible in some areas but only at the expense of other courses. Thus, to increase flexibility in one course results in less flexibility in another.

Item 23: "In your opinion, to what extent could you innovate in your school under the confines of your present schedule?" One principal felt that most of the concepts incorporated in flexible scheduling could be implemented with their present schedule. Another principal was more concerned with the staff's flexibility. Given staff flexibility, the schedule presents little in the way of restrictions. The others felt that innovation is

somewhat limited by the schedule and even more so by the Department of Education regulations.

REPORT OF THE FINDINGS

Research Question 1: Identifying Scheduling Procedures

One area of concern in the study was to determine the present scheduling procedures in use in the St. John's high schools. As such, specific questions were included in the questionnaire to provide the study with this information. Generally speaking, all schools are scheduled manually using the trial-and-error or hand-mosaic method. All schools approached the schedule making process by, first of all, considering the strengths and weaknesses of the teachers and the previous year's schedule. Also, a major determining factor was the course requests of students.

Although the basic procedure was the same, some variations did exist, both in the preparation phase and the actual construction phase. In most schools, the preparatory work was done by the principal and vice-principal, while other schools found a committee more effective. There was no particular trend apparent in who assumed responsibility for the schedule construction phase. Either the principal, the vice-principal, a committee, or a combination of these were involved in producing the final product. The length of the construction phase was determined to a large extent

by those involved. All schedules took from one to three months to complete, with the majority indicating that one month of work was required. All schedules were completed within a one-month period, however, because of the number of people involved it represented anywhere from one month to three months for different schools (e.g. one month times three people equals three months' work).

Research Question 2: Significant Differences in Scheduling Practices

Another major focus of this study was to determine if any significant differences existed in the scheduling practices of schools in St. John's. From the information gathered, it is evident that very few, and certainly no significant, differences exist in the scheduling practices of the schools studied. Basically, all schools use a standard seven-period day, operating on a five-day cycle. There were a number of minor variations such as the construction techniques, limited independent study in one school, back-to-back scheduling for science and physical education, and an experiment in team-teaching. These exceptions did not demand any major changes in the standard type schedule.

Research Question 3: Identifying Scheduling Problems

Several scheduling problems were identified by the school administrators. All problem areas resulted either from regulations that demanded a particular type of schedule or from a schedule that was unable to accommodate necessary elements of the school program. In summary these problems are as follows:

1. Teachers involved in more than one subject area create a workload problem.
2. The master schedule cannot provide the desired degree of flexibility because of the program restrictions made necessary by the present pupil-teacher ratio.
3. Inadequate guidance services makes it difficult to properly advise students about appropriate programs.
4. Because of uniform standard period lengths, experimentation with innovations such as team-teaching places a considerable amount of pressure on the present master schedule.
5. Because of unresolved conflicts, many students are unable to take desired courses or are unable to take all classes in a particular course. This becomes a major problem when schools are involved in subject promotion. Consequently an essential part of a school's program is unjustly restricted.
6. The master schedule is too rigid. Its format makes it almost impossible to arrange for special activities.

7. The schedule forces many students into courses that are unsuited to them. Thus, the schedule gives rise to many discipline problems that, otherwise, would not occur.

Research Question 4: Determining the Adequacy of Present Master Schedules

All principals felt that their schedules were not adequate. However, the inadequacies were centered more around the framework in which the schedule was built and not the schedule itself. Most principals felt that:

(1) their schedule was too academically oriented, (2) many student course requests could not be honoured, (3) the schedule had no flexibility, and (4) the school day was not long enough to permit students to take the courses they would like to experience.

Many principals felt that independent study could be a desirable innovation in their schools, but were not too optimistic about its success for a number of reasons. The most serious problems of implementing such a program were: (1) a lack of supervisory and guidance services, and (2) a lack of adequate resources such as equipment, study and research areas.

Research Question 5: Consideration and Experimentation with Alternate Forms of Scheduling

With few exceptions, alternate forms of scheduling have never been seriously considered or experimented with.

One school planned to experiment with the McBee system the following year. Although the remaining principals have thought about other forms of scheduling they admitted giving it very little serious consideration. All principals were sure that a different schedule was necessary but were reluctant to experiment at the expense of their students.

All respondents agreed that the concept of flexible scheduling was a good one and should be beneficial to both the students and teachers. They felt, however, that more evidence of its success and additional resources were necessary before they would consider using it. All principals predicted that because of the increasing complexity of schools, both flexible and computer scheduling would soon become necessary. It was felt, therefore, that the Department of Education should assume leadership in this respect, both in the form of finances and consultants.

Research Question 6: Effects of Present Schedules on Curricular Innovations

There was no consensus on the effects of the present schedules with respect to curricular innovations. Some felt that innovations could only take place within the classroom so as not to interfere with the schedule. Others felt that any major innovations would be impossible without upsetting the present schedule. Present schedules were too

stereotyped and only reinforced the teacher's resistance to change. One principal stated, however, that any change was possible if the need was there to demand it. It was generally agreed that the present schedules emphasized the academic areas too much and allowed little or no room for non-academic areas.

CHAPTER V

ANALYSIS OF COMPUTERIZED SCHEDULING

The information presented in this chapter was derived from a comparison of the manually constructed schedule and the computer generated schedule of Lester Pearson Memorial High School at Wesleyville, Newfoundland. The school has an enrollment of 320 students and a staff of fourteen teachers. The program consists of three levels: (1) a college preparatory or academic level, (2) a vocational or general program, and (3) a senior special education program. Through a guidance program, each student is given the opportunity to select his appropriate course of study. The school has a total of nineteen learning centers including a library, gymnasium, Industrial Arts Shop, Home Economics Shop, large-group facilities, small-group areas and provisions for individual learning experiences.

The chapter is organized into two major divisions. Section one deals mainly with the results of both the manual and computer scheduling efforts. Section two presents the findings arising out of the comparison of the two schedules.

REPORTING THE DATA

Preparation Time

In the initial stages, both the manual and the computer scheduling processes were similar in nature, since the phase consisted mainly of data gathering and decisions with respect to course requirements and staffing. The basic departure from normal scheduling procedures was the need for a coded course request form made necessary for the computer processing. However, this form served both scheduling procedures because it contained both coded and uncoded information. Essentially then, the initial phase in each case coincided with respect to the time element involved. This consisted of a two week time period for both the principal and the vice-principal exclusive of secretarial help. Table 2 provides information on the construction time of each schedule.

Phase two of each of the scheduling procedures had very little, if anything, in common. The manual scheduling consisted of basically two steps. Step one involved the construction of a conflict diagram to reveal potential clashes among courses, particularly with respect to single section courses. This step took the principal two days to complete. Step two required total staff involvement. Instead of one or two people constructing a class schedule and a teacher schedule, only the class schedule was

necessary. One might say that the teacher schedule was there ready to be rearranged and ready to talk should a conflict occur. Additionally, total staff involvement meant much more input and, consequently, increased the efficiency of the process as well as adding the feature of increased teacher satisfaction. This step consumed two days for each of the fourteen teachers, the vice-principal and the principal. The total scheduling process consisted of a total of fourteen days or fifty-four man days.

The computer scheduling procedure required the services of the principal, a computer consultant, and a keypunch operator. The keypunch operation required three days to complete. Both the principal and the computer consultant worked at the schedule over a period of eighteen days, with the consultant being involved for ten days at intervals during that period. Because of inadequacies within the Stanford School Scheduling System, the schedule was not completed to a satisfactory stage. The total time involved in the partial completion of the computer schedule was twenty-eight calendar days or fifty-one man days.

TABLE 2

A COMPARISON OF THE MANUAL AND COMPUTER
SCHEDULING TIME PERIODS

Person Involved	Manual		Computer	
	Time Period in Days*	Man Days	Time Period in Days*	Man Days
Principal	14	14	28	28
Vice-Principal	12	12	10	10
Staff	2	28	0	0
Computer Consultant	0	0	10	10
Keypunch Operator	0	0	3	3
Total	14	54	28	51

* The principal was involved during the total scheduling period, thus determining the number of schedule construction days.

Scheduling Costs

Table 3 provides a summary of the costs incurred during the construction of both the manual and computer generated schedules. The manual schedule cost a total of \$2620. This represents a cost of approximately \$8.45 per

TABLE 3

A COMPARISON OF THE MANUAL AND COMPUTER SCHEDULING COSTS

Cost Variable	Manual			Computer		
	Time Period in Days	Daily Rate	Cost	Time Period in Days	Daily Rate	Cost
Principal	14	\$60	\$840	28	\$60	\$1680
Vice-Principal	12	\$55	\$660	10	\$55	\$ 550
Staff	28	\$40	\$1120	-	-	-
Computer Consultant	-	-	-	10	-	\$ 800
Keypunch Operator	-	-	-	3	-	\$ 200
Computer	-	-	-	-	-	\$ 300
Total	-	-	\$2620	-	-	\$3530
Per Pupil Cost	-	-	\$8.45	-	-	\$11.40

student. By comparison, the incomplete schedule produced by the computer cost \$3530. The cost per student to produce this schedule is approximately \$11.40. This amount reflects extraordinary difficulties experienced with the computer programs. A more adequate computer scheduling system might reduce or increase this cost significantly. However, one must assume, on the basis of this study, that the cost of computer scheduling can be and probably will be greater than manual scheduling. This is certainly true for schools in Newfoundland because they have to hire consultants, expert help, and rent computer time. At present, administrative and staff costs are included in their present salaries.

In arriving at the total cost of each schedule, staff expenses were calculated on the basis of an average of \$40.00 per day for each member. The estimated cost per day for the principal was \$60.00 and \$55.00 for the vice-principal. Computer, computer consultant, and keypunching fees were set on a contract basis.

Functional Aspects of the Schedules

Both the manual and the computer schedules were identical with respect to structural specifications. That is, each schedule consisted of a five-day cycle with each day having nine forty-minute periods. Periods five and six were reserved for lunch in both cases. There were no

scheduling restrictions placed on the remaining seven periods of each day.

Table 4 gives a comparative summary of the adequacies of each schedule. In both cases, 167 course sections requested scheduling. The computer was able to schedule 144 sections or eighty-six per cent of those requested. The manual schedule was able to accommodate 167 or one hundred per cent of the course section requests. The school required that 394 teacher periods be scheduled; however, the computer was able to assign 349 or eighty-eight per cent of these as compared to the one hundred per cent scheduled manually. Course enrollments totalled 4238. Of these, only 3297 or seventy-eight per cent were scheduled by the computer. The manual scheduling accommodated 4223 or ninety-nine per cent of the requests. The total number of periods required to accommodate all courses was 10850. The computer was able to honour 9200 or eighty-five per cent of these, whereas the manual effort respected all but seventy-five or less than one per cent. The computer was unable to schedule any student for his total number of requested courses. All but fifteen students were scheduled manually. Each student was left with an average of three courses that could not be honoured by the computer. By comparison, the manual schedule rejected less than an average of one-tenth

TABLE 4

A COMPARISON OF MANUAL AND COMPUTER TEACHER, COURSE, PERIOD,
AND STUDENT SCHEDULING REQUESTS HONOURED

Scheduling Variable	Manual			Computer		
	Requests	Hon.	% Hon.	Requests	Hon.	% Hon.
Course Sections	167	167	100	167	144	86
Teacher Periods	394	394	100	394	349	88
Course Enrollments	4,238	4,223	99	4,238	3,297	78
Student Periods	10,850	10,775	99	10,850	9,200	85
Students	310	295	95	310	0	0
Student* Courses	7	6.9	99	7	4.0	57

*.Data for this variable represents averages

of a course per student and these rejections were confined to fifteen students. All rejected students in the manual schedule were on subject promotion; that is, requesting courses from at least two grades. The computer scheduled several of the courses completely; however, the schedule was

unable to successfully assign any students to all their classes.

Tables 5 to 12 present the computer generated master schedule and the manually constructed master schedule for each grade. Generally speaking, the computer was unable to completely schedule any of the grade level schedules. Collectively, this meant that a major portion of the school master schedule was not completed. The manual grade level schedules were all finalized and, consequently, the school master schedule was satisfactory to all concerned. All but a few of the restrictive measures such as double periods were honoured by the manual schedule. In order for the computer schedule to achieve its maximized status, all restrictions, except in Industrial Arts and Home Economics had to be removed. This led to an unsatisfactory result because original course plans had to be altered. This meant that the school was back to the age-old problem of modifying the school program to meet scheduling demands. For some undetermined reason the computer assigned almost all four period courses to the same time pattern. That is, the same period on Monday, Wednesday, Thursday and Friday. The only courses in which this did not happen were those that the scheduler changed to four phases of one period each. The computer also scheduled the courses and teachers at the expense of producing many conflicts in student

TABLE 5

GRADE EIGHT MANUAL MASTER SCHEDULE

P E R I O D	DAY				
	1	2	3	4	5
1	Hist. 1 Eng. 2 Geog. 3	Eng. 1 Math. 2 Eng. 3	Math. 1 Math. 2 Math. 3	Math. 1 Hist. 2 Science 3	Math. 1 Math. 2 Math. 3
2	Math. 1 Math. 2 Math. 3	Math. 1 Eng. 2 Hist. 3 (M) P. Ed. 3 (F)	Eng. 1 Geog. 2 Eng. 3	Geog. 1 Geog. 2 Math. 3	Science 1 Eng. 2 Eng. 3
3	Eng. 1&2 (M) P. Ed. 1 (F) Ind. Arts 2 H. Ecom. 2	Hist. 1 Ind. Arts 1 H. Ecom. 1 Math. 3	Science 1 Science 2 Ind. Arts 2 H. Ecom. 2	Eng. 1&2 (M) P. Ed. 1 (F) Hist. 3	French 1 Ind. Arts 1 H. Ecom. 1 Math. 3
4	French 1 Geog. 2 Ind. Arts 2 H. Ecom. 2	Geog. 1 Ind. Arts 1 H. Ecom. 1 Hist. 3 (F) P. Ed. 4 (M)	Math. 1 Hist. 2 Geog. 3	Hist. 1 Math. 2 Eng. 3	Geog. 1 Ind. Arts 1 H. Ecom. 1 Science 3
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Math. 1 Hist. 2 Eng. 3	Math. 1 Eng. 2 Geog. 3	Geog. 1 Eng. 2 Eng. 3	Eng. 1&2 (F) P. Ed. 2 (M) Ind. Arts 2 H. Ecom. 2	Eng. 1 Math. 2 Hist. 3
8	Eng. 1&2 (F) P. Ed. 2 (M) Eng. 3	Science 1 Geog. 2 Eng. 3	Eng. 1 Math. 2 Math. 3	French 1 Science 2 Science 3	Hist. 1 Eng. 2 Geog. 3 (F) P. Ed. 4 (M)
9	Science 1 Math. 2 Math. 3	Eng. 1 Science 2 Science 3	French 1 Science 2 Hist. 3	Math. 1 Math. 2 Math. 3	Eng. 1 Hist. 2 Geog. 3 (M) P. Ed. 3 (F)

TABLE 6

GRADE EIGHT COMPUTER MASTER SCHEDULE

P E R I O D	DAY*				
	1	2	3	4	5
1	Math. 1 Math. 2 Eng. 3	Math. 1 Math. 2 Geog. 2 P.Ed.1(F)	Math. 1 Math. 2 Eng. 3 P.Ed.1(F)	Math. 1 Math. 2 Eng. 3	Math. 1 Math. 2 P.Ed.1(M) Eng. 3
2	Science 1 Eng. 2 Math. 3	P.Ed.1(M) Ind.Arts 1 Math. 3 Geog. 1	Science 1 Eng. 2 Math. 3	Science 1 Eng. 2 Math. 3	Science 1 Eng. 2 Math. 3
3	H. Ecom. 1 Hist. 1 Science 2	Geog. 2 Ind.Arts 1 P.Ed.2(F)	Hist. 1 Science 2 Geog. 3	Hist. 1 Science 2 Geog. 3	Hist. 1 H.Ecom. 1 Science 2
4	Eng. 1 Hist. 2 Science 3	Geog. 1 Geog. 2 Geog. 3	Eng. 1 Hist. 2 Science 3	Eng. 1 Hist. 2 Science 3	Eng. 1 Hist. 2 Science 3
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Math. 2 Math. 3	Geog. 1 Geog. 2 Geog. 3 Ind.Arts 1	Math. 2 Math. 3 P.Ed.3(F)	Ind.Arts 1 Math. 2 Math. 3 P.Ed.2(F)	Math. 2 Math. 3 P.Ed.2(M)
8	Eng. 1 Math. 1 French 1	Geog. 1 H.Ecom. 1 Ind.Arts 2 P.Ed.2(M)	Eng. 1 Math. 1 French 1 Ind.Arts 2	French 1 Eng. 1 Math. 1 P.Ed.3(M)	Eng. 1 Math. 1 French 1 Ind.Arts 2
9	Eng. 2 Hist. 3 Eng. 3	H.Ecom. 1 Ind.Arts 2 P.Ed.3(F)	Eng. 2 Hist. 3 Eng. 3	Eng. 2 Hist. 3 Eng. 3	Eng. 2 Hist. 3 Eng. 3

* Courses not scheduled by computer: (a) One period of Phys. Ed., Sect. 3 (Male)
(b) Sec. 2 of Home Ecom.

TABLE 7

GRADE NINE MANUAL MASTER SCHEDULE

P E R I O D	DAY				
	1	2	3	4	5
1	Alge. 1 Geom. 2 Eng. 3	Hist. 1 Geog. 2	Eng. 1 Eng. 2&3 (M) P.ED. 2 (F)	Eng. 1 Eng. 2 Ind.Arts 2 H.Ecom. 2	Eng. 1 Science 2 Eng. 3
2	Eng. 1 Eng. 2&C (M) P.ED. 2 (F)	Eng. 1 (M) P.ED. 1 (F) Eng. 2 Science 3	Hist. 1 Geog. 2	Science 1 Science 2 Ind.Arts 2 H.Ecom. 2	Eng. 1 Science 2 Science 3
3	Hist. 1 Geog. 2	Alge. 1 Eng. 2 G.Math. 1	Science 1 Alge. 2 G.Math. 1	French 1 H.Ecom. 1 Ind.Arts 1 Eng. 3	Geog. 1 Hist. 2
4	Science 1 Alge. 2 G. Math. 1	Eng. 1 (F) P.ED. 4 (M) Science 2 Eng. 3	Geom. 1 Eng. 2&3 (F) P.ED. 3 (M)	French 1 H. Ecom. 1 Ind.Arts 1 Science 3	Geom. 1 Eng. 2 G. Math. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	French 1 Ind.Arts 1 H. Ecom. 1 Science 3	Geog. 1 Hist. 2	Geog. 1 Hist. 2	Eng. 1 Eng. 2 G.Math 1	French 1 H.Ecom. 1 Ind.Arts 1 Eng. 3
8	Geog. 1 Hist. 2	Geom. 1 Alge. 2 Ind.Arts 2 H.Ecom. 2	Eng. 1 Eng. 2 G.Math. 1	Geom. 1 Alge. 2 Eng. 3	Alge. 1 (M) P.ED. 1 (F) Eng. 2 Ind.Arts 2 H.Ecom. 2
9	Eng. 1 Eng. 2&3 (F) P.ED. 3 (M)	Science 1 Geom. 2 G.Math. 1	Alge. 1 Geom. 2 Eng. 3	Hist. 1 Geog. 2	Alge. 1 (F) P.ED. 4 (M) Geom. 2 G.Math. 1

TABLE 8

GRADE NINE COMPUTER MASTER SCHEDULE

P E R I O D	DAY*				
	1	2	3	4	5
1	Hist. 1 Eng. 2	P.Ed. 1 (F) Eng. 2	P.Ed. 1 (F) Eng. 2 Hist. 1	Hist. 1 Eng. 2	Hist. 1 Eng. 2 P.Ed. 1 (M)
2	Eng. 1 Geom. 1 Hist. 2	P.Ed. 1 (M) Eng. 1	Eng. 1 Geom. 1 Hist. 2	Eng. 1 Geom. 1 Hist. 2	Eng. 1 Geom. 1 Hist. 2
3	Geog. 1 Alge. 2 Eng. 3	P.Ed. 2 (F) Eng. 3	Geog. 1 Alge. 2 Eng. 3	Geog. 1 Alge. 2 Eng. 3	Geog. 1 Alge. 2 Eng. 3
4	G.Math. 1	French 1	G.Math. 1	G.Math. 1	G.Math. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Eng. 1 Eng. 2 Science 2	French 1	P.Ed. 3 (F) Eng. 1 Eng. 2 Science 2	P.Ed. 2 (F) Eng. 1 Eng. 2 Science 2	P.Ed. 2 (M) Eng. 1 Eng. 2 Science 2
8	G.Math. 1 Eng. 3 Science 3	French 1 P.Ed. 2 (M)	G.Math. 1 Eng. 3 Science 3	P.Ed. 3 (M) G.Math. 1 Eng. 3 Science 3	G.Math. 1 Eng. 3 Science 3
9	Alge. 1 Science 1 Geog. 2	French 1 P.Ed. 3 (F)	Alge. 1 Science 1 Geog. 2	Alge. 1 Science 1 Geog. 2	Alge. 1 Science 1 Geog. 2

* Courses not scheduled by computer: (a) 1 period P.Ed. 3 (Male)
 (b) 4 periods Geom. 2
 (c) 2 sections Home Econ
 (d) 2 sections Ind. Arts

TABLE 9

GRADE TEN MANUAL MASTER SCHEDULE

P E R I O D	DAY				
	1	2	3	4	5
1	Eng. 1 Ind.Arts 1 H. Ecom. 1	Physics 1 Biology 1	Hist. 1 Eng. 2	Eng. 1 G.Math. 1 Alge. 2	Geom. 1 Eng. 2
2	Hist. 1 Ind.Arts 1 H. Ecom. 1	Geog. 1 G.Math. 1 Alge. 2	French 1 E.Science 1 G.Math. 1 Geom. 2	Alge. 1 Hist. 2 French 2	Hist. 1 G.Math. 1 Alge. 2
3	Physics 1 Biology 1	Eng. 1 Geog. 2	Eng. 1 Hist. 2 French 2	Physics 1 Biology 1	Eng. 1 G.Math. 1 Alge. 2
4	Alge. 1 Eng. 2	Alge. 1 Eng. 2	Eng. 1 G.Math. 1 Alge. 2	Geog. 1&2 (M) P.Ed. 1 (F)	Alge. 1 Hist. 2 French 2
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Eng. 1 Geog. 2	Eng. 1 G.Math. 1 Geom. 2	Geom. 1 Eng. 2	Physics 1 Biology 1	Geog. 1&2 (F) P.Ed. 2 (M)
8	French 1 E.Science 1 G.Math. 1 Geom. 2	Hist. 1 Eng. 2	Geog. 1&2 (M) P.Ed. 1 (F)	Eng. 1 H. Ecom. 1 Ind.Arts 1	Geog. 1 Eng. 2
9	Geom. 1 Eng. 2	Geom. 1 Hist. 2 French 2	Geog. 1&2 (F) P.Ed. 2 (M)	French 1 E.Science 1 Eng. 2	French 1 E.Science 1 H. Ecom. 1 Ind.Arts 1

TABLE 10

GRADE TEN COMPUTER MASTER SCHEDULE

P E R I O D	DAY*				
	1	2	3	4	5
1	Alge. 1 Geog. 1	Hist. 1	Alge. 1 Geog. 1	Alge. 1 Geog. 1	Alge. 1 Geog. 1
2	Eng. 1 Geom. 2	Eng. 1 Hist. 2	Eng. 1 Geom. 1	Eng. 1 Geom. 1	Eng. 1 Geom. 1
3	Eng. 2 Alge. 2 French 2	Eng. 2 Hist. 1 H.Ecom. 1	Eng. 2 Alge. 2 French 2	Eng. 2 Alge. 2 French 2	Eng. 2 Alge. 2 French 2
4	G.Math. 1 French 1 E.Science 1	P.Ed.1(M) H.Ecom. 1	G.Math. 1 French 1 E.Science 1	G.Math. 1 French 1 E.Science 1	G.Math. 1 French 1 E.Science 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Eng. 1	P.Ed.1(M) H.Ecom. 1	Eng. 1 Hist. 2	Eng. 1 Hist. 2	Eng. 1 Hist. 2
8	Hist. 1 Geog. 2	Biology 1 Hist. 1	Biology 1 Geog. 2	Ind.Arts 1 Geog. 2	Biology 1 Geog. 2
9	Eng. 2	Biology 1 Physics 1	P.Ed.1(F) Ind.Arts 1 Eng. 2	Physics 1 H.Ecom. 1 Ind.Arts 1 Eng. 2	P.Ed.1 (F) Ind.Arts 1 Eng. 2

- * Courses not scheduled by computer:
- (a) Section 2 of Geom.
 - (b) Four periods of General Mathematics, Section 1
 - (c) Two periods of Physics, Section 1

TABLE 11

GRADE ELEVEN MANUAL MASTER SCHEDULE

P E R I O D	DAY				
	1	2	3	4	5
1	Geog. 1 G.Math. 1	Hist. 1&2 (M) P.Ed.1(F)	Biology 1 Physics 1 Eng. 2	Geog. 1 Eng. 2	Hist.1&2(F) P.Ed.2 (M)
2	Eng. 1 Geog. 2	Eng. 1 Biology 2	Trig. 1 G.Math. 1	Eng. 1 G.Math. 1	Eng. 1 G.Math. 1
3	Alge. 1 Eng. 2	Biology 1 Physics 1 Eng. 2	Geog. 1 Econ. 2	Alge. 1 Econ. 2	Alge. 1 Econ. 2
4	Econ. 1 Biology 2	Trig. 1 Econ. 2	Hist. 1 Geog. 2	Biology 1 Physics 1 Eng. 2	Eng. 1 Biology 2
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Biology 1 Physics 1 Eng. 2	Hist. 1&2 (F) P.Ed.2(M)	Trig. 1 G.Math. 1	Eng. 1 Geog. 2	Alge. 1 Eng. 2
8	Trig. 1 G.Math. 1	Econ. 1 G.Math. 1	Hist. 1 Eng. 2	Econ. 1 G.Math. 1	Trig. 1 G.Math. 1
9	Eng. 1 Hist. 2	Eng. 1 Geog. 2	Econ. 1 Hist. 2	Hist. 1&2 (M) P.Ed. 1 (F)	Geog. 1 Biology 2

TABLE 12

GRADE ELEVEN COMPUTER MASTER SCHEDULE

P E R I O D	DAY*				
	1	2	3	4	5
1	Eng. 1 G.Math. 1	Econ. 1 G.Math. 1 Biology 1	Eng. 1 G.Math. 1	Eng. 1 G.Math. 1 P.Ed.1(M)	Eng. 1 G.Math. 1
2	Eng. 2 Hist. 1	Biology (1 & 2)	Eng. 2 Hist. 1	Eng. 2 Hist. 1	Eng. 2 Hist. 1
3	Hist. 2 Econ. 1	Econ. 1 Biology 1	Hist. 2	Hist. 2	Hist. 2 Econ. 1
4	Trig. 1 Geog. 1	Trig. 1 Biology 1	Trig. 1 Geog. 1 Econ. 2	Trig. 1 Geog. 1 Econ. 2	Trig. 1 Geog. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	G.Math. 1 Geog. 2	Biology 2	G.Math. 1 Geog. 2	G.Math. 1 Geog. 2	G.Math. 1 Geog. 2
8	Eng. 1 P.Ed.1(M)	Econ. 2	Eng. 1 P.Ed.1(F)	Eng. 1	Eng. 1 P.Ed.1 (F)
9	Alge. 1 Eng. 2	Econ. 2	Alge. 1 Eng. 2	Alge. 1 Eng. 2	Alge. 1 Eng. 2

* Courses not scheduled by computer: (a) two periods of Biology, Sect. 2
(b) one section of Physics

schedules. In other words, the computer master schedule, in its present form, prevented many students from attending several of their required courses.

Teacher Satisfaction

Total teacher satisfaction was not expressed for either of the schedules. However, greater dissatisfaction was indicated for the computer schedule than for the manual schedule. Tables 13 to 18 present data pertinent to teacher dissatisfaction. Criticism for the computer schedule centered around three main areas. First of all, teachers were concerned over the fact that for some of them, their unscheduled periods were clustered. Table 16 is a sample of this. In this case all unscheduled periods occur on day "two" for teacher B. Some teachers weren't pleased with the majority of their unscheduled periods being confined to either the morning session or the afternoon session. This was a problem with both master schedules.

The second major problem caused by the computer schedule was that of scheduling several periods of one course section on the same day. Table 18 shows that three periods of History X, section one, were scheduled for day two. This is most undesirable especially for a four-period course. Several cases of two periods in the same course occurring on the same day is shown in Table 14. The manual schedule exhibited a few of these situations but some were

TABLE 13

A MANUAL TIMETABLE FOR TEACHER A

P E R I O D	DAY				
	1	2	3	4	5
1	Geog. VIII Sec. 3		Eng. XI Sec. 2	Eng. XI Sec. 2	
2	Eng. XI Sec. 1	Eng. XI Sec. 1		Eng. XI Sec. 1	Eng. XI Sec. 1
3	Eng. XI Sec. 2	Eng. XI Sec. 2	Econ. XI Sec. 2	Econ. XI Sec. 2	Econ. XI Sec. 2
4	Econ. XI Sec. 1	Econ. XI Sec. 2	Geog. VIII Sec. 3	Eng. XI Sec. 2	Eng. XI Sec. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Eng. XI Sec. 2	Geog. VIII Sec. 3		Eng. XI Sec. 1	Eng. XI Sec. 2
8		Econ. XI Sec. 1	Eng. XI Sec. 2	Econ. XI Sec. 1	Geog. VIII Sec. 3 (M)
9	Eng. XI Sec. 1	Eng. XI Sec. 1	Econ. XI Sec. 1		Geog. VIII Sec. 3 (F)

TABLE 14

A COMPUTER TIMETABLE FOR TEACHER A

P E R I O D	DAY				
	1	2	3	4	5
1	Eng. XI Sec. 1	Econ. XI Sec. 1	Eng. XI Sec. 1	Eng. XI Sec. 1	Eng. XI Sec. 1
2	Eng. XI Sec. 2		Eng. XI Sec. 2	Eng. XI Sec. 2	Eng. XI Sec. 2
3	Econ. XI Sec. 1	Econ. XI Sec. 1	Geog. VIII Sec. 3	Geog. VII Sec. 3	Econ. XI Sec. 1
4		Geog. VIII Sec. 3	Econ. XI Sec. 2	Econ. XI Sec. 2	
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7		Geog. VIII Sec. 3			
8	Eng. XI Sec. 1	Econ. XI Sec. 2	Eng. XI Sec. 1	Eng. XI Sec. 1	Eng. XI Sec. 1
9	Eng. XI Sec. 2	Econ. XI Sec. 2	Eng. XI Sec. 2	Eng. XI Sec. 2	Eng. XI Sec. 2

TABLE 15

A MANUAL TIMETABLE FOR TEACHER B

P E R I O D	DAY				
	1	2	3	4	5
1	Eng. X Sec. 1	Eng. VIII Sec. 1	Eng. X Sec. 2	Eng. X Sec. 1	Eng. X Sec. 2
2		Eng. VIII Sec. 2	Eng. VIII Sec. 1		Eng. VIII Sec. 2
3	Eng. VIII Sec. 1 & 2 (M)	Eng. X Sec. 1	Eng. X Sec. 1	Eng. VIII Sec. 1 & 2 (M)	Eng. X Sec. 1
4	Eng. X Sec. 2	Eng. X Sec. 2	Eng. X Sec. 1		
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Eng. X Sec. 1	Eng. X Sec. 1	Eng. X Sec. 2	Eng. VIII Sec. 1 & 2 (F)	Eng. VIII Sec. 1
8	Eng. VIII Sec. 1 & 2 (F)	Eng. X Sec. 2	Eng. VIII Sec. 1	Eng. X Sec. 1	Eng. X Sec. 2
9	Eng. X Sec. 2	Eng. VIII Sec. 1		Eng. X Sec. 2	Eng. VIII Sec. 1

TABLE 16

A COMPUTER TIMETABLE FOR TEACHER B

P E R I O D	DAY				
	1	2	3	4	5
1	Eng. VIII Sec. 2		Eng. VIII Sec. 2	Eng. VIII Sec. 2	Eng. VIII Sec. 2
2	Eng. X Sec. 1	Eng. X Sec. 1	Eng. X Sec. 1	Eng. X Sec. 1	Eng. X Sec. 1
3	Eng. X Sec. 2	Eng. X Sec. 2	Eng. X Sec. 2	Eng. X Sec. 2	Eng. X Sec. 2
4	Eng. VIII Sec. 1		Eng. VIII Sec. 1	Eng. VIII Sec. 1	Eng. VIII Sec. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Eng. X Sec. 1		Eng. X Sec. 1	Eng. X Sec. 1	Eng. X Sec. 1
8	Eng. VIII Sec. 1		Eng. VIII Sec. 1	Eng. VIII Sec. 1	Eng. VIII Sec. 1
9	Eng. X Sec. 2		Eng. X Sec. 2	Eng. X Sec. 2	Eng. X Sec. 2

TABLE 17

A MANUAL TIMETABLE FOR TEACHER C

P E R I O D	DAY				
	1	2	3	4	5
1	Hist. VIII Sec. 1	Hist. IX Sec. 1	Hist. X Sec. 1	Hist. VIII Sec. 2	
2	Hist. X Sec. 1	Hist. VIII Sec. 3(M)	Hist. IX Sec. 1	Hist. X Sec. 2	Hist. X Sec. 1
3	Hist. IX Sec. 1	Hist. VIII Sec. 1	Hist. X Sec. 2	Hist. VIII Sec. 3	Hist. IX Sec. 2
4		Hist. VIII Sec. 3(F)	Hist. VIII Sec. 2	Hist. VIII Sec. 1	Hist. X Sec. 2
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Hist. VIII Sec. 2	Hist. IX Sec. 2	Hist. IX Sec. 2		Hist. VIII Sec. 3
8	Hist. IX Sec. 2	Hist. X Sec. 1			Hist. VIII Sec. 1
9		Hist. X Sec. 2	Hist. VIII Sec. 3	Hist. IX Sec. 1	Hist. VIII Sec. 2

TABLE 18

A COMPUTER TIMETABLE FOR TEACHER C

P E R I O D	DAY				
	1	2	3	4	5
1	Hist. IX Sec. 1	Hist. X Sec. 1	Hist. IX Sec. 1	Hist. IX Sec. 1	Hist. IX Sec. 1
2	Hist. IX Sec. 2	Hist. X Sec. 2	Hist. IX Sec. 2	Hist. IX Sec. 2	Hist. IX Sec. 2
3	Hist. VIII Sec. 1	Hist. X Sec. 1	Hist. VIII Sec. 1	Hist. VIII Sec. 1	Hist. VIII Sec. 1
4	Hist. VIII Sec. 2		Hist. VIII Sec. 2	Hist. VIII Sec. 2	Hist. VIII Sec. 2
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7			Hist. X Sec. 2	Hist. X Sec. 2	Hist. X Sec. 2
8	Hist. X Sec. 1	Hist. X Sec. 1			
9	Hist. VIII Sec. 3		Hist. VIII Sec. 3	Hist. VIII Sec. 3	Hist. VIII Sec. 3

requested by the teacher concerned; others were agreed to by teachers in order to offset other major scheduling difficulties. In any case, the frequency of occurrence was much greater in the computer schedule.

Finally, teachers felt that the computer was too uniform in the scheduling of each course. Many courses were selected for the same period each day. They felt that this led to some courses claiming prime periods and added monotony to several courses. Periods should have been staggered on separate days. For example, History VIII, section three, in Table 18 was at a disadvantage since the course had to be taught at the end of each day when students are tired. The problem could not be controlled since it was an inadequacy within the logic of the computer programs. It was, however, a consideration that received a high priority in the manual schedule and, consequently, was overcome.

Student Satisfaction

Computer student schedules were unacceptable in all cases. As mentioned previously, all students were rejected for at least one course and some were rejected in many course areas. Tables 19 and 20 point out this major difficulty. This student was unable to attend classes for Physical Education and Physics. Table 21 shows the manual scheduling for grade ten student B and Table 22 illustrates the problems experienced in scheduling the same student by computer.

TABLE 19

A GRADE ELEVEN MANUAL TIMETABLE FOR STUDENT A.

P E R I O D	DAY				
	1	2	3	4	5
1	Geog. Sec. 1	Hist. Sec. 1	Physics Sec. 1	Geog. Sec. 1	Phys. Ed. Sec. 2
2	English Sec. 1	English Sec. 1	Trig. Sec. 1	English Sec. 1	English Sec. 1
3	Algebra Sec. 1	Physics Sec. 1	Geog. Sec. 1	Algebra Sec. 1	Algebra Sec. 1
4	Economics Sec. 1	Trig. Sec. 1	History Sec. 1	Physics Sec. 1	English Sec. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Physics Sec. 1	Phys. Ed. Sec. 2	Trig. Sec. 1	English Sec. 1	Algebra Sec. 1
8	Trig. Sec. 1	Economics Sec. 1	History Sec. 1	Economics Sec. 1	Trig. Sec. 1
9	English Sec. 1	English Sec. 1	Economics Sec. 1	History Sec. 1	Geog. Sec. 1

TABLE 20

A GRADE ELEVEN COMPUTER TIMETABLE FOR STUDENT A

P E R I O D	DAY*				
	1	2	3	4	5
1	English Sec. 1	Economics Sec. 1	English Sec. 1	English Sec. 1	English Sec. 1
2	History Sec. 1		History Sec. 1	History Sec. 1	History Sec. 1
3	Economics Sec. 1	Economics Sec. 1			Economics Sec. 1
4	Trig. Sec. 1	Trig. Sec. 1	Trig. Sec. 1	Trig. Sec. 1	Trig. Sec. 1
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Geog. Sec. 2		Geog. Sec. 2	Geog. Sec. 2	Geog. Sec. 2
8	English Sec. 1		English Sec. 1	English Sec. 1	English Sec. 1
9	Algebra Sec. 1		Algebra Sec. 1	Algebra Sec. 1	Algebra Sec. 1

* Because of computer program limitations, student A was unable to be scheduled for Physical Education and Physics.

TABLE 21

A. GRADE TEN MANUAL TIMETABLE FOR STUDENT B

P E R I O D	DAY				
	1	2	3	4	5
1	Ind. Arts Sec. 1	Biology Sec. 1	English Sec. 2	Gen. Math. Sec. 1	English Sec. 2
2	Ind. Arts Sec. 1	Gen. Math. Sec. 1	Gen. Math. Sec. 1	History Sec. 2	Gen. Math. Sec. 1
3	Biology Sec. 1	Geog. Sec. 2	History Sec. 2	Biology Sec. 1	Gen. Math. Sec. 1
4	English Sec. 2	English Sec. 2	Gen. Math. Sec. 1	Geog. Sec. 2	History Sec. 2
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	Geog. Sec. 2	Gen. Math. Sec. 1	English Sec. 2	Biology Sec. 1	Phys. Ed. Sec. 2
8	Gen. Math. Sec. 1	English Sec. 2	Geog. Sec. 2	Ind. Arts Sec. 1	English Sec. 2
9	English Sec. 2	History Sec. 2	Phys. Ed. Sec. 2	English Sec. 2	Ind. Arts Sec. 1

TABLE 22

A GRADE TEN COMPUTER TIMETABLE FOR STUDENT B

P E R I O D	DAY*				
	1	2	3	4	5
1	Geog. Sec. 1		Geog. Sec. 1	Geog. Sec. 1	Geog. Sec. 1
2	English Sec. 1	English Sec. 1	English Sec. 1	English Sec. 1	English Sec. 1
3					
4		Phys. Ed. Sec. 1			
5	Lunch	Lunch	Lunch	Lunch	Lunch
6	Lunch	Lunch	Lunch	Lunch	Lunch
7	English Sec. 1	Phys. Ed. Sec. 1	English Sec. 1	English Sec. 1	English Sec. 1
8		Biology Sec. 1	Biology Sec. 1	Ind. Arts Sec. 1	Biology Sec. 1
9		Biology Sec. 1	Ind. Arts Sec. 1	Ind. Arts Sec. 1	Ind. Arts Sec. 1

* Because of computer program limitations, student B was unable to be scheduled for History and General Mathematics.

The computer, in its efforts to schedule teachers and courses, ignored the numerous conflicts in student schedules. The manual schedule resulted in a limited number of conflicts for students taking courses in more than one grade. These students had to take alternate courses.

Students also expressed their discontent with the computer schedule in two other major areas. In that respect, their comments were similar to those of the teachers. They did not favour the ideal of uniform time periods for courses, particularly at the end of morning and afternoon sessions. Finally, they were opposed to the thought of having to attend class for the same course three times on one day. They felt that this would be a problem since they would have to cover considerable material on one day and for the remainder of the cycle, would get little or no exposure to the course. The gap was too big, provided no continuity, and preparation for three classes was too difficult.

Scheduling Resources Needed

Before any school can embark on scheduling requiring computer assistance, three basic requirements must be met. First of all, a computer with a large memory capacity is needed. Most scheduling packages require large memory storage because they are designed to accommodate educational institutions with high enrollments. Secondly, a scheduling

package is required that is flexible enough to handle the peculiar circumstances of any one school. Finally, unless, the school administrator is a competent computer specialist, a computer consultant will be essential to the success of the venture. The school administrator can provide the necessary input from the school, but only a specialist will be able to control the technical aspects of the computerization phase.

At the present time, only two of the three essentials are available to Newfoundland high schools. Newfoundland and Labrador Computer Services has both adequate computer facilities and competent computer consultants. However, this study is the first attempt at providing scheduling programs. This study met with very little success using the Stanford School Scheduling System. (One of the larger schools of St. John's, Newfoundland tried unsuccessfully to schedule its program with the same system.) The latter was attempted after this study had made the system operational. At the present time, facilities are available for experimental work only.

REPORT OF THE FINDINGS

Research Question 7: Computer Scheduling Advantages

After a careful review of the literature, it was felt that computer scheduling would hold many advantages over manual scheduling. It is true that the computer has more speed and can produce an abundance of relevant scheduling material. It does produce schedules for all scheduling variables including the school, teachers, students and rooms. However, the efforts of this study showed that much more varied research will be required before any advantages for computer scheduling can be claimed. The researcher is still optimistic, but before computers can be of any assistance in Newfoundland high schools, either a new system of scheduling must be developed or a system different from the one used in this study must be found. The Stanford School Scheduling System is designed to accommodate students in a more flexible institution such as a University. In Newfoundland high schools, students spend most of their time in scheduled classes with little or no study time and that results in increased scheduling difficulties too great for systems like the SSSS.

Research Question 8: Computer Scheduling Disadvantages

Within the limits of this study the computer scheduling procedures presented several major disadvantages.

They are as follows:

1. The computer required less personnel to perform the scheduling process; however, the scheduling time period was much longer than the manual process. In this study the computer construction time was double that of the manual time. That is, twenty-eight days as compared to fourteen days.

2. The computer scheduling process cost much more than the manual effort. The cost per pupil for the manual schedule was \$8.45 as compared to \$11.40 per pupil for the computer schedule.

3. The computer was unable to complete the scheduling process. Many of the courses and teachers were not completely scheduled. None of the students were able to attend classes in all courses.

4. Teacher schedules were unsatisfactory for several staff members. For some unknown reason the computer scheduled most courses in periods on Monday, Wednesday, Thursday and Friday only. This meant that several teachers received all their unscheduled class time on Tuesday or a course was forced to be scheduled for several periods on one day.

5. Student schedules were not complete for any students. All students were unable to attend classes for an average of three courses because of master schedule conflicts or

unscheduled courses.

6. Most courses were scheduled for the same time period each day. This meant that some courses got prime time periods and others had the disadvantage of coming at the end of each session every day. By careful consideration this condition did not exist in the manual schedule.

Research Question 9: Computer Resources Necessary

If a school decides to schedule by computer, three major resources must be available. First, a computer with large storage facilities is needed. Secondly, computer consultants must be available to provide technical advice. Finally, a scheduling system flexible enough to accommodate the special needs of the school must be available. Some knowledge of computers would also be a great asset for the school administrator.

Research Question 10: Computer Resources Available

The prime resource, an adequate computer, is available to all schools in Newfoundland. This facility is located at St. John's and is provided by Newfoundland and Labrador Computer Services. Being geographically remote from this service is inconvenient but presents no major difficulty. Communications are such that all schools can have access to the resource. Computer consultants can also be provided by the same company or schools can hire the

services of an independent consulting agency.

The third and final resource is not available except on an experimental basis. The scheduling system used in this study is operative but, as has been pointed out, in the opinion of the researcher, it is not suitable for scheduling Newfoundland high schools. To date, it is the only system operative in the province.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

SUMMARY

Statement of the Problem

The purpose of this study was to investigate the present practices and problems of scheduling high schools in St. John's, Newfoundland. Additionally, this study attempted to determine the potential of computer developed master schedules for Newfoundland high schools. In keeping with these objectives, the following research questions were considered:

1. What procedures are presently being used to schedule high schools in St. John's, Newfoundland?
2. Do the scheduling practices used in the high schools of St. John's differ significantly?
3. What scheduling problems, if any, do high school administrators consider most significant?
4. Are high school administrators satisfied with their present master schedules and scheduling practices?
5. Have high school administrators given any consideration to alternate forms of scheduling

and have they experimented with any of these alternate forms?

6. Are the present high school schedules retarding curriculum innovation?
7. What are the advantages of scheduling Newfoundland high schools by computer?
8. Are there any disadvantages of scheduling Newfoundland high schools by computer?
9. What resources are necessary to enable a high school to utilize the computer for scheduling?
10. Are these resources available?

Procedures

In an attempt to answer the above questions, two instruments were used. The first, an interview questionnaire, was developed by the researcher. The literature review provided the framework for the construction of the instrument. The questionnaire was designed to solicit information of two types. First of all, the instrument contained items to collect factual data concerning the school, its facilities, schedule, program, and personnel. Secondly, several items were constructed to reflect the views of each of the principals with respect to scheduling concepts, scheduling problems, and factors, both technical and non-technical, that affect scheduling in any way.

Interviews were conducted in four of the high schools of St. John's, Newfoundland. Each interview lasted approximately two hours and principals were asked to express their views on many aspects of their schedules and scheduling in general. Because of the small population and emphasis on open-ended questions, no statistical treatment was applied to the data. Basically, all responses were reported as they were recorded and comparisons were made where it was necessary to do so. Responses were organized around each of the relevant research questions.

The second instrument, the Stanford School Scheduling System, was obtained from a group of researchers led by Robert Oakford of Stanford University, California. This system was selected because of its reported flexibility and adaptability to unique school situations. The SSSS consists of nine major computer programs and several supplementary programs written in FORTRAN IV for use on the IBM 360-40 or larger computer.¹

To conduct this phase of the study, it was felt that a representative of the size of majority of the high schools in the province would be most relevant. Since the average

¹The S4 programs for this research effort were made available through the office of the Dean of Education, Dr. G.A. Hickman. It is intended that they be available to any school requesting their use.

high school has an enrollment of approximately 250 to 300 students, it was apparent that the large schools of St. John's would not meet this desired requirement. For this reason, and the researcher's knowledge of the school's program and facilities, Lester Pearson Memorial High School at Wesleyville was chosen to participate in the study.

Both a manual schedule and a computer generated schedule were constructed for the school. The schedules were compared on the basis of cost, construction time, staff satisfaction, student satisfaction, and course requests honoured. This information is reported in Chapter V in both written and tabular form.

Summary of Findings

All schools used the trial-and-error or hand mosaic method in scheduling their programs. No school used or had ever used a computer to assist them in their scheduling efforts. Basically, either the principal, vice-principal, a committee, or a combination of these looked at the strengths and weaknesses of previous schedules and then constructed their schedule with this information plus the necessary school data. Construction time, including the preparation phase, ranged from one to three months.

No significant differences existed in the scheduling practices of the schools. Basically, all schools used a

standard seven-period day, operating on a five-day cycle. Some minor variations did exist such as limited independent study in one school, back-to-back scheduling for science and physical education, and an experiment in team-teaching in another.

Several scheduling problems were identified by the school administrators. In summary the following were indicated as being of particular concern:

1. Workload problems caused by teachers being involved in more than one subject area.
2. The present pupil-teacher ratio restricted the flexibility of the master schedule by imposing program restrictions.
3. A lack of student guidance services.
4. Standard periods imposed considerable problems when any form of experimentation was desired.
5. Unresolved conflicts in the master schedule forced students to take alternate courses. In many cases, students were not interested in the alternates and discipline problems resulted.
6. The schedule is so rigid that arrangements for special activities upset the whole program at times.

All principals felt that their present schedules were inadequate. The major shortcomings of their schedules were that (1) they were too academically oriented; (2) many student requests could not be honoured; (3) the schedules were inflexible; and, (4) that there was not enough time built into the schedules to adequately accommodate student needs.

Presently, experimentation in the area of scheduling is practically non-existent. Most principals felt that new scheduling concepts had some merit, but were reluctant to experiment or consider new forms of scheduling because of possible detrimental effects on the students. It was expressed, however, that in the future, alternate forms of scheduling would become necessary. It was felt this should be an endeavour taken on by the Provincial Department of Education and not necessarily the schools. Although present schedules were too stereotyped, it was stated that many curricular changes could still be accommodated by these schedules if the demand existed.

It was found that the disadvantages of computer generated master schedules are presently too great to be of significant assistance to Newfoundland high schools. Its major advantage is that it reduces a considerable amount of clerical work. The Stanford School Scheduling System used in this study proved to be of little value as a scheduling

aid to high schools in the province. Its design can only accommodate schools with flexible scheduling practices. Because of highly demanding school schedule requirements and inadequacies within the SSSS, many disadvantages were revealed.

First of all, the computer did not reduce scheduling time in the test high school. Rather, the time period was extended. The manual schedule required fourteen days as opposed to twenty-eight days required by the computer for construction. Secondly, computer costs were far greater than manual costs. The SSSS cost \$11.40 per student as compared to a manual cost of \$8.45. Thirdly, the SSSS was unable to successfully schedule many of the courses, teachers, and none of the students. Fourthly, several teachers found their computer schedule unsatisfactory. Many of their unscheduled class periods were clustered on one day or several periods of the same course appeared on the same day. Fifthly, no student schedules were complete because of unscheduled courses or master schedule conflicts. Finally, course scheduling was too uniform. This meant that some courses got prime periods each day and others were always placed at the end of each day's session.

Three major resources are necessary to produce computer generated master schedules. These resources consist of a computer with large memory storage facilities; computer

consultants to provide technical services; and a flexible scheduling system. All three resources are available to Newfoundland high schools; however, the scheduling system used in this study and presently in operation is appropriate only for experimental purposes. All facilities are available at Newfoundland and Labrador Computer Services in St. John's. Independent consultants also offer their services should anyone require them. SSSS should prove to be of some value to any school that plans to implement a flexible schedule where students are assigned several study hall periods. This last requirement, study hall assignment, is necessary because it reduces the student density ratio. That is, a student spends less than one hundred per cent of his time in class and, thus, gives the computer more flexibility in assigning class times.

Conclusions

Within the limitations of this study, the following conclusions are made:

1. Schools are using the trial-and-error or hand mosaic method for master schedule construction.
2. Schools have not used computer systems for schedule construction.
3. Master schedules are built by either the principal, vice-principal, a committee or a combination of these.

4. Most schools require from one to three months for schedule construction.
5. Scheduling practices do not differ significantly in the high schools.
6. All schools use a standard seven-period day, operating on a five-day cycle.
7. The major scheduling problems identified by school administrators may be grouped as follows:
 - (1) workload problems caused by teachers assigned to more than one subject area,
 - (2) inflexible schedules caused by the present pupil-teacher ratio,
 - (3) a lack of student guidance services,
 - (4) standard length periods,
 - (5) discipline problems that occur because of unresolved schedule conflicts forcing students into courses in which they have no interest, and
 - (6) schedules that are too rigid.
8. Schools are operating with schedules that are not adequately meeting program needs.
9. School principals favour new scheduling concepts such as flexible and modular scheduling.
10. Schools are not actively engaged in schedule experimentation.
11. School principals feel that the Department of Education should experiment with new scheduling techniques.

12. Computer scheduling would not be an asset to schools at present unless some basic changes are made in the fabric of school organization.
13. The major disadvantages of computer scheduling relative to the present operating environment are summarized as follows: (1) lengthened scheduling time, (2) increased scheduling cost, (3) unsuccessful scheduling of courses, teachers, and students, (4) unsatisfactory teacher schedules, (5) incomplete student schedules, and (6) uniform course scheduling.
14. The three basic scheduling resources (a computer, consultants, and a computer scheduling system) are available to Newfoundland high schools. The computer scheduling system that is available can only be used for experimental purposes.
15. The Stanford School Scheduling System is not suitable to the needs of Newfoundland high schools given the present operating environment.

RECOMMENDATIONS

From the findings and conclusions of this study, the following recommendations are made:

Recommendations for Implementation

1. School districts should endeavour to provide in-service programs which would make school administrators aware of proven scheduling techniques. At present, most administrators are scheduling schools on a trial-and-error basis. In-service programs can help administrators to develop new and improved scheduling procedures and also enlighten them as to new organizational patterns for high schools.
2. School administrators should not be satisfied with maintaining the status quo in terms of their scheduling practices in high schools. There are many organizational and scheduling innovations taking place in secondary schools elsewhere today. All are not good but many have merit. The means to implement many of these changes are available and every school administrator should take steps to study them and to incorporate worthwhile ideas into his school program.
3. Before any change can take place in the high school, careful study must be made to ensure its success. In this respect, school administrators and their staffs should familiarize themselves

with new curricular and organizational innovations and investigate their possible effects before they are included into the school program.

4. The master schedule plays a vital role in the smooth and effective operation of a school. Yet, in its training program for administrators, Memorial University of Newfoundland places very little emphasis on proven scheduling procedures. Therefore, the Department of Educational Administration of the University should include at least one course dealing with scheduling both in a practical and theoretical sense. It is rather ironic that such an important aspect of school administration receives so little attention.
5. There is a lack of adequate high school program offerings to meet the needs of many students, especially in non-academic areas. School Boards should make representation to the Department of Education with a view to eliminating this problem. Additionally, schools should change their schedules so that non-academic courses can be accommodated as their requirements dictate.
6. The Department of Education should assume a leadership role in utilizing computers in

secondary education. Studies should be made to determine the feasibility and costs involved in implementing computer scheduling in the Province's high schools.

7. High schools should not attempt to schedule with computer assistance in the near future within the framework of their present organization. Major program and organizational changes are needed before such a step can be taken. Present computer programs are designed to accommodate a flexibly organized school such as outlined by Bush, Allen and Trump.

Recommendations for Further Research

The basic purpose of this study was to focus attention on master scheduling, its problems and the potential of computer generated master schedules in the Province of Newfoundland. The researcher feels that this purpose has been achieved and that this research effort has revealed the need for increased attention in this area.

The following are suggested topics that the researcher feels need to be investigated:

1. A study should be made to determine the relationship between various degrees of program and requisite schedule sophistication.

(such as team teaching, modular programs, individual study programs, and other administrative and curricular innovations), and the efficiency and cost of computer generated master school schedules.

2. The replication or conducting of studies similar to the present study in schools such as the one utilized in the second phase of this study. More evidence is needed before the present findings can be generalized to other school situations.
3. Continued research should be directed towards the improvement of curriculum in the high school. Experiments can be conducted to reveal the effects that varied time patterns, class size, instructional and organizational methods, teacher utilization, and space allocation have on student motivation and learning. Results obtained from these studies can be utilized to improve patterns for instruction in schools throughout the province.
4. Cost analysis studies between traditional scheduling, flexible scheduling, and computer scheduling should be pursued.

5. Computer scheduling should be thoroughly studied with emphasis on finding a computer scheduling system adaptable to high schools in this province. It is likely that there are many systems available that are worthy of investigation and development.
6. A research study of particular value to school administrators and school boards could be undertaken to obtain data which would discover if the interests and attitudes of the principal toward the importance of the scheduling function, as one of his administrative duties, are in any way related to the complexity of the scheduling system in his school.

APPENDIX A

INTERVIEW QUESTIONNAIRE

INTERVIEW QUESTIONNAIRE

AN INVESTIGATION OF THE PRACTICES, PROBLEMS,
AND POTENTIAL ASSOCIATED WITH COMPUTER
GENERATED MASTER SCHEDULING FOR
HIGH SCHOOLS IN NEWFOUNDLAND
AND LABRADOR

by

Joseph Price

The following questions are designed to elicit factual information about your school, its facilities and personnel. Also many of the questions will require your opinions.

1. Name of school _____
2. Address of school _____
3. Telephone number of school _____
4. Name of principal _____. Teaching certificate _____
5. How many students are enrolled in each grade of your school? Grade IX _____ Grade X _____ Grade XI _____

TOTAL ENROLLMENT _____

6. How many classes of students comprise each grade of your school? If applicable, specify the number of academic and general classes per grade.

Grade IX _____ Grade X _____ Grade XI _____

7. How many instructional spaces are presently being used in your school? (Include all spaces in which instruction is given. Include laboratories, gymnasiums, etc.) _____

8. Are there any additional instructional spaces available in your school but are not presently being used?

Yes _____ No _____

If yes, please indicate the number _____

9. How many teachers are there in your school? _____

Full-time _____ Part-time _____

10. The list below is designed to determine the course offerings of your school, the grades in which each course is offered, the number of teachers assigned to each course, and the amount of time provided for each course. Please complete.

Course	Grades in which offered	Number of teachers assigned (specify if by grade)	Amount of time provided
English Language			
English Literature			
General Mathematics			
Algebra			
Geometry			
Trigonometry			
History			
Geography			
Civics			
General Science			
Health			
Physical Education			
Art			
Music			
French			
Industrial Arts			
Home Economics			
Religious Education			
Education Drama			
General English			
German			
Latin			
Spanish			
Economics			
Earth Science			
Physical Science			
Physics			
Physiology			
Chemistry			
Biology			
Business Education			

Course	Grades in which offered	Number of teachers assigned (specify if by grade)	Amount of time provided
- English			
- Shorthand			
- Typewriting			
- Arithmetic			
- Office practice			
- Bookkeeping			
Others (please list)			

11. In your opinion, do the course offerings of your school differ in any way from those recommended by the Department of Education?

Yes _____ No _____

Please comment _____

12. Please indicate if your school has the following spaces. Also please specify how many and the accommodation factor of each space.

Space	Quantity	Accommodation Factor
Regular Classrooms		
Large group rooms		
Seminar rooms		
Library		
Study Room		
Laboratories (Specify)		
Music room		
Art room		
Industrial Arts shop		
Home Economics room		
Gymnasium		
Auditorium		
Business Education room		
Others (please list)		

13. Are you solely responsible for the construction of the master schedule?

Yes _____ No _____

14. Do you delegate the responsibility for, schedule construction to others?

Yes _____ No _____

If yes, please specify _____

15. How much time is involved in schedule construction in your school? Please respond by indicating the approximate number of calendar days and the number of man power days.

Calendar days _____ Manpower days _____

16. Please comment briefly upon the methodology employed in constructing the master schedule for your school.

17. Please outline any problems that you feel are posed by your present methodology. _____

18. What kinds of problems, if any, does your present schedule cause during the school year (educational, operational, etc.)? _____

19. Briefly describe the master schedule presently in use in your school _____

20. If your present schedule adequately fulfilling the needs of your school?

Yes _____ No _____

Comment _____

21. Do you see your present schedule as an inhibiting factor relative to organizational innovation?

Yes _____ No _____

Comment _____

22. Do you see your present schedule as an inhibiting factor relative to curricular innovation?

Yes _____ No _____

Comment _____

23. In your opinion, to what extent could you innovate in your school under the confines of your present schedule?

24. Have you given serious consideration to a method of scheduling different from your present one?

Yes _____ No _____

If yes, please specify _____

25. Have you experimented with alternate forms of scheduling?

Yes _____ No _____

Please describe _____

26. To what extent does your master schedule change from year to year?

27. Flexible scheduling, for purposes of this study, is defined as a form of scheduling that utilizes the concepts of variable group sizes, modular time units, teaching teams, and independent study. Have you been exposed to any of these concepts either through formal course work or through your own investigations?

Yes _____ No _____

If yes, please specify and elaborate on the amount of exposure. _____

28. "The flexibly scheduled school gives teachers a better opportunity to interact with students and each other."

Comment _____

29. "A flexibly scheduled school provides students with a better learning environment and an opportunity to profit more from the learning experiences provided."

Comment _____

30. Many authors claim that the flexibly scheduled school is a step in the "right direction" towards providing students with optimum learning experiences. Please comment _____

31. Do you feel that a flexible schedule would provide opportunities to add new elements to your existing program without increasing the number of teachers and spaces?

Yes _____ No _____

Comment _____

32. Are you interested in the concept of flexible scheduling?

Yes _____ No _____

Comment _____

33. Would you consider implementing flexible scheduling in your school in the near future?

Yes _____ No _____

Comment, indicating the conditions under which you would be willing to implement a flexible schedule _____

34. Are you and your staff studying the concept of flexible scheduling with the intention of adopting such a schedule or various aspects of it?

Yes _____ No _____

Comment _____

35. Do you feel that much of the time teachers spend presenting course material to the students could be utilized by students themselves to obtain this information?

Yes _____ No _____

Please comment on whether students would benefit less, benefit as well, or benefit more from independent study _____

36. Are you in favour of independent study for students?

Yes _____ No _____

Comment _____

37. What percentage of the school day, if any, should a student be given for independent study?

0% _____ 26% - 40% _____
 10% _____ 41% - 60% _____
 10% - 25% _____ 60% _____

38. Would you be willing to grant the students of your school independent study?

Yes _____ No _____

Comment _____

39. Have you considered scheduling your school with the aid of a computer?

Yes _____ No _____

Comment _____

40. If you are in favour of computer scheduling but have not taken advantage of this facility, then what are your reasons for not doing so? _____

41. If you feel that computers should not be utilized to schedule schools, then please indicate why: _____

42. Please include a copy of your present master schedule and, if possible, a copy of the floor plan of your school.

APPENDIX B

SSSS INPUT CODING FORMS

SAMPLE FORMS

A complete set of forms is presented in this section. A school using the SSSS may find it convenient to reproduce these forms and record their data thereon. When the data have been recorded and checked, the keypunch operator should transcribe directly from these forms.

FREEMOD

Course Code	Switch	T/S	Teacher List						R/S	Room List		
			CC	TCH		CC	TCH			CC	Room	
cc 1-3	5	7							49			
			9-11	1		29-31	6			51-53	1	
			13-15	2		33-35	7			55-57	2	
			17-19	3		37-39	8			59-61	3	
			21-23	4		41-43	9			63-65	4	
			25-27	5		45-47	10			67-69	5	
			9-11	1		29-31	6			51-53	1	
			13-15	2		33-35	7			55-57	2	
			17-19	3		37-39	8			59-61	3	
			21-23	4		41-43	9			63-65	4	
			25-27	5		45-47	10			67-69	5	

FREEMOD Sort Data CC

70	71				75	76	77	78	80
*						1	1		

INCA

School Parameters (Deck 1)

	cc	2	3	(20)																22	23					
1. School Name	\$																									\$
2. Date (Leave Blank) (6)	cc	26	(6)																							
3. School Number (Leave Blank) (3)	cc	33	35																							
4. Run Number (Leave Blank) (3)	cc	38	40																							
5. Number of Days in a Cycle (2)	cc	43	44																							
6. Number of Periods in a Day (2)	cc	47	48																							
7. First Lunch Period (2)	cc	51	52																							
8. Last Lunch Period (2)	cc	55	56																							
9. Number of Periods for Lunch (1)	cc	59																								
10. The Constant number of Student Request Cards (1)	cc	62																								
11. The Constant number of Student Course Requests (2)	cc	65	66																							

INCA Deck 1 Sort Data (10)

70	71					75	76	77	78		80
*						0	1	1			

INCA

Course Enrollment Transfers (Deck 2)

From: School Course I.D. Number			To: School Course I.D. Number			Total Number of Students to be Transferred*		
cc 2-4			cc 7-9		cc 12-15			
19-21			24-26		29-32			
36-38			41-43		46-49			
53-55			58-60		63-66			
2-4			7-9		12-15			
19-21			24-26		29-32			
36-38			41-43		46-49			
53-55			58-60		63-66			

CARD 1

CARD 2

* If all students are to be transferred write 9999 in this column.

INCA Deck 2 Sort Data (10)

cc 70	71			75	76	77	78	80
*	0			0	1	2		

INCA

Combinations (Deck 3)

FROM: Sub Course (Course I.D. Number)			TO: Master Course (Course Phase Number)		
CC	2-4		CC	7-11	
	15-17			20-24	
	28-30			33-37	
	41-43			46-50	
	54-56			59-63	
	2-4			7-11	
	15-17			20-24	
	28-30			33-37	
	41-43			46-50	
	54-56			59-63	

CARD 1

CARD 2

INCA Deck 3 Sort Data

70	71			75	76	77	78	80
*				0	1	3		

INCA

Teacher List Data (Deck 4)

Teacher Code Number				Teacher Name Last Name First		
cc	2	4	7	8	19	20
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$
			\$			\$

INCA Deck 4 Sort Data

cc	70	71		75	76	77	78	80
	*				1	4		

Teacher Code No.

INCA

Room List Data (Deck 5)

Room Code Number	Room Name
3 5 8 9 12 13	
\$	\$
\$	\$
\$	\$
\$	\$
\$	\$
\$	\$
\$	\$
\$	\$

INCA Deck 5 Sort Data

cc

70	71	75	76	77	78	80
*			1	5		

Room Code No.

INCA

Course Data Packet (Deck 6)

Course Phase Basic Data													
cc	2	3	4-6	8	9-18	19	21	23-24	26-27	29	31	33-34	36-38
No. PHS.	PHS. I.D.	Course Code		Course Name		PPM	MPC	NT	T/S	No. Rooms	No. Sections	Max.	
5 Digit Code				Course Name	Structure	Teachers		Rooms	Sections	Section Size Max.			
Course Phase Special Features													
40	42-43	45-46	48-49	51-60	62	64	66	68-69					
Non Unif.	TP Spec.	ESP	LFP	DPS	ESS	TV	DI	Rm. Class					
Time Pattern Spec.				Day Pattern Spec.	Exclu. Stu. Section	Teacher Var.	Day Ind.	Room Type Class If'n.					
Course Phase Teacher Data													
cc	2-4	6-7	9-11	13-14	16-18	20-21	23-25	27-28	30-32	34-35	37-39	41-42	
Teacher I.D.	No. Sect.	Teacher I.D.	No. Sect.	Teacher I.C.	No. Sect.	Teacher I.D.	No. Sect.	Teacher I.D.	No. Sect.	Teacher I.D.	No. Sect.	Teacher I.D.	
Teacher 1/7		Teacher 2/8		Teacher 3/9		Teacher 4/10		Teacher 5/11		Teacher 6/12			
Course Phase Room Data													
cc	3	5-7	12-14	19-21	26-28	33-35	40-42	47-49					
R/S	Room ID	Room ID	Room ID	Room ID	Room ID	Room ID	Room ID	Room ID					
	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7						

INCA Sort Data

70	71					75	76	77	78		80
*							1	6			

INCA

Student Course Request Form (Deck 7)

cc	2	3	Student Number and Name (Last Name First) (24)	26	27	Card One
	\$				\$	

Sequence Priority Number	Card 2 Course Requests	Card 3 1st Alternate	Card Columns
1			2-4
2			6-8
3			10-12
4			14-16
5			18-20
6			22-24
7			26-28
8			30-32
9			34-36
10			38-40
11			42-44
12			46-48

INCA Deck 7 Sort Data

cc	70	71			75	76	77	78	80
	*						7		

I N C A

Restriction / Specification Form

(Sequence 9)

cc
 Day in Cycle * ☐ ☐ 2
 Starting Period ☐ ☐ 3, 4
 Finishing Period ☐ ☐ 5, 6

*Indicate Day in Cycle by its
 alphabetic value:

A. 5 Day or Less Cycle: Monday - M
 Tuesday - T
 Wednesday - W
 Thursday - H
 Friday - F

Day in Cycle ☐ ☐ 8
 Starting Period ☐ ☐ 9, 10
 Finishing Period ☐ ☐ 11, 12

B. 6 Day or More Cycle: Day 1 - A
 Day 2 - B

Day in Cycle ☐ ☐ 14
 Starting Period ☐ ☐ 15, 16
 Finishing Period ☐ ☐ 17, 18

Day 10 - J

** If more than one card is needed to
 complete the restriction/specification,
 fill in the continuation field with an *.

Sequence 9 Sort data:

One of the following appears in cc77

Restriction Resource

All School - Deck 1
 Teacher - Deck 4
 Room - Deck 5
 Student - Deck 7

Specification Resource

Course-Phase - Deck 6

Day in Cycle ☐ ☐ 56
 Starting Period ☐ ☐ 57, 58
 Finishing Period ☐ ☐ 59, 60

Day in Cycle ☐ ☐ 62
 Starting Period ☐ ☐ 63, 64
 Finishing Period ☐ ☐ 65, 66

Continuation** ☐ 69

cc	70	71			75	76	77	78	80
	*					9			

R A P

Room Assignment Program

Room Data (Deck 1)

Room Sequence Code	Max. Room Capacity	Room Type Code	Room Sequence Code
4 6	12 14	20 21	73 75

Room Sequence Code	Max. Room Capacity	Room Type Code	Room Sequence Code
4 6	12 14	20 21	73 75

RAP Deck-1 Data

cc	70	71	72	76	77	78	80
	*	0	0	1	1		

R A P

Room Assignment Program Teacher Data (Deck 2)

cc 2 4 6 8									
Teacher Sequence Code	Teacher Assign. Priority	Room Type Code		Priority 1		Priority 2		Priority 3	
		cc		cc		cc		cc	
		11-12		14-16		18-20		22-24	
		26-27		29-31		33-35		37-39	
		41-42		44-46		48-50		52-54	
		56-57		59-61		63-65		67-69	
		11-12		14-16		18-20		22-24	
		26-27		29-31		33-35		37-39	
		41-42		44-46		48-50		52-54	
		56-57		59-61		63-65		67-69	

RAP Deck 2 Sort Data

cc	70	71	75	76	77	78	80
*					2		

Note: cc 76 is card continuation
column for each teacher

R A P

Room Assignment Program

Section Data (Deck 3)

From Section	To Section	Room Type Code	Section Number
3 6	11 14	20 21	72 75

From Section	To Section	Room Type Code	Section Number
3 6	11 14	20 21	72 75

RAP Deck 3 Data

cc 70 71 76 77 78 80

*	0	1	3	
---	---	---	---	--

R A T S

Individual Resource Data (RAT 1, RAT 2, and RAT 3 Decks)

Sequence Code	Sequence Code	*
7 10	72 75	77

Sequence Code	Sequence Code	*
7 10	72 75	77

RATS Data cc 70 71 76 78 80

*	0	3	
---	---	---	--

* RAT Deck *Code
1. Student
2. Teacher
3. Room

S A P 2

Section Data

Section No.

cc 7	10

Section No.

cc 7	10

Section No.

cc 7	10

Section No.

cc 7	10

SAP 2 Deck 1 Sort Data

cc	70	71				75	76	77	78		80
*							2	1			

TRANLINE / TRANBLOK

Selective Class List Data

(TRANID Deck)

Inclusive Section Numbers

From Section To Section

cc 7 10 17 20

Inclusive Section Numbers

From Section To Section

cc 7 10 17 20

Inclusive Section Numbers

From Section To Section

7 10 17 20

	8
	7

TRANID Deck Sort Data

cc	70	71			75	76	77	78		80
	*					5	1			

UDAMC

Key Changes (Deck 4-7)

CC 2	5 10	13 14	21 22	33	77
Resource Sequence	Room Limit →	Teacher and Course Limit →	Student Limit →		*

UDAMC Deck 4-7 Sort Data cc

70	71	75	76	77	78	80
*			1			

cc 77: Deck Values

- 4. Teacher
- 5. Room
- 6. Course
- 7. Student

UDAMC

Section Changes (Deck 8)

cc	2	5	8	10	12	17	19	20	22	23	25	26	28	29	31	32	34	35	37	38	40	41	43	44	46	47
Section Number	Type*			Time Pattern Change																						
	A	B	C	P	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10												

UDAMC Deck 8 Sort Data

cc

70	71				75	76	77	78	80
*						1	8		

Time Pattern Change; specify PPM and new starting periods.

- * Type of Change P = PPM
 A. Deschedule Section
 B. Delete Teachers
 C. Delete Rooms

UDAMC

Section Changes (Deck 9)

cc	2	5	8	10	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47
	Section Number	SSMAX Change			Teacher Assignments																	
			T1	T2	T3	T4	T5	T6	T7	T8	T9											

50		52	54	56	58	60	62	64	66	68
Room Assignments										
R1	R2	R3	R4	R5						

UDAMC Deck 9 Sort Data:

cc

70	71					75	76	77	78	80
*								1	9	

UDCREQ

Drop / Change - Status Data
(UDCRD5 Deck)

cc	7	10	20	72	75
	Student Sequence Code			Student Sequence Code	

7	10	20	72	75
Student Sequence Code			Student Sequence Code	

UDCRD5 Deck Sort Data

cc	70	76	77	78	80
	*	2	5		

Drop/Change Status Code

1. Drop
2. Change to Status 3
3. Change to Status -1

BIBLIOGRAPHY

Books

Anderson, L.W. and L.A. Van Dyke. Secondary School Administration. Boston: Houghton Mifflin Company, 1963.

Anderson, V.E. and W.T. Gruhn. Principles and Practices of Secondary Education. New York: The Ronald Press, 1962.

Austin, D.B. and N. Gividen. The High School Principal and Staff Develop the Master Schedule. New York: Bureau of publication, Teachers College, Columbia University, 1960.

Bush, R.N. and D.W. Allen. A New Design for High School Education. San Francisco: McGraw Hill Book Company, 1964.

Bushnell, D. and D.W. Allen. The Computer in American Education. New York: John Wiley and Sons, Inc., 1967.

Faunce, R.C. Secondary School Administration. New York: Harper and Brothers, 1955.

Goodlad, J.I., J.F. O'Toole, and L.L. Tyler. Computers and Information Systems in Education. New York: Harcourt, Brace, and World, Inc., 1966.

Janes, J.J., C.J. Salisbury, and R.L. Spencer. Secondary School Administration. New York: McGraw-Hill Book Company, 1969.

Jesser, D.L. and R.C. Stutz (ed.). Scheduling for Flexibility in Small Schools. Salt Lake City: Western States Small Schools Project, 1966.

Koos, L.V. Administering the Secondary School. New York: American Book Company, 1940.

Manlove, Donald C. and David W. Beggs. Flexible Scheduling. Bloomington: Indiana University Press, 1965.

Newsome, N.W. and R.E. Langfitt. Administrative Practices in Large High Schools. New York: American Book Company, 1940.

Trump, J. Lloyd and Dorsey Baynham. Focus on Change: Guide to Better Schools. Chicago: Rand McNally and Company, 1961.

Wey, H.E. Handbook for Principals. New York: Schaum Publishing Company, 1966.

Articles and Periodicals

Allen, D.W. "Elements of Scheduling a Flexible Curriculum," The Journal of Secondary Education, Vol. 38, November, 1963, pp. 84-91.

----- "First Steps in Developing a More Flexible Schedule." National Association of Secondary School Principals Bulletin, Vol. 46, May, 1962, pp. 34-36.

Allen, D.W. and D. Delay. "Flexible Scheduling: A Reality," Stanford, California: School of Education, Stanford University.

Allen, D.W. and R. Oakford. "Flexible Class Scheduling by Computer," School and Society, Vol. 92, Summer, 1964, p. 220.

Anderson, Ernest G. "Data Processing: Time Lag for Ideas; 30 Years," Nation's Schools, Vol. 78, December, 1966, p. 50.

Anderson, G.E. "How Computers Assign Students," Nation's Schools, Vol. 75, February, 1965, p. 70.

----- "New Computer Programs Help Flexible Schedules," Nation's Schools, Vol. 81, June, 1968, p. 67.

Anderson, R.H. "Organizational Character of Education: Staff Utilization and Deployment," Review of Educational Research, Vol. 34, October, 1964, pp. 459-464.

Bishop, L.K. "Independent Study," Clearing House, Vol. 42, September, 1967, pp. 9-14.

Bush, R.N. et al. "Using Machines to Make the High School Schedule," School Review, Vol. 64, Spring, 1961, pp. 48-59.

Bush, R.N. and D.W. Allen. "Flexible Scheduling," National Association of Secondary School Principals Bulletin, Vol. 47, May, 1963, pp. 73-98.

Cawelti, Gordon. "Innovation Practices in High Schools: Who Does What - and Why - and How," Nation's Schools, Vol. 79, April, 1967, pp. 56-88.

Cohler, M.J. "Curriculum: Its Basis in the High School Schedule," American High School Journal, Vol. 144, April, 1962, pp. 13-14.

Davis, Harold S. and Joseph E. Bechard. "Flexible Scheduling," Cleveland, Ohio: Educational Research Council of America, 1968.

Devilbiss, W. "Criteria of a Good Master Schedule," National Association of Secondary School Principals Bulletin, Vol. 31, November, 1947, pp. 31-38.

Fast, J.J. "Advantages of Student Scheduling by Computer," National Association of Secondary School Principals Bulletin, Vol. 53, January, 1969, p. 30.

"Five Flexible Schedules That Work," Nation's Schools, Vol. 82, August, 1968, pp. 28-31.

Grossman, A. "Data Processing: An Answer to the Shackles of Paperwork and Decision Making," National Association of Secondary School Principals Bulletin, Vol. 46, April, 1962, pp. 17-18.

Leigh, T.G. "Big Opportunities in Small Schools Through Flexible-Modular Scheduling," Journal of Secondary Education, Vol. 42, April, 1967, pp. 175-187.

Manley, C.B. and C.C. Holt. "What is the Case For and Against Machine Techniques for School Scheduling," National Association of Secondary School Principals Bulletin, Vol. 63, April, 1959, pp. 195-198.

Morland, S.P. "Redistribution of Time Allotted to Academic Subjects in Secondary Schools: An Experiment in Increasing Hours of Classroom Work in Certain Subjects and Decreasing the Hours in Certain Other Subjects, With the Objective of Gaining an Increased Net Measurable Achievement by the Pupil," Dissertation Abstracts, Vol. 16, February, 1955, p. 274.

Murphy, Judith. School Scheduling by Computer: The Story of GASP. New York: Educational Facilities Laboratories, Inc., 1964.

Murphy, R.M. "Data Processing System for the Small High School," National Association of Secondary School Principals Bulletin, Vol. 46, April, 1962, pp. 19-21.

"National Association of Secondary School Principals Set for 5-Year Innovations," Education News, Vol. 2, May, 1968, p. 7.

Oakford, Robert V. The Stanford School Scheduling System. Stanford, California: School of Education and Department of Industrial Engineering, Stanford University, 1968.

Palmer, L.R. "The Module - A New Mode for Gaining Flexibility," Minnesota Foreign Language Bulletin, Vol. 7, January, 1967, p. 2.

Puckett, R.C. "An Aid in Schedule Making," American School Board Journal, Vol. 91, August, 1935, p. 30.

Ricksecker, C.W. "Check List of Steps Used in Scheduling a Modern High School," American School Board Journal, Vol. 83, September, 1931, p. 61.

Ruffing, A. "Proper Use of Teacher Time," School and Society, Vol. 47, February, 1959, p. 76.

Sleight, R.H. "Administrative Problems as a Result of Flexible Scheduling and Team Teaching," Journal of Secondary Education, Vol. 42, December, 1967, pp. 358-362.

Templeton, F.L. "The Use of IBM Techniques in Program Making and Class Scheduling," National Association of Secondary School Principals Bulletin, Vol. 34, October, 1962, pp. 15-22.

Trump, J. Lloyd. "Flexible Scheduling; Fad or Fundamental," Phi Delta Kappan, Vol. 44, May, 1963, p. 370.

-----, "Developing and Evaluating a Class Schedule to Help Each Pupil Learn Better," Journal of Secondary Education, Vol. 36, October, 1961, pp. 338-345.

----- "Images of the Future," National Association of Secondary School Principals Bulletin, Vol. 25, October, 1959, p. 11.

Unpublished Material

Adamo, E.A. "A Study of Scheduling for Team-Teaching and Television in Selected Secondary Schools." Unpublished Doctoral dissertation, Columbia University, 1964.

Ball, D.D. "A Traditional School's Approach to Implementing Modular-Flexible Scheduling." Unpublished Master's thesis, California State College, 1969.

Beacom, J.F. "A Survey of Administrative Problems of Flexible Scheduling." Unpublished Master's thesis, California State College, 1969.

Beggs, D.W. "A Study of the Implementation Strategy Employed by Selected Schools Using a Flexible Class Schedule." Unpublished Doctoral dissertation, Indiana University, 1965.

Boyles, N.L. "Theoretical Rules for the Construction of a Secondary School Master Schedule Utilizing an Electronic Computer." Unpublished Doctoral dissertation, University of Tennessee, 1963.

Brandt, A. "Two Types of Flexible Scheduling." Unpublished Master's thesis, California State College, 1966.

Brummitt, B.R. "The Impact of Machine Data Processing Systems on the Central Schools of New York State." Unpublished Doctoral dissertation, Syracuse University, 1965.

Courm, A.L. "A Study of Scheduling and Staffing Practices in the Public Schools of Dade County, Florida." Unpublished Doctoral dissertation, University of Miami, 1968.

Dombrow, R.T. "A Study of Manual and Machine Techniques for Processing Clerical Data in a Secondary School of 1,000 Students." Unpublished Doctoral dissertation, Temple University, 1960.

Duncan, J.R. "A Study of Teachers' Expectations of Flexible Scheduling in Three Selected Secondary Schools." Unpublished Doctoral dissertation, Indiana University, 1967.

Egge, D.E. "Secondary School Program Scheduling Factors and Their Influence on Schedule Flexibility." Unpublished Doctoral dissertation, Washington State University, 1967.

Evans, R.L. "The Creation of A Flexible Schedule." Unpublished Master's thesis, California State College, 1966.

Fawcett, R.H. "A Comparative Study of Electronic Data Processing Schedule Making and Other Current High School Schedule-Making Practices in Connecticut." Unpublished Doctoral dissertation, University of Connecticut, 1970.

Fleming, J.O. "Flexible Scheduling in the Junior and Senior High Schools." Unpublished Master's thesis, Pepperdine College, 1968.

Fugate, J.P. "An Analysis of the Implementation Year of a Junior High School Modular Schedule as it Relates to Teachers, Students, Parents, Achievement, and Grades." Unpublished Doctoral dissertation, University of Idaho, 1970.

Guiliano, F.J. "Implementation of Certain Flexible Scheduling Concepts with the Aid of Computer Programs in Selected Secondary Schools." Unpublished Doctoral dissertation, Boston University School of Education, 1970.

Gividen, N.J. "Improving the Design and Implementation of Small High School Master Schedules with Emphasis on Flexibility." Unpublished Doctoral dissertation, Columbia University, 1959.

Heath, J.C. "An Investigation of the Economic Feasibility of Scheduling Certain Small High Schools by Means of Electronic Computers." Unpublished Master's thesis, Southwest Texas State College, 1966.

Howell, S.D. "A Study of Scheduling Practices, Procedures, and Related Influential Factors in Selected Publish High Schools of Pennsylvania. Unpublished Doctoral dissertation, Temple University, 1970.

Jacobson, M.E.L. "A Study of Scheduling Practices in High Schools Which Employ and Do Not Employ Data Processing." Unpublished Doctoral dissertation, University of Michigan, 1966.

- Keefe, W.A. "A Review of Recent Literature Concerning Flexible Scheduling and Team Teaching." Unpublished Master's thesis, Redlands University, 1966.
- Kilgore, J.R. "An Investigation of the Practicality of the Flexible Schedule in Secondary Schools." Unpublished Master's thesis, Chapman College, 1968.
- LaPray, J.J. "Flexible Scheduling in the Junior High School." Unpublished Master's thesis, Utah State University, 1968.
- Lawson, I.R. "Flexible Scheduling in Secondary Schools." Unpublished Master's thesis, East Tennessee State University, 1968.
- McClure, Charles T. "A Study of Problems and Solution Strategies Following Implementation of Flexible Class Schedules in Secondary Schools." Unpublished Doctoral dissertation, Indiana University, 1970.
- Onweller, M.J. "An Appraisal of Flexible Scheduling as a New Design for High School Education." Unpublished Master's thesis, University of Toledo, 1967.
- Parent, G.A. "Specific Theories of Scheduling for the Secondary Schools of Ontario." Unpublished Master's thesis, Niagara University, 1968.
- Parker, J.J. "A Study of Master Schedules in Secondary Schools." Unpublished Doctoral dissertation, Columbia University, 1971.
- Prance, H.T. "The Application of Automation to the Scheduling of High School Students into Class." Unpublished Doctoral dissertation, University of Miami, 1964.
- Puckett, R.C. "The Difficulties of Making a High School Schedule of Recitations." Unpublished Doctoral dissertation, University of Iowa, 1933.
- Rogers, H.K. "An Investigation of Concepts in Automated Scheduling for the Secondary School." Unpublished Master's thesis, East Tennessee State University, 1967.
- Schramm, G.E. "Modular Scheduling: Implementation into a Small School." Unpublished Master's thesis, Mankato State College, 1969.

Stegall, J.W. "Descriptive Analysis of Class Scheduling Procedures in Selected Secondary Schools in Texas." Unpublished Doctoral dissertation, Texas A & M University, 1970.

Thayer, G.E. "The Use of Unusual Time Modules for Scheduling Secondary School Students." Unpublished Doctoral dissertation, University of Southern California, 1966.

Vogt, R.L. "A Computerized Modular Schedule Model for the Florida State University School." Unpublished Doctoral dissertation, Florida State University, 1967.

Wax, I. "A Study of the Hand Mosaic and GASP Methods of Master Scheduling to Determine the more Desirable for Use at an Innovation Junior High School." Unpublished Doctoral dissertation, University of Miami, 1968.

Wright, R.D. "Computer Scheduling in Selected Secondary Schools in New Jersey." Unpublished Doctoral dissertation, Rutgers - The State University, 1965.

