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ANALYSIS OF SELECTED FACTORS RELATIVE TO AUTOMATED SCHOOL SCHEDULING PROCESSES.

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PROJECT PASS (PROJECT IN AUTOMATED SCHOOL SCHEDULING) WAS SPONSORED IN 1965 BY THE WESTERN NEW YORK SCHOOL STUDY COUNCIL TO PROVIDE IN-SERVICE EDUCATION FOR SCHOOL PERSONNEL CONTEMPLATING THE USE OF AUTOMATED APPROACHES TO SCHOOL SCHEDULING. TWO TECHNIQUES WERE UTILIZED--CLASS LOADING AND STUDENT SELECTION (CLASS), AND GENERAL ACADEMIC SIMULATION PROGRAM (GASP). TWO PILOT SCHOOLS FROM NEW YORK, EACH USING BOTH TECHNIQUES, WERE SCHEDULED WITH BOTH PROCESSES. THE PROJECT YIELDED TWO SETS OF DATA TO PROVIDE PARTIAL ANSWERS TO THE FOLLOWING PROBLEMS--(1) THE COSTS INVOLVED IN SCHEDULING BY GASP AND CLASS IN EACH SCHOOL, (2) THE PERSONNEL COMMITMENT REQUIRED FOR THE TWO TECHNIQUES IN EACH SCHOOL, (3) THE SPECIAL COMPETENCIES REQUIRED OF PERSONNEL TO COLLECT AND PREPARE DATA FOR USE IN THE TWO TECHNIQUES, (4) THE ALTERATIONS IN THE SCHEDULING PROCEDURE NECESSARY WHEN CHANGING FROM CLASS TO GASP, AND (5) THE RELATIVE EFFICIENCY OF THE GASP-GENERATED MASTER SCHEDULE WHEN COMPARED TO THE CONVENTIONAL HAND-DEVELOPED SCHEDULE. THE ANALYSIS OF THE DATA SHOWED THAT CLASS AND GASP COULD NOT BE COMPARED IN TERMS OF THEIR ULTIMATE OBJECTIVES BECAUSE CLASS IS A "SECTIONING" TECHNIQUE, WHILE GASP DEVELOPS A MASTER SCHEDULE. THE PRINCIPAL CONCLUSIONS OF THE ANALYSIS ARE OFFERED AS AN AID TO THOSE SCHOOLS CONTEMPLATING AN IN-SERVICE PROGRAM IN AUTOMATED SCHEDULING. (HW)

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Contents

Tables

I. Introduction

The Problem.

The schedule of the modern secondary school is becoming more and more complex as subjects, time patterns and provisions for class and staff organization become increasingly varied. In medium sized and large secondary schools it is virtually impossible to cope with the many alternative time patterns required by modern instructional techniques, while at the same time attempting to offer the variety of subjects demanded to prepare adequately our youth. For approximately ten years school administrators in some secondary schools have utilized a variety of sectioning techniques involving the use of computers. The computer-based Class Loading and Student Scheduling (CLASS) program has facilitated the assignment of pupils to classes. However, the advent of the recently developed General Academic Simulation Program (GASP) will go a step beyond the CLASS technique and actually create a master schedule for a secondary school that will permit the utilization of more recent organizational innovations as well as the scheduling of additional courses.

The experience in scheduling a limited number of schools using the GASP program indicates that the cost of scheduling by this method may vary from three to ten dollars per pupil.[1] This is many times greater than the cost of scheduling by CLASS. No attempt had been made to analyze a single school's application when utilizing both CLASS and GASP in order to have a comparison of not only the cost involved, but other facets such as types of personnel and time involved, utilization of personnel, preparation of soft ware, and the relative efficiency of developing the actual schedule via machine. Due to the dearth of comparative material, school administrators are hesitant to make use of the more costly GASP approach. If we hope to facilitate the utilization of innovations which require flexible scheduling, such information must be made available to school administrators.

Related Literature.

During the past decade, educators have created many curriculum and organizational innovations in an attempt to improve the educational offerings afforded students. Attempts to program block

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[1]Murphy, Judith and Sutter, Robert, School Scheduling by Computer, The Story of GASP. New York: Educational Facilities Laboratories, Inc., 1964, p. 6.

or core courses, the use of team teaching techniques, coupled with the tremendous increases in school enrollment have made the scheduling task an extremely difficult one. According to Murphy and Sutter, in The Story of GASP,

> If schedule 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 nongraded 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 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.[2]

Williams points out that scheduling to meet tomorrow's needs "calls for variation in the time allotted to classes, coordination of effort by teaching teams, the provision of more time for each student by the teacher, the combination of certain subject areas in a core or a block of time, and the placement of the appropriate students into track plans that are suitable to the gifted, college preparatory, vocational or slow-learning."[3] James Whitlock would add that "the nature of the schedule with which a school begins the school year affects the attitude of staff members and thus, may have impact upon the organization's operation for the year."[4]

Turning to the computer for aid in the solution of scheduling problems offers hope to the administrator who wants to keep pace with change and innovation. G. Ernest Anderson points to the computer as an excellent planning aid, since it has the unmatched ability to simulate the plans of man, thereby measuring the degree

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[2]Murphy, Judith, and Sutter, Robert, op. cit., p. 6.

[3]Williams, Stanley W., Educational Administration in Secondary Schools. New York: Holt, Rinehart, and Winston, 1964, p. 22.

[4]Whitlock, James W., Automatic Data Processing in Education. New York: MacMillan Company, 1964, p. 48.

of success of the proposed changes in a scheduling program.[5] Such ability allows the school administrator to plan a master schedule and apply it to the pre-determined student demand pattern. It is also recognized that automated school scheduling will be an asset only to the extent that it can do a better job than manual methods, and most of the present automated programs do offer considerable improvements. Large schools have had fewer complaints about unbalanced classes, or an abnormal number of problem students in a given class when scheduling with computer-based programs. This results from the computer's ability to take care of the mechanical details, allowing the administrator to give his full professional attention to individual problems.[6] Manual methods make it difficult to adjust master course requests or to experiment with the newer types of school schedules. With automated scheduling techniques, the administrator realizes greater accuracy in his output, fewer scheduling conflicts, a reduction in counselor clerical, and administrative paperwork, and a better end-product with reference to class size and equality of teacher load.[7]

As more schools turn to automated scheduling techniques, they find the computer to be more than a versatile clerk since it functions most importantly as a planning tool in the vital process of scheduling. It is essential, however, that the user of any computer-based program be aware of the machine's limitation--that it can do nothing that a man cannot do.[8] It simply does it faster with less possibility of error. Edgar Smith points out that no mathematical formula, or algorithm presently exists that provides an optimum solution to master schedule construction. In the absence of such a formula, some programs written for computers begin with a "probabilistic" approach which represents a reasonable spread of the load of classes throughout the day.[9] The computer then tests

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[5]Anderson, G. Ernest, "School Scheduling by Computer" in Harwith, Edith and Gille, Frank, Automated Education Handbook, Detroit: Automated Education Center, 1965, pp. va 39-52.

[6]Ibid.

[7]Gould, Mary Frances, "Data Collection: A Challenge in Student Scheduling," Journal of Educational Data Processing, Vol. 1, No. 2 (May, 1964), p. 42.

[8]Smith, Edgar T., "The Computer in Student Scheduling (IBM "CLASS")," Journal of Educational Data Processing, Vol. 1, No. 2 (May, 1964), pp. 53-60.

[9]Anderson, loc. cit.

this plan against the student demand pattern embodied in the student requests. Such "hueristic" approaches will continue until mathematical advances such as linear programming and simulation are more fully developed.[10]

The computer-developed schedule will be useful to the extent that it allows students and teachers to work more effectively than they could without it. It must therefore embrace the school's philosophy as it pertains to curricular offerings, school-time patterns, large group-small group instruction, heterogeneous vs. homogeneous groupings or any other curriculum desire. Another possible problem area involves the actual construction of the master schedule, and the assignment of the students to this schedule. In the process, classes must be balanced according to predetermined limits, student groupings considered, and final student schedules produced. It is here that data processing techniques are extremely effective and efficient. The decision-making ability of the computer, coupled with its speed makes it ideal for solving a host of problems. Gould cautions that the scheduler will need absolute autonomy in making decisions with respect to student course selection, and the placement and assignment of teachers to sections and working areas.[11] Such authority is a prerequisite for the scheduler who favors experimentation and thus needs the freedom to try out new alternatives.

Presently, most programs are supplied through service bureaus using the manufacturers equipment. Some of these include such well known programs as the IBM pioneered CLASS technique, the General Electric Company's scheduling package for their 200 series computer, SOCRATES (Scheduling of Classes Realized Through Effortless Systemization), the Stanford Flexible Scheduling Program and GASP.

The CLASS program has been in use for over seven years and is one of the original automated techniques for assigning students to classes. Other "sectioning", or class assignment programs have been developed since CLASS differing primarily in the extent of information they provide and in their utilization of the smaller size computers. The SOCRATES program developed for the Richmond, California School System was written specifically for the IBM 1401 System.[12] It initially schedules students into courses that can

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[10]Faulkner, Martin, "Computer Sectioning and Class Scheduling," Datamation (June, 1965), pp. 35-37.

[11]Gould, loc. cit.

[12]Wilkes, Charles F., "SOCRATES: A System for Student Scheduling," Journal of Educational Data Processing, Vol. 1, No. 2 (May, 1964), pp. 46-52.

be taken at only one time during the day. By beginning with one-choice courses and passing over those offering two choices during the day, it establishes a priority in student requests. SOCRATES' other features include, 1) a provision for an alternate course offering if the preferred course is impossible to schedule, and 2) identification symbols to indicate anticipated student ability in a preferred course which facilitates ability grouping in classes.[13] Many of the previously mentioned programs offer their own distinctive services. The relatively new program of the IBM Student Scheduling System/360 provides a tremendously expanded output to aid the administrator utilizing the smaller size computer.[14]

Whereas, the majority of automated programs assign pupils to predetermined master schedules, a new emphasis is being placed on techniques which complete the entire process of assigning times, rooms, teachers, and students to classes as required by the school's curriculum. The Flexible Scheduling Project at Stanford University and the GASP program focus on the entire construction of the schedule with a full awareness of the changes necessitated by the newer educational patterns. At the present time these "hueristic" approaches at master schedule building are of great interest, since they produce schedules which achieve optimum efficiency. Robert Holz, a co-developer of the GASP technique, points out that it simply divides the scheduling process into two segments.[15] Initially, a timetable is constructed in which times, classrooms and teachers are assigned to each class. Then the students are assigned to classes in the timetable. GASP attempts to simulate or mimic the clerical aspects of the typical, idealized manual scheduling procedure. Holz would add that it might be intellectually more desirable to develop algorithms based on sound mathematical models which produce exact or optimal solutions to a particular problem rather than simulate procedures that are far from ideal. However, in the absence of such an ideal formula, the pragmatic approach was deemed the most feasible and appropriate.[17] While simulation programs like GASP are admittedly weak in many of the same ways as manual procedures, they do have some important advantages. These

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[13] Ibid.

[14] Data Processing Center, Student Scheduling Handbook. Board of Cooperative Educational Services, No. 1, Erie County, New York, 1966, p. 2.

[15] Holz, Robert E., "Computer-Assisted Scheduling," Journal of Educational Data Processing, Vol. 1, No. 2 (May, 1964), pp. 36-40.

[16] Holz, loc. cit.

[17] Ibid.

would include:

a) the accuracy and speed gained through the utilization of the large computer;

b) the opportunities inherent in the program for testing a variety of alternatives;

c) a greater amount of trial and error which offers the best practical possibility, if not the assurance, of a better solution;

d) the computer's ability to take over most of the clerical drudgery associated with the scheduling process;

e) the ability to test for the feasibility of proposed innovations in policy and practice.[18]

Because of the nature of the GASP program and the problem to which it is addressed, the philosophy of the user must be different from that usually associated with data processing applications. Typical computer use calls for certain information to be converted into checks, ledgers, information lists or some other output predetermined by the given program. GASP, however, requires a different kind of interaction between the person or persons responsible for building the schedule and the computer. The actual construction of the schedule calls for several runs with a certain amount of analysis and evaluation between each run. In most computer applications, complete instructions covering the contingencies can be stated, but in simulating a complex process such as scheduling, the inclusion of instructions covering all the alternatives is presently impossible.[19] Thus a rather intimate man-computer relationship is visualized, where the man is the decision-maker and the computer a fast-working and efficient aid. The scheduler is in a position to ask many questions of a "what-would-happen-if" nature with answers that provide more reliable information about his total scheduling problem.

In 1963-64 a significant study was made of three schools that operated with GASP schedules. Two of these schools were "Trump" schools -- which are schools embodying the innovations of team teaching, and flexible groupings of various sizes for instruction. The third school was a traditional school. The following results ensued:

1. a schedule of great complexity, can be built by computer at less over-all costs than if it were done by hand by an administrator.

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[18] Ibid.

[19] Ibid.

2. the computer-built schedule has fewer conflicts than does the hand-made schedule.
3. class lists, room utilization lists, teacher schedules and student schedules are extremely accurate.
4. the computer in generating the master schedule, is able to construct a large number of preliminary schedules. ...[20]

The use of high speed computers with the sectioning programs has done much to relieve the scheduling drudgery previously experienced by counselors and administrators. However, such programs are incapable of coping with the newer innovations in secondary schools because it fails to provide assistance in the creation of the master schedules. The GASP program offers the promise of overcoming this difficulty.

Objectives.

A. To conduct a detailed analysis of the costs involved in scheduling two schools each utilizing two computer-based scheduling techniques.

B. To conduct an analysis of the two scheduling techniques utilized by the schools which will include items such as cost, procedures, type of personnel required, personnel-time involved, and relative effectiveness of the master schedules created.

In addition, answers to the following questions were sought:

. What are the costs involved in scheduling by GASP and by CLASS in each school?

. What personnel commitment (kinds and time) are required in each school to schedule with the GASP and the CLASS programs?

. What special competencies are required of personnel to collect and prepare data for use in the CLASS program and for use in the GASP program?

. What alterations in the scheduling procedure must be implemented when changing from the CLASS to the GASP program?

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[20] Murphy and Sutter, op. cit., p. 11.

- What is the relative efficiency of the GASP-generated master schedule when compared to the conventional hand-developed master schedule?

The answers to the preceding questions would provide the basis for guidelines to assist school administrators in making the decision as to which scheduling procedure is better suited to their individual systems.

II. Method

General Design.

The proposal was for the analysis of the data secured in the scheduling of two high schools utilizing the CLASS and GASP techniques during the spring and summer of 1965 known as the Project in Automated School Scheduling (PASS). The project was established to provide a structure within which it would be possible to experiment with computer-based scheduling techniques. The basic purposes of the total project were two-fold:

1. to develop a cooperative organization that would facilitate the in-service education of school personnel contemplating the use of the newer approaches related to automated school scheduling, and
2. to secure data concerning the scheduling process from which it would be possible to ascertain pertinent information necessary for school officials to make decisions relative to possible use of automated scheduling techniques in their schools.

Another important aspect of the total project involved representatives of four additional school districts. These participant-observers sat in on all sessions directly involving the two schools being scheduled in order to become familiar with the various techniques used in the scheduling processes. Each representative had extensive experience in the field of conventional school scheduling and, thus, was able to serve as a local consultant during the evaluation phase of the project.

The analysis of the costs involved in scheduling the schools via two computer-based scheduling techniques was achieved by making a careful appraisal of the expenditures related to the use of each technique. Logs were maintained for each school scheduled from which expenditures related to all aspects of the scheduling process could be identified. The data provided in the logs were classified and then evaluated by members of the project staff, selected representatives of the school districts involved in the project and the

project consultants from the firm of Hewes, Holz, and Willard, Inc., Winchester, Massachusetts.

In addition to cost data, the logs were a source of data relative to the types of personnel necessary in scheduling via computer-based techniques. Also, the amounts of time required of various personnel to complete the many operations were available for analysis.

The determination of any special competencies required of school personnel in order for them to collect and prepare effectively the data necessary for computer use involved all members of the project team--consultants, participant-observers, and staff. They assisted in the analysis of any special skills and/or items of knowledge necessarily developed by personnel of the two schools directly involved in the scheduling process. It was hoped that the guidelines developed could be employed by officials of school districts contemplating the use of computer-based scheduling techniques in upgrading their scheduling processes.

Procedures.

The funded proposal was for the analysis of data secured during the scheduling of two high schools utilizing the CLASS and GASP techniques during the spring and summer of 1965. One school was a suburban high school with an enrollment of approximately 1100 students; the other school enrolled approximately 2200 students and is located in an urban area. Personnel from four other school districts participated in the project as what might be termed participant-observers.

Separate records were maintained for each school district describing the total process necessary to schedule the school under the two programs. At the conclusion of the scheduling process, two complete sets of histories illustrating the cost, personnel involvement, data collection techniques, and material preparation were made available. Analyses of these data was made by members of the project staff; selected participating school personnel including participant-observers; and consultants.

Population and Sample.

Two schools were scheduled--each utilizing both the CLASS and GASP techniques. One, Kenmore West Senior High School of the Union Free School District No. 1, Town of Tonawanda, New York, is an urban school enrolling approximately 2200 students. The school program was conventional for this type of school with little emphasis placed on such approaches as team teaching, large and small group instruction or scheduling students for independent study time during

the school day. The Kenmore physical facilities were judged to be adequate to house the present educational program.

The second school, Clarence Central High School in Clarence, New York, is a suburban school with an enrollment of about 1100 students. The Clarence program incorporated team teaching methods involving large and conventional-size class groupings which create additional problems for those charged with the responsibility of developing the master schedule. In addition, at the time of the PASS project, the number of teaching spaces in certain areas was less than required by the school enrollment.* Thus, further limitations confronted personnel responsible for the school schedule.

The project staff used two criteria in selecting the sample schools. First, it was believed desirable to have schools representing two different size categories and, second, it was believed desirable to have schools that, because of the nature of their respective programs, would offer different type challenges to the two computer-based scheduling techniques.

Data and Instrumentation.

The data collected include cost items related to all aspects of the scheduling process--salary of personnel involved, cost of machine time, information concerning the skills and knowledge required to use computer-based techniques, procedures necessary to permit schools to effectively utilize newer scheduling methods, and other information related to the aforementioned items.

The data collection method was the log. A log was maintained in each school for both scheduling processes in order to record information relative to the total scheduling process as it developed with each of the two computer-based scheduling techniques.

Analysis.

The data collected in the record logs of each school scheduled was categorized utilizing the topics suggested by the questions listed under Objectives. All members of the research team joined in the analysis of the categorized data. Data in the various categories were analyzed in terms of the specific questions to be answered. Although the analysis was of a subjective nature, the participation of consultants, local school representatives, officials of the schools scheduled, and members of the research staff was felt to provide a sufficiently broad evaluation to make the results useful.

*At the time of the project, the building served as a junior-senior high school.

Facilities.

In addition to the University and the Western New York School Study Council services, the Bell Aerosystems Corporation participated extensively in the PASS project both in terms of providing consultative personnel and use of computers and related equipment.

The cooperating school systems involved in the project committed time of personnel and financial support. Personnel representing the cooperating school districts agreed to continue their efforts throughout the term of the project with which the proposal was concerned.

The firm of Hewes, Holz, and Willard continued to serve as major consultants to the project in order to lend their special competencies. Robert Holz developed one of the computer-based scheduling techniques (GASP) used in this project.

III. Results

The analysis of selected factors in automated school scheduling indicated that:

A. 1. Cost comparisons between the GASP and CLASS techniques were unrealistic in terms of their differing scheduling potentials.
   2. The cost of GASP scheduling was partially attributable to the inexperience of participating school personnel in its operational techniques.

B. 1. The CLASS technique required less technical training in data processing fundamentals prior to its use.
   2. GASP required special competencies by the scheduling staff before any regular use of its techniques could be successfully attempted.
   3. Schools considering GASP should participate in a comprehensive in-service program; staff members responsible for scheduling should be freed from regular duties.
   4. School schedulers utilizing GASP need consultant help for basic instruction in computer scheduling processes, data card preparations and analysis of output. This is particularly important in the in-service program.
   5. The GASP manual in use at the time of this study was too complex for personnel unfamiliar with data processing terminology.
   6. A major obstacle in generating a GASP schedule was the program's inability to detect errors made in data card

preparation.

7. The pilot schools in this project experienced difficulty in time-table construction with GASP.
8. The GASP program showed its value as a simulation device with its capacity to examine the feasibility of future changes and innovation.

IV. Discussion

A. Analysis of Cost Factors in Scheduling Two Schools with Computer-Based Techniques.

The analysis attempted to appraise the expenditures incurred using each scheduling program. The logs maintained by the pilot schools indicated that cost comparisons between CLASS and GASP were unrealistic based on their scheduling potentials. The CLASS program is a "sectioning" technique that does not attempt to generate a master schedule. It uses the computer to develop a conflict matrix that aids the scheduler in the construction of his schedule. He is still left with the responsibility for assigning teachers, rooms and time periods. Once developed, the data are fed to an additional computer run and applied to the students requested courses. In this project, it used less computer time, consultant help and clerical staff than did the GASP program.

The greater expense for GASP in this project rested partially on the need for more consultant assistance and clerical time in data preparation. These data included information such as the following:

1) lists of all teaching personnel;
2) lists of rooms, giving capacity and general purpose;
3) a list of all subjects, the number of sections, maximums on class size, their time pattern;
4) staff available and the distribution of rooms.

This involved a greater use of both clerical and keypunch time. During Project PASS much of this work was done by the data processing staff of one of the participating schools at a substantial savings in cost to the total project. It also required a substantial time commitment from the participating administrators, and as much consultant time as was possible for the interpretation and analysis of data.

Computer time was an additional cost factor for GASP. Its process utilized the IBM 1401 to prepare the input for GASP which, in turn, was fed to the IBM 7090 for processing and preparation. The output included a master timetable analysis; a student schedule

analysis and descriptive reports; teacher, room and student scheduling assignments; and class lists. The experience of the pilot schools showed a need for consultant help at every stage of the training program. This included the preparation of data for the 7090 as well as the analysis of final runs. Consultants served to answer questions relative to the output data. Numerous computer runs were required to attain a degree of satisfaction approaching that necessary for scheduling a school. Every rerun required the punching of new data cards with the updated or corrected information. Thus, a portion of the cost for GASP rested in its time demands on the administrative, consultant and clerical staff coupled with the more frequent and expensive use of a larger computer.

The participants recognized that a reduction of the costs in GASP scheduling would be possible with additional experience in data preparation. Project PASS was primarily a familiarization program whose participants were all relatively inexperienced in the use of the more sophisticated automated scheduling techniques. Errors made during this experience should be reduced with additional training and familiarization with the process.

The following figures represent cost data for the GASP and CLASS techniques in scheduling each of the pilot schools. They reflect estimates only of the expenses incurred in scheduling the two schools.

1. Administrative Personnel Cost (at suggested professional hourly rate of $5.50)

Administrators from the Clarence Central Senior High School estimated that eight hours of preparation were necessary before each session for both individual study and preparation. No administrator participating in the project was paid for his time but an estimate was felt essential to illustrate the expense in administrator time for automated scheduling. The $5.50 figure represents the median hourly rate for administrative personnel participating in this study.

	CLASS	GASP (two administrators)
Kenmore West Administrators	seven (8 hr.) days required for the manual development of the master schedule	June - 32 hrs. - $176.00 July - 64 hrs. - 352.00 Aug. - 38 hrs. - 209.00 Sept.- 8 hrs. - 44.00 est. time for independent study - 38.50 $819.50
Total	$616.00	
		(two administrators)
Clarence Administrators	- estimated the same cost	May - 10 hrs. - $ 55.00 June - 64 hrs. - 352.00 July -112 hrs. - 616.00 Aug. - 48 hrs. - 264.00 $1287.00
	Estimated Total	$2106.50

2. Consultant and Technical Co-ordinator Advisory Fees

The total refers to expenses incurred in GASP scheduling during Project PASS for consultant services and travel costs. The consultant help was provided by Hewes, Holz and Willard, Inc., the GASP developers, who were retained during the project.

Consultant Services	$2100.00
Travel Costs	1114.20
Total	$3214.20

3. Computer Expense for Both Pilot Schools in GASP Scheduling

The following figure includes four regular runs and three simulation runs by Kenmore West and nine runs by Clarence on the 7090 computer. It should be noted that the Bell Aerosystems Computer Center did not charge Project PASS for its 1401 time. The total actual computer cost to the participants was for 4 hours, 17 minutes of 7090 time or a billing of $1926.00.

	1401 Computer ($50.00 per hour)		7090 Computer ($450.00 per hour)	
Kenmore West	7 hours, 35 minutes	$375.00	2 hours, 17 minutes	$1026.00
Clarence	9 hours, 30 minutes	475.00	2 hours	900.00
	Total	$850.00	Total	$1926.00

4. Clerical and Keypunch Expense

The staff of the data processing center of the Union Free School District No. 1 of the Town of Tonawanda, New York (Kenmore Public Schools) were used in the preparation of much of the data at a substantial savings for the PASS participants. The estimated expense for these services was $150.00.

5. Total Expenses for GASP Scheduling

Both the release-time salaries for the participating school staff members and the 1401 time were not charged to the project but represent estimates of what such costs might have been.

Consultant Fees	-	$3214.20
Computer Time (7090)	-	1926.00
Clerical (Keypunchers)	-	150.00
Release-Time Salaries	-	2106.50
Computer Time (1401)	-	850.00
Total		$8246.70

B. Analysis of the GASP and CLASS Programs

The second objective of the analysis was to assess the two scheduling techniques in terms of their procedures; the types of personnel required; the amount of personnel time involved and the relative effectiveness of the master schedules generated by each.

The CLASS and GASP Programs: A General View.

It was shown in Project PASS that the CLASS program could be introduced to a school with a conventional schedule and program and that relatively little technical skill was necessary on the part of school personnel. GASP, by comparison, required a well-trained, technically experienced staff for its implementation. It was a more sophisticated program designed to construct the entire master schedule. It appears to be particularly valuable to those schools in which organizational and curriculum innovation are being implemented. The introduction of such programs greatly increases the number of variables in the schedule.

As the result of the experiences in this study, it would appear that the CLASS program might be more appropriate for use by schools with conventional schedules. However, as innovations such as modular scheduling are introduced the strengths of GASP become evident. To use GASP for conventional scheduling would be inappropriate in light of its scheduling potential.

1. Personnel Requirements in CLASS Scheduling

TABLE I.
PERSONNEL NEEDS FOR CLASS SCHEDULING
(Recommended by the Project PASS Participants)

Category	Training and Experience	Function	Estimated Time Required
Guidance	1. certification 2. no previous experience with data processing required	1. work with students in course selection 2. assist in translating requests to data processing cards	same time requirements as traditional scheduling procedures
Other School Personnel Assigned to Scheduling (if differen than above)	1. certification 2. knowledge of the CLASS scheduling process 3. limited experience with data processing	build master schedule manually in traditional manner	one to two weeks--varying with the enrollment of the school
Technical People in Data Processing Field	1. knowledge of data processing fundamentals 2. familiarity with the CLASS manual	interpret manual and supervise card preparation	time estimates vary from one to three days
Consulting Personnel Familiar with the Program	NOT CONSIDERED ESSENTIAL FOR CLASS		

Table I. continued on next page.

TABLE I. (Continued)
PERSONNEL NEEDS FOR CLASS SCHEDULING

Category	Training and Experience	Function	Estimated Time Required
Clerical and Keypunching	1. district personnel with general training 2. keypunch operator	assist in the preparation of input card data and keypunch	ten to twelve days

2. Personnel Requirements of the GASP Program

School Administrators

The staff of the pilot schools felt that GASP required the scheduler to either have more staff assistants, or a substantial reduction of his duties. It is also important that he have training in the operational techniques of the program. Prior to using GASP, policy decisions relative to room utilization and personnel assignment must be made. During the course of this project the need for immediate decisions by the scheduler in these matters was recognized. Therefore it is important for him to understand the limitations of his responsibility. If such authority is not forthcoming, he should have easy access to those personnel who can make such decisions. In many instances, the work of the two pilot schools was delayed because the output suggested alternatives incompatible with existing scheduling policy.

Training Staff Personnel for GASP Scheduling

Project PASS was a first experience for the participants in the use of the GASP scheduling technique and certain assumptions were made in its training procedures that proved a handicap. The project was structured to run two days a week for the entire summer (ten weeks). The pilot school personnel were to derive their training "by doing" with the observer-participants attending the work sessions and gathering information about the scheduling operations. As the project progressed it became obvious that its original format had instructional weaknesses. The major difficulty was that participants had regular duties that detracted from their full involvement in the project. The observer-participants, in particular, were not sufficiently close to the work of the two

pilot schools to gain familiarity with each one's specific scheduling problems. Learning would have been enhanced by using a prepared sample run of an existing schedule developed with GASP before using the more complicated scheduling configuration of one of the participating schools. The double effort in keypunching, in itself a problem, might have been even more formidable had not one of the participating systems had its own data processing center.

Provisions were made within the project for each school to have one run per week, but the infrequent work sessions (two days per week) resulted in the rushed preparation of data and concomitant errors. Thus, mistakes caused by the pressures of time and the instructional format left little opportunity for learning the techniques and approaches of GASP for meeting each school's problems. Therefore, it is strongly recommended that the GASP technique be utilized only after careful planning preparation has been provided.

Participants in the PASS project had not expected that either of the pilot schools would open with a GASP generated schedule in September. This meant that the schedulers from the pilot schools had to concern themselves with opening school under their regular schedules. The result was a waning interest in GASP as the project approached late August. The participants concluded that the training would have been more valuable if they had been freed from this regular scheduling assignment. It was agreed that a released time program during the school year or over the summer which offered a continuous, comprehensive format of two or three weeks duration for schedule development would have been a more successful in-service experience.

Project PASS was designed to provide sufficient consultant and clerical assistance to the pilot schools. Again the problem of scheduling two schools simultaneously deprived each of the full benefit of such services. It was also recognized that too much was expected from the consultants. Neither school got the individual attention it required and, in the absence of GASP consultants, work stalled because of a fear of moving in the wrong direction. A shared learning experience in which only one schedule was developed would have provided for better instruction in the fundamentals. Once having learned the fundamentals, participants could have moved to GASP's capability for handling problems that utilize its capacity for flexibility. Problems in the project related to the GASP process were the result of not giving the participants sufficient opportunity to reinforce their basic learnings through shared application. Despite these training difficulties, it was the consensus of the participants that the GASP technique, once mastered, had a tremendous potential for solving their scheduling problems.

Local Co-ordinators or Technicians Required for GASP Scheduling

Some educators believe that the use of the GASP program requires limited data processing understanding by the school scheduler. The experiences gained in scheduling the pilot schools showed that staff members may encounter difficulty without consultant help in interpreting GASP's technical requirements. Technical help deemed essential in GASP scheduling includes computer technicians who have a reasonable familiarity with the school's program and educational specialists with an understanding of automated scheduling techniques. The participants concluded that prior to undertaking the use of GASP, it should be determined that these personnel are readily available.

GASP Consultants

Project PASS arranged for consultants from the GASP developers, Hewes, Holz and Willard, Inc., to be available to serve both in an instructional and advisory capacity. Funds were allocated for their fees and expenses during the summer of 1965.

The participants indicated that the assistance of these consultants was invaluable in resolving the problems in generating the schedules. Each of the pilot schools presented unique problems for GASP. All of the variables in each school's master schedule had to be encoded. Although the manual provided instructional designations, these proved to be too technical for the school staffs and local technicians. The GASP consultants were able to assist in the encoding of the input data. Their understanding of the mechanics of the program and the needs of each school were crucial in the interpretation of runs and reruns. They were able to suggest alternative actions based on the deficiencies revealed in the output of a run.

The participants recommended that a sufficient budgetary allotment be reserved for consultative personnel when embarking on a school scheduling program involving GASP. It is believed that these consultants should play a major role in basic instruction, data preparation and in the analysis of final output. Expenditures in these training ventures should result in long-range savings.

TABLE II.

PERSONNEL NEEDS FOR CLASS SCHEDULING

(Recommended by the Project PASS Participants)

Category	Training and Experience	Function	Estimated Time Required
Guidance	As in CLASS, plus a knowledge of data preparation	same as CLASS	same time requirements as traditional procedures
Other School Personnel Assigned to Scheduling (if different than above)	Knowledge of GASP Process (reasonable understanding of the program)	Build the Master Schedule through evaluation and revision of repeated computer runs	three to four weeks
Technical Consultants	1. Ability to interpret GASP technical data 2. could be a regular staff scheduler or computer center technician	1. interpret the GASP manual 2. supervise card preparation	three to four weeks
GASP Consultants	1. working advisors 2. ability to adjust GASP to the problems of each school	Advise possible solutions for problems encountered in the schedule building process	three to four weeks (essential in the interpretation of runs) Systems using the program for the first time should use consultants during data preparation

3. The GASP Manual

Although improvements have been made in the GASP manual, it is believed that it should be further altered to decrease the amount of technical terminology. School administrators had difficulty understanding the 1965 GASP manual and had to resort to consultant help for interpretation. Perhaps this stems from the fact that GASP was written by a group dealing with problems of a highly technical nature.

Due to the fact that GASP was designed initially to schedule a university, the manual did not contain sufficient information to deal with the complex problems of the secondary school with the concomitant constraints upon its scheduling freedom. For example, the manual provides few alternative solutions to many scheduling problems. As a result, pilot school personnel had to adopt a "try it and see" approach in many of their problems.

4. Problems in Developing a GASP Master Schedule

Although GASP has the potential to generate a workable master schedule, the pilot schools found that a multitude of unperceived variables interfered with this process. Errors made in the input data cannot be edited by any internal safeguards in the program. It was quickly learned that school personnel must be impressed with the need for careful preparation of data cards. As the result of preparation errors it was possible for an entire run to be processed with the erroneous information manifested in the output. Consequently, an analysis of the output data will reveal the error and necessitate extensive revision of scheduling material. In certain cases attempts to remedy one situation would result in the creation of several other problems which had not previously existed.

The major learning from GASP was the realization of the need for accuracy in data preparation. It cannot be stressed too emphatically that there is a need for accuracy in the preparation of the input data in the GASP program.

5. Time-Table Construction with GASP

Personnel were forewarned by consultants that, when scheduling with GASP, careful attention must be given to the matter of time-table construction. If properly instructed, the computer can choose among available time patterns, but it does not design overall patterns for the day or week.

Schools with innovative programs featuring a modular schedule with tie-ins for large group-small group instruction must keep their time-patterns from overlapping.

Some of the participants were disturbed because the program did not actually develop a master schedule as they perceived one. The human factor still had to build the time-table for the schedule. Any attempt at modular scheduling required the creation of patterns through which modular courses could be interlocked. Although the program was designed to give the user as much flexibility as possible, the constraints existing in each school presented problems. In most instances, these problems revolved around difficulties resulting from localized needs and desires. These included the establishment of ties for large group-small group instruction; gym and band classes that had to be scheduled during the regular school day; ties between individual teachers and rooms; and lunch period configurations. An unusual situation such as staggered lunch periods required the schedulers to work out the appropriate time pattern, then lock in that part of the time pattern, since GASP lacks the capacity to work out the desired combination. Manual construction is necessary to solve such problems. Failure to give adequate attention to these matters can result in schedules in which students have unassigned time modules, study hall assignments which place a student in a different room each day of the week and similar unrealistic assignments. School personnel using GASP should recognize that its use will permit scheduling flexibility of a nature sometimes incongruous with accepted scheduling practices. In a highly innovative school, the unassigned module might provide an opportunity for independent study, and the study hall might be non-existent.

Unless instructed, GASP gives no special consideration to teacher desires. For example, teachers are simply assigned to times that have not already been used, and to open rooms. Prior constraints in regard to both time and room assignments must be established. Therefore, participants spent a great deal of time building portions of the time period manually then locking it in to GASP. These adjustments increased man-hours of work in data preparation and increased the number of runs necessary to satisfy such localized constraints.

6. Simulation Characteristics of the GASP Program

Kenmore West Senior High School used the simulation capability of GASP to evaluate its capacity for handling an expected increase in enrollment. The developers of GASP suggest that full capacity for simulation will not accrue if the school simply draws on past scheduling experiences. GASP becomes an extremely useful tool for those schools contemplating curriculum change or attempting to

ascertain future space requirements to house the curriculum.

At Kenmore West it was anticipated that five hundred additional students would have to be accommodated in the existing building within five years. To determine the building's capacity to accommodate such an increase GASP was used to simulate an overlapping double session, modular type schedule. The simulated schedule contained fourteen twenty-five minute modules. Some students would arrive at school one module later and leave one module later than the others. Theoretically, this would have added one period per day to the existing schedule. About one-quarter of the total school population (600) would be in the late session. To simulate the increase of five hundred students a random selection from the existing student body was made. In other words, five hundred existing student programs were used to exemplify the increased number of students. Approximately thirty-seven hours were required to encode the input data for this simulation problem. After three simulation runs, the schedule created provided for teacher, room and student assignments in a reasonably satisfactory manner. With only minor adjustments it would have been possible to create a workable simulation schedule. Most of the errors encountered in this simulation problem were traced to the physical descriptions encoded on the data cards for physical education and driver education classes, and the limitations that had been placed on class size in some courses. The participating schools felt that this simulation capability presented a potentially valuable service to school districts wishing to assess future building needs.

V. Conclusions, Implications and Recommendations

A. Conclusions

As expected, in analyzing the cost data accumulated during Project PASS a greater initial expense was experienced when scheduling with the GASP program. This probably can be attributed to the greater time commitment of staff members particularly during the in-service phase; the need for consultant help in both instruction and data interpretation; the increased need for clerical and keypunch personnel; and the large amount of computer time required by the program. It is believed that the costs could be decreased substantially once the staff had more experience with GASP's operational processes.

General Comparison of the GASP and CLASS Scheduling Programs

The experiences of the participants revealed that the two programs could not be compared in terms of application or final objectives. CLASS is a "sectioning" technique which assigns students

to classes after the scheduler has manually developed a school's master schedule. It does eliminate many of the more tedious aspects of the scheduling process in schools which have a conventional curriculum. Most conventional curricula suggest a seven or eight period day with few, if any, innovative practices.

GASP is a more sophisticated technique which reportedly is capable of constructing the master schedule. The project under discussion here did not have as an objective the opening of school with a GASP generated schedule.

Although GASP can be applied to schools with conventional programs, its real value seemingly rests with those schools planning curricular and/or organizational innovations. Introduction of such changes increases the number of variables in the master and complicates the problems of the scheduler. If the schedule is constructed manually, the time commitment of personnel will be increased significantly. Indeed, experience has shown that it is nearly impossible to manually construct a schedule that contains all the demands of a new program. GASP's flexibility and simulation capacity are more of an aid to the scheduler under such circumstances, assuming, of course, that the method was properly understood and applied.

School Personnel Requirements for GASP Scheduling

In this project, it was shown that school personnel anticipating the use of GASP need a substantial amount of training before its actual use. Although participants gave a great deal of their time to the study of GASP it was found that duties in their home schools interfered with the project instruction. Other factors that appeared to reduce instructional effectiveness included the project schedule which spread the sessions over too great a time period; the scheduling of two schools simultaneously which reduced the individual attention that each school could be given; and a lack of full participation by the observers due to their unfamiliarity with the programs of the pilot schools.

Consultant Staff Required for Instruction in GASP Scheduling

Knowledge of data processing techniques required for scheduling schools using CLASS were found to be inadequate for initiating the GASP program. No commitment should be made to adopting the GASP program unless knowledgeable technical personnel are available. Financial provision should be made for consultants to assist the school staff in the preparation of data and in the interpretation of output data.

The GASP Manual

The manual used in the GASP program is a technical document with terminology that is difficult for the school man to understand. The participants favored a revision that would be more suited to the layman's basic understandings of data processing. It was also felt that many of the constraints inherent in secondary school scheduling could not be resolved with the alternatives presented in the manual. This is understandable in the light of the intended purpose of the original GASP program.

Problems in the Construction of a GASP "Generated" Master Schedule

Our experiences in scheduling the pilot schools indicated the need for impressing upon the staff the necessity of careful preparation of input data. This phase cannot be a "hit or miss" affair. It requires extreme care since the GASP technique lacks the capacity to edit out errors in the input data. Many of the errors during the Project PASS experience could be traced to the participant's inexperience with the program, but a fair warning to interested school districts suggests a careful consideration of this factor from the standpoint of staff training and time commitment for the scheduling process.

Time-Pattern Construction with GASP

GASP does not develop time patterns for the day or week, it chooses among those time-patterns that the scheduler provides. Prior to this training experience the participants had assumed that the ability to develop a master schedule included the construction of time-patterns. However, they found that GASP does permit schedulers much flexibility in the construction of these time-patterns. In fact, many schools, because of local constraints, will be unable to take full advantage of this capability.

GASP as a Simulation Technique

A feature of the GASP program found most valuable was its ability to simulate future curriculum and planning. In the case of the pilot school in which an increase in enrollment was simulated, the schedule generated showed the existing building's capacity to accommodate the projected increase through use of an overlapping double start and modular schedule. Participants believe that this aspect of GASP could be utilized by any school moving into uncharted areas.

B. Implications

1. Cost Factors

Analysis of the evaluation data revealed that the increase in cost as the result of scheduling with GASP rather than CLASS was due to increased time spent in data preparation, the increased amount of computer time required, and the need for consultant help. Initially a large time demand was placed on the scheduling staff. This was due to the training philosophy--that of reaching a final solution by repeated attempts or iterations. Scheduling procedures, such as CLASS, are less technical in their information demands but do not provide the output data generated by GASP.

Schools contemplating the adoption of GASP should allow for the increased costs and understand that the increased initial expenditure should result in worthwhile feasibility studies of proposed changes in the school program or, perhaps, guide the staff in the renovation or construction of a school building. An expenditure for GASP would seem unwise for those schools who do not plan such innovations or changes in their instructional program. CLASS serves the conventional school's needs at a substantially lower cost.

2. The CLASS Program

CLASS requires little understanding of data processing fundamentals. Although it is not as comprehensive a program as GASP, it does produce a variety of outputs. These include student conflict charts; an up-dated master schedule print-out which includes the percentage of seats assigned in each class; and individual student schedules. It is important to remember that when using the CLASS program the scheduler must still manually construct the schedule (assigning teachers, rooms and time periods). The program is extremely valuable in the large conventional high school with many sections of the same course.

In Project PASS, the limitations of CLASS were evident in the case of the pilot school that had the more innovative program that included team teaching; ties between large groups and small groups; provisions for independent study and a variety of elective offerings. When using CLASS, the scheduler still had to schedule these new variables manually.

3. Training of School Personnel for the Use of GASP and CLASS

Although an excellent beginning, the Project PASS approach should be altered to take into account what was found in regard to the training needs of school administrators. GASP, in particular,

requires the scheduling staff to have thorough training, perhaps best achieved in a program of two to three weeks duration without the distraction of regular school duties. Such a program should be structured to provide the participants with more common learning experience such as the scheduling of a model school with GASP. Ample consultant help should be available to reinforce the learning process during these sessions. Scheduling two schools simultaneously, as was the case during Project PASS, made it difficult to study and plan for the preparation of good runs. Neither school could receive the individual attention it oftentimes required.

4. The GASP Manual

A handicap for the staff member being introduced to GASP is the operations manual which taxes the mind of the layman when he must try to convert his expectations into the technical form the program mandates. Without consultant help its meanings are just too confusing for reference.

5. Consultant Requirements for Automated School Scheduling

Many of the pitfalls in GASP scheduling arose from the failure to consult with technical help soon enough or with enough frequency to fully understand each school's unique problems when related to the program's peculiarities. A primary task of the project was to have the participants learn to encode all the variables in the master schedule. Without the assistance of the consultants this would have been extremely difficult if not impossible. In addition, the matter of interpretation of output data at the conclusion of each run should be considered; consultant help was very necessary at this point. Initially, we experienced errors that resulted from clerical mistakes, lack of information, and inadequate planning by schedulers.

The consultant was required to spend considerable time with the school staff studying the output and preparing the corrected input data. He aided the staff member in making those manual adjustments that were necessary. It is probable that the need for consultant help would decline as the school scheduler attains experience with GASP.

6. Master Schedule Development with GASP and CLASS

CLASS does not generate a master schedule but it still constitutes a significant aid to the scheduler in "sectioning" or assignment of students to classes. GASP goes much farther, once understood, by constructing the entire schedule. Its difficulty lies in the need of the staff to gain proficiency in the skills it demands, and in accepting its assumptions about flexibility in the school

program. The pilot schools found that many of the problems arising from their efforts with GASP stemmed from constraints tied to localized needs or limitations. These included teacher and room problems due to limited physical facilities; problems with irregular lunch periods; the difficulty of scheduling physical education and band classes during the regular school day and the completion of ties between large group and small group classes. Since the program was designed originally for university scheduling it assumed more flexibility than was found in the pilot schools. Many of the alternatives it presented would not have been so awkward in a higher education setting. For example, it indicated the feasibility of placing all sections of a particular course into the same modules of the day rather than spreading sections throughout the day. The problem, of course, is related to the utilization of teachers under such an arrangement, since many would have to teach outside their regular assignments to implement such a concept.

Time-table construction presented difficulties with the result that the GASP scheduler still had to build a significant portion of his time-table manually and then lock it into GASP. It was also weak in terms of its ability to detect errors in the input data. An improvement that would save much frustration would be some sort of internal safeguard that would prevent spurious information from ruining a total run which, in turn, increases the cost. As it presently stands, one must adopt a "try it and see" approach running the risk of higher computer costs through repetitious error-correcting reruns.

7. GASP as a Simulation Technique

An implication for future use would be GASP's value in answering all kinds of "what if" questions relating to innovations in a school's instructional program. We can simulate a future condition to determine enrollment capability, or a school's potential for better utilization of existing facilities and the possible need of new ones.

C. Recommendations

1. District Commitment to GASP Scheduling

School districts contemplating the use of GASP must be prepared to release their scheduler from other school duties. The initial time commitment is sufficiently heavy to justify this expenditure.

2. Cost Factors in CLASS and GASP Scheduling

Before a school embarks on the use of GASP, a budgetary allotment should be made which provides for, a) the released-time training of the scheduling staff; b) sufficient clerical, keypunch and consultant help; and c) a substantial amount of computer time.

3. The Use of the CLASS and GASP Techniques

CLASS may be used by those schools with a conventional instructional program. The use of GASP may be impractical for such a school since little use of its scheduling felxibility would be made. GASP should be reserved for schools initiating changes and innovations in their instructional program and who need additional help in dealing with the complexities of such a schedule.

4. Training of School Personnel for the Use of CLASS and GASP

It was the determination of the Project PASS participants that CLASS required no special training. GASP, however, requires careful preparation in a program that allows for the complete involvement of the patticipants preferably through a released-time arrangement. Preparation for GASP should be made well enough in advance to insure that appropriate staff people and technical consultants will be available. Insofar as policy will permit the staff member responsible for scheduling should be authorized to make all decisions pertinent to room utilization and personnel assignments. To facilitate learning the participants should begin with an easy scheduling model then move to more complicated situations that utilize the more sophisticated features of GASP.

5. Consultant Requirements for Automated School Scheduling

In addition to the administrative staff assigned to scheduling and clerical and keypunch help, two types of consultative assistance are helpful in situations in which GASP is used. These include a person familiar with the school's program who can be assigned full time to the scheduling process. This person would be utilized in the preparation of input data which requires an ability to interpret the GASP manual. A local data processing center with competent staff people might supply this need. It is requisite that a consultant from the GASP developers be available, in a working advisor capacity, to suggest possible solutions to problems encountered in the schedule building process. He would have to have an understanding of the localized constraints existing in a school that limit its capacity for flexibility. During a school's first effort with GASP it would be essential to have this aid in the preparation of input data as well as in the analysis of computer runs.

CLASS was felt to be so basic in its design as to require limited consultant help.

6. Master Schedule Building with CLASS and GASP

One should not contemplate the use of GASP without first understanding the limitations of automated scheduling. Included should be:

a. a recognition that the computer can do only what it is told to do. The human mind prepares the alternatives within the computer, makes choices, but the machine cannot make choices that are not programmed.
b. an awareness that errors in the preparation of input data or an unrealistic use of the program's flexibility can result in the inclusion of spurious information in the final output with a resultant increase in cost in computer time that most schools can ill afford. This requires school schedulers to work with the greatest possible clarity and explicitness.
c. a realistic understanding on the part of the scheduler of the constraints on his scheduling freedom. These constraints limit the use of the flexibility which is available within the GASP program and force the scheduler to establish priorities for some of his innovative desires.
d. understanding that the GASP program is not equipped to design overall time patterns. The school scheduler will have to create the patterns by which his modular courses will interlock. He must devote much of his time and planning to this matter of time-table construction.

The GASP program should make several alterations in its structure for the benefit of secondary school personnel. These would include a capacity to detect errors in the input data before their submission to the run. This would forestall the expensive errors that may arise when using the current process. Another modification would be a revision of the technical manual to a form designed explicitly for secondary school use.

VI. Summary

The goal of Project PASS (Project in Automated School Scheduling), sponsored by the Western New York School Study Council during the summer of 1965, was to provide in-service education for school personnel contemplating the use of automated approaches to school scheduling. The two techniques utilized were CLASS and GASP. Two pilot schools were selected for participation in the project; these schools were scheduled with both processes. Records were maintained for each method describing the processes

necessary to develop useable schedules. At the conclusion of the project two sets of data were available describing estimated comparative costs, personnel involvement (kinds and time), data collection techniques and material preparation.

This report focused upon the findings of the analyzed data provided through the joint efforts of the members of the project staff; the participating school personnel, including the participant-observers; and the consultants to the project. It is hoped that partial answers to the following questions have been provided.

- What are the costs involved in scheduling by GASP and by CLASS in each school?
- What personnel commitment (kinds and time) are required in each school to schedule with the GASP and CLASS programs?
- What special competencies are required of personnel to collect and prepare data for use in the CLASS program and for use in the GASP program?
- What alterations in the scheduling procedure must be implemented when changing from the CLASS to the GASP program?
- What is the relative efficiency of the GASP-generated master schedule when compared to the conventional hand-developed schedule?

The desire of the participants and the staff of Project PASS was that the answers to these questions would provide a basis for guidelines to assist administrators in making the decisions as to which scheduling procedure was best suited to their individual systems.

The analysis of the data showed that CLASS and GASP could not be compared in terms of their ultimate objectives. CLASS is a "sectioning" technique, whereas GASP develops a master schedule. It also provided some significant information relative to training for the use of automated scheduling techniques, and GASP in particular. The principal conclusions of the analysis are offered as an aid to those schools contemplating an in-service program in automated scheduling. It also discusses some of the factors which might be significant for those anticipating the use of such techniques for the first time. It should be pointed out that Project PASS served as a stimulation for several schools to continue their utilization of the GASP technique. Further, certain school districts which sent participant-observers to Project PASS have since adopted the use of GASP in their schools.

1. Organization of Project PASS

Project PASS was structured to meet two days a week for ten weeks during the summer of 1965. As a result of our experience, certain changes in the instructional format would be implemented. A concentrated in-service program where participants are freed from other duties is recommended.

The project was designed to allow each pilot school one run per week, but with only two meetings per week too little time was available for the study and planning necessary for developing the input data. Such a program requires the complete involvement of scheduling personnel, each working individually with consultant help from the initial preparation of the input data to the final interpretation of the output data. It is suggested that sufficient time be allowed for the participants to get the individual attention necessary to develop a workable understanding of the more sophisticated GASP scheduling techniques.

2. The GASP Program

GASP was developed by computer experts who were attempting to solve a technical problem in scheduling at the university level. The operations manual developed was, as a result, quite technical in its nature. If its content is to be understood it must be rewritten for secondary school personnel who lack background in data processing procedures. A revision should also provide an increased number of alternatives to the scheduler in the development of his master schedule. The program does not deal realistically with certain scheduling constraints found in the secondary school.

3. Preparation of Data for Automated School Scheduling

The participants in the project learned the importance of being familiar with data processing fundamentals, and the necessity for careful preparation of data for computer use. CLASS can be used with just a basic knowledge of fundamentals, but GASP requires a thorough understanding of its techniques before implementation. An extensive use should be made of consultants to aid in both data preparation and the analysis of output.

4. Personnel (Kinds and Time)

The CLASS program when compared to manual scheduling, requires relatively little in the way of increased personnel. GASP, however, in its introductory stage, requires that provision be made for more administrative, clerical and consultant help. With experience this need would probably diminish substantially.

5. Factors Influencing the Use of the CLASS and GASP Programs

It would be financially impractical for schools with conventional programs to adopt GASP as their automated scheduling technique. GASP is primarily for schools contemplating innovative instructional programs which increase the number of variables to be considered in the development of the master schedule. The flexibility of GASP, if properly used, permits the construction of the master schedule at a substantial savings in staff time. GASP also showed its versatility by allowing school schedulers to conduct feasibility studies through the use of its simulation capacity.

6. Cost Factors in CLASS and GASP Scheduling

The CLASS program could be used efficiently by the school administrator with little change in his normal scheduling requirements. Its fiscal savings stem from the reduction in the time demands upon the scheduler in the student assignment, or scheduling phase. GASP goes far beyond "sectioning," producing a schedule that takes a fuller account of student and teacher choices, curricular innovations that complicate scheduling, and other variables related to scheduling the individual school. The decision as to whether a school should be scheduled using either the GASP or CLASS method should be based on rationale that consider factors other than cost.

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