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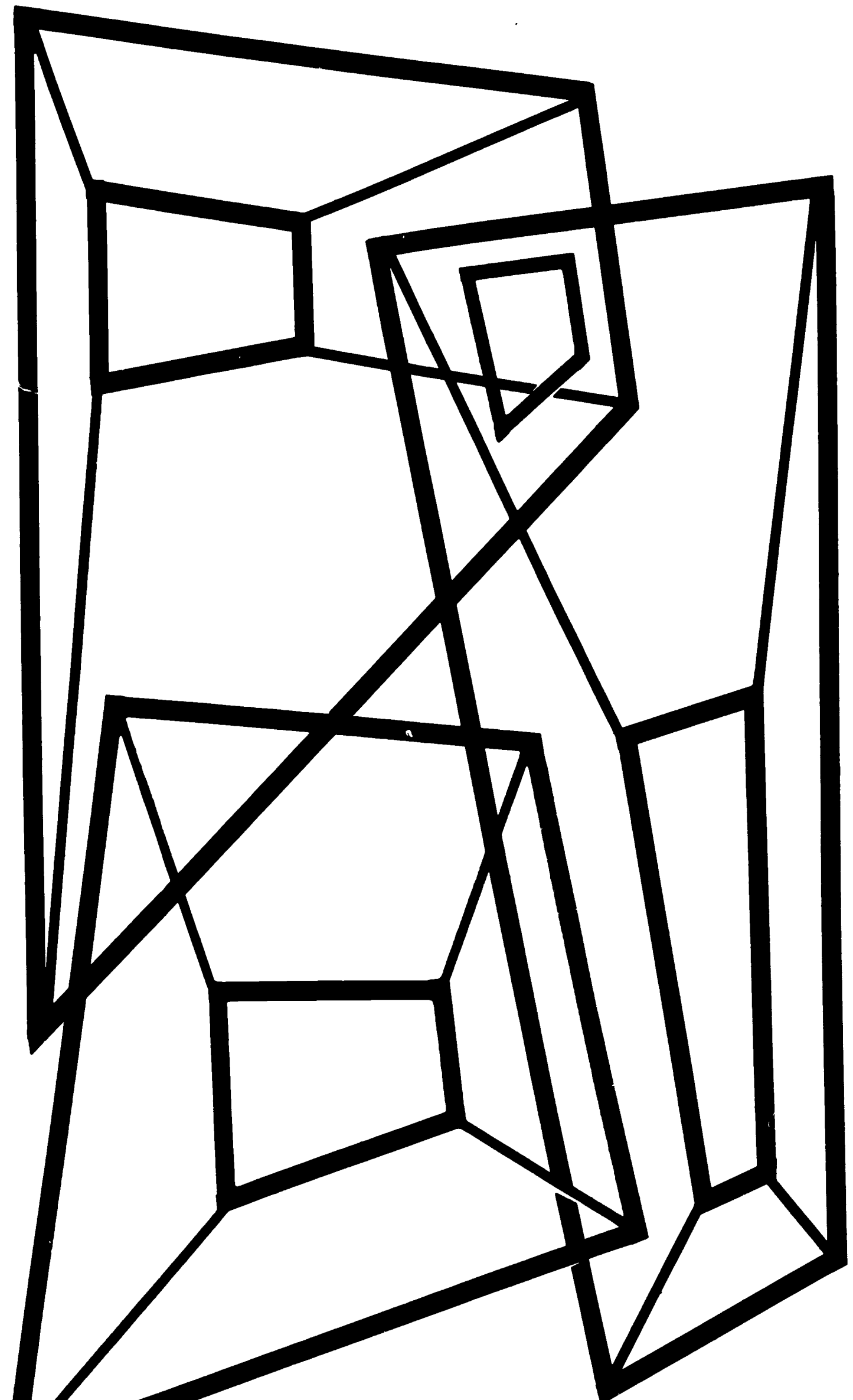
Certain factors are examined that contribute to the utilization of middle and high school facilities in the planning stage in the School District of Philadelphia. The study addresses itself to certain factors related to the methods of rostering schools which affect utilization of facilities in an urban area. A suggested program is developed outlining certain time allocations for various subject matter areas. These time allocations are projected into space needs, which are then compared to those of presently planned facilities. Based on analyses of time, space, capacities and program, several conclusions are made concerning the utilization of school facilities. A brief bibliography is included. (FS)

DESTINATION AS A FACTOR IN PLANNING FACILITIES



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STUDY OF SPACE UTILIZATION

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SCHOOL DISTRICT OF PHILADELPHIA

SCHOOL PLANNING DEPARTMENT

TABLE OF CONTENTS

INTRODUCTION

The Capital Program is predicated upon the need for new facilities in the School District of Philadelphia to alleviate excessive overcrowding and to enable teachers to utilize modern teaching methods. It is a recognized fact that school buildings can have a profound effect upon learning in many ways, one of which is the mere provision of various spaces in which learning takes place. Conversely, the absence of adequate space can impede the best educational program. Efficient utilization of all available space, both new and existing, is vital to the long-range goal of the Capital Program.

This study examines certain factors that contribute to the utilization of the middle and high school facilities presently in the planning stage in the School District of Philadelphia. In addition, the study addresses itself to certain factors related to the methods of rostering schools which affect utilization of facilities in an urban area.

It is demonstrated in parts of this study that the maximum capacity of a building may be increased beyond the optimal capacity by the manipulation of certain variables. Development of these statements recognizes, but does not dwell on, the limitations placed upon capacities of the entire school by the capacities of specialized spaces such as cafeterias, gymnasia, or similar areas. Other publications of the School District are addressed to these particulars.

UTILIZATION FACTORS

Introduction

Ideally, the use of a school facility is dependent solely upon the type of education program desired and offered. However, in practice, the utilization rate is determined by the interaction of the variables of class size and spaces available to support the given educational program, and in the planning of new schools a decision concerning the rate of utilization can become the determinent of class size and type of educational program. This is to say that a predetermined rate of utilization could, in effect, influence the capacities of a building and also the extent and depth of the educational program.

Efficient utilization of all school facilities, both existing and projected has been one of the premises of Philadelphia's Capital Improvement Program. The major goal of the Capital Improvement Program is, however, to provide facilities for a quality educational program.

A quality educational program, as defined by the Capital Program lays primary emphasis upon a high degree of individualized instruction to serve the unique qualities of each student and, thereby, maximize his achievement. This emphasis pervades all phases of an innovative instructional program.

The school facilities planned under the existing Capital Program reflect this emphasis upon individualized instruction. Because the new facilities are planned for an individualized approach, traditional student rostering

practices such as found in schools today can be used only to suggest circumscribed ways in which the facility can be utilized for a limited period of time - until an individualized instructional program is implemented. To base any long-range projection of utilization upon one approach to teaching while the facilities themselves are planned for a diametrically opposed approach to teaching would negate a major program premise of the Capital Program. It is, however, useful and necessary to make certain existing programs and rostering procedures can be accommodated in the new schools.

One segment of the plan to house a quality program of education concerns average class size (pupil-teacher ratio). These average class size figures are used in developing utilization rates for other parts of the report. The Capital Improvement document delineates the following average class size as optimum: Elementary Schools - 30 students; Secondary Schools - 25 students; and Special Schools - 8-12 students per class. [1] Although these capacities may not be immediately achieved, the ratios will be maintained when the building program has significantly reduced existing overcrowding and matches increasing enrollments.

Class Size and School Capacity

Capacities of any school facility may refer to any predetermined quota within: (1) a given school building, (2) a particular program, or (3) within any and/or all specific classes. Thus, while a given building may have a capacity which is predetermined, the facilities within a given

1 Capital Program, School District of Philadelphia, (Philadelphia: May 27, 1968), Page 24-25.

building that serve a particular program (such as vocational education in the high schools) may, in addition, have a capacity which further limits the facility predetermined by policy restricting class size. In addition to the above capacities, individual class capacities have been predetermined and serve as a limiting factor.

In the School District of Philadelphia, all schools and programs are based upon a pre-determined "planning" class capacity. These class capacities range from 24 students to 120 students depending upon the particular class offering. For example, all laboratory-type subjects such as vocational education, home arts, and science have a capacity of 24 students. Conversely, physical education, music, and certain information dissemination classes have capacities of 60 to 120 students. There are, in addition, some classes in the field of business education and advanced courses in the humanities that have an optimal capacity of 18 students. The Special Education classes such as R.E., R.T., and E.D., etc., have a capacity of 8-18 students. However, the median class size for planning purposes is 25 students, and this number then allows considerable flexibility in local school staffing arrangements, if sufficient ancillary instructional spaces are provided.

School Capacity With Class Size As A Variable

Table I illustrates the affect of class size upon the needs of teaching stations or classrooms for varying school capacities. It can be seen that the number of teaching stations required for a student body of 2,500 students with an average class size (or student-teaching ratio) of 25-1

would be 100, but if the average class size is increased to 35-1, the spaces needed would be reduced almost 30%. Conversely, for a student body of 3,000 students the reduction of class size (or student-teacher ratio) from 35-1 to 25-1 would require a 40% increase in teaching stations.

TABLE I

TEACHING STATIONS REQUIRED FOR ENROLLMENTS OF 2,500, 3,000 and 3,500 STUDENTS UTILIZING 25-1, 30-1, AND 35-1 STUDENT-TEACHER RATIOS (2)

	25-1 Student-Teacher Ratio			30-1 Student-Teacher Ratio			35-1 Student-Teacher Ratio		
Enrollment	2,500	3,000	3,500	2,500	3,000	3,500	2,500	3,000	3,500
Teaching Stations Required	100	120	140	83.3	100	116.6	71.4	85.7	100
Enrollment	1,200	1,600	2,000	1,200	1,600	2,000	1,200	1,600	2,000
Teaching Stations Required	48	64	80	40	53.3	66.6	34.2	45.7	57

It is obvious that the number of classrooms required for an enrollment of 2,500 students or 3,500 students is 100, depending upon the student-teacher ratio (or average class size). Likewise, the 64 teaching stations commonly specified in the Middle School would accommodate 1,600 students at a 25-1 student-teacher ratio, or, 2,000 students at a 35-1 student ratio. The essential point here is that the utilization of any facility can be increased if the goal is simply housing more students regardless of the educational program. If a quality educational program is paramount, however, a high

2 A Report on Space Utilization: School Planning Department, The School District of Philadelphia, (Philadelphia: August, 1967), Page - 4.

degree of utilization may not be desirable or obtainable.

Ideally speaking, when a facility is initially planned, the desired educational program is determined through investigations of the goals of the School District and the local community, and the numbers of students to be served. During the initial planning stage, however a determination of optimum class size will insure a sufficient number of instructional stations to accommodate the program. After the building is constructed, changes in the educational program may occur by changing any one of the previously constant factors of planning. To accommodate such changes in the future, the rate of utilization of a facility must include a projection of changes in the program. Without this projection, the rate of utilization of facilities becomes more paramount than the educational program.

Middle School Analysis

Table II, Pupil Stations and Pupil Period Stations for a typical middle school, illustrates a gross measure of capacity "fitness" for total numbers of students in a projected facility.

Data for this table was developed by listing all instructional areas (classrooms and specialized labs) of the school, assigning a capacity of each space, and determining the periods each space is available. The assumption is made that the majority of spaces will be available for 8 periods (100% of the time of a typical middle school day), the exception being specific areas which have unique limitations.

Table II demonstrates that a total of 13,556 student period stations in rostered areas are available each day for student use. A student body of

TABLE II

STUDENT STATIONS AND STUDENT PERIOD STATIONS
Assume Facility Available 8 Periods, Students Rostered for 7 Periods

Middle School

Rostered Areas	Student Cap.	No. of Units	Total Student Stations	Periods Available	Total Student Period Stations
G.P. Classrooms	25	36	900	8	7,200
R.E. Classrooms	18	4	72	8	576
Science Labs	25	4	100	8	800
I.A. Labs	25	3	75	8	600
Commercial Rooms	25	2	50	8	400
H.E. Rooms	25	3	75	8	600
Language Lab	25	1	25	8	200
Choral Hall	75	1	75	8	600
Instrument Hall	75	1	75	4	300
Gym)	40	4	160	8	1,280
P.E. Activity Room)	80	1	80	4	320
Swimming Pool)	40	1	40	2	80
Art Labs	25	3	75	8	600
Sub-Totals		64	1,802		13,556
Non-Rostered Areas					
A-Group-Theater	450	1	450	8	3,600
Conference	20	1	20	8	160
Large Group	150	2	300	8	2,400
Rem. Gym	20	1	20	8	160
B-Individual Areas					
IMC	100	1	100	8	800
Resource	10	8	80	8	640
Sub-Totals		15	975		7,800
Grand-Totals		79	2,777		21,356

NOTE: 1,650 students x 7 period roster = 11,550 pupil period stations needed.
13,556 student period stations x 85% utilization = 11,522 pupil stations provided (rostered area).

1,650 students rostered for the typical 7 period day would require only 11,550 student period stations. Thus, the total student period stations could accommodate a student body of 1,936 if all rostered facilities could be utilized 100% of the time and all students were rostered for 7 periods, (286 students in excess of the stated 1,650 capacity). However, the total student period stations (13,556) does not accurately reflect true capacity unless all students are grouped into equal sized classes and move through the school day in a lock-step fashion. As this is neither educationally feasible or desirable, a reduced utilization rate is commonly followed. This reduced utilization rate reflects such factors as staff limitation, reduced student demand on certain courses, elective courses and facility limitations.

If the total student period stations which originally were assumed to be available 100% of the time were reduced by an 85% utilization factor, only 11,522 stations would be available. Thus, the proposed Middle School is programmed within .0159% of the 1,650 student capacity set for the school.

Using the same base data as generated in Table II, it is possible to project total capacity based upon any given rate of utilization and class capacity. By manipulating the two variables of rate of utilization and class capacity, it is possible to increase the capacity of any facility. Table III presents data illustrating how these variables affect capacities. These data assume that the instructional day contains 8 periods per day. As mentioned above, 1,650 students rostered for a 7 period day would generate the need for 11,550 student period stations.

TABLE III

TOTAL STUDENT PERIOD STATIONS FOR TYPICAL MIDDLE SCHOOL AT VARYING UTILIZATION PERCENTAGES AND STUDENT CAPACITIES

NUMBER OF S/P/S* FOR 1650 STUDENTS	TOTAL S/P/S @ 25/CLASS @ 85%	DIFFERENCE S/P/S / ADDITIONAL STUDENTS @ 7 PERIODS/DAY	TOTAL S/P/S @ 30/CLASS @ 85%	DIFFERENCE IN S/P/S / ADDITIONAL STUDENTS @ 7 PERIODS/DAY	TOTAL S/P/S @ 25/CLASS @ 90%	DIFFERENCE IN S/P/S / ADDITIONAL STUDENTS @ 7 PERIODS/DAY	TOTAL S/P/S @ 30/CLASS @ 90%	DIFFERENCE IN S/P/S / ADDITIONAL STUDENTS @ 7 PERIODS/DAY	S/P/S FOR SELECTED NON-ROSTERED AREAS @ 15% UTILAZATION / ADDITIONAL STUDENTS @ 7 PERIODS/DAY
11,550	11,522	(28) / (4)	12,746	1,196 / 70	12,20[illegible]	651 / 33	13,497	1,947 / 278	1170 / 167

* STUDENT PERIOD STATIONS

The typical Middle School under design in Philadelphia contains space that can provide 13,556 student period stations in rostered areas. The typical school can also provide 7,800 additional student period stations in areas not commonly rostered, i.e., auditorium, conference areas, library (IMC), large group lecture areas, and remedial spaces. The teaching/learning spaces contained in the non-rostered catagory can be assigned a rate of utilization that is arbitrary yet logical.

Use of the large group areas, such as the theater and large group instruction spaces will depend entirely on changing instructional techniques in grouping as will the extent of utilization of the individual study areas. The utilization might reach a high of 90% if an extensive program of independent research is implemented whereby 30% to 40% of the student's time is in individual pursuit of learning.[3] Initially, however, the utilization rate is expected to be lower.

In any event, Table III makes use of the student period stations to display theoretic capacities at both an 85% and 90% utilization and at both 25 and 30 student class capacities. The table further translates the non-rostered student period stations at a 15% utilization rate into 167 additional student capacity. To understand the table, one must keep in mind that 1,650 students at 7 periods per day generate 11,550 student period stations. Any number of student period stations in excess of 11,550 indicates additional student capacity above the ratio capacity of 1,650.

Table IV indicates the maximum capacity of a school when both the rostered and

3 J. Lloyd Trump, Secondary School Curriculum Improvement, Boston: Allyn and Bacon, Inc., 1968 - Page 265

non-rostered student period stations are translated into student capacity. The purpose of this table is to illustrate the maximum capacities of the Middle School under varying utilization rates regardless of the desirability of the educational program housed in such an arrangement.

TABLE IV

MAXIMUM STUDENT CAPACITIES OF ROSTERED
AND NON-ROSTERED AREAS FOR TYPICAL MIDDLE SCHOOL

Student Capacities Per Class	100%	90%	80%
25	2,103	1,910	1,813
30	2,309	2,095	1,987

Program Analysis - Middle School

Although no precise Middle School Educational Program presently exists for the School District of Philadelphia, several programs are evolving in existing buildings. It is possible, therefore, to define program areas which are desirable or which might reasonably be expected to be included in a quality middle school educational program, based upon data available from the evolving programs and from the experiences of other districts with similar goals. These instructional area descriptions, of necessity, need to be general in nature and need not detail explicitly or restrict the subject-matter content. The purpose is to compare elements of a given program with facilities available in the Middle Schools. Table V and VI present data relative to instructional disciplines for Middle School students, including periods each child will spend in these disciplines during a week, and teaching space needs to accommodate the program. Table V presents data for students in the first and second year of the Middle School. These students are comparable to the present 5th and 6th graders. A similar program of time allotments per subject area or discipline was developed for the 3rd and 4th year students in a Middle School and is presented in Table VI.

TABLE V

Teaching Stations Needed for a Given Program for 1st and 2nd Year Students in a Middle School

Subject/ Capacity	(1) Number Periods Required Per Week	(2) Number Students	(3) Student Periods (1x2)	(4) Number Periods Available (pds/week)	(5) Student Capacity Per Class (policy)	(6) Total Number Class Periods (3÷2)	(7) Total Number Teaching Stations (6÷5)	(8) Adjusted Number Teaching Stations	(9) Adjusted Number Teaching Stations 2 - Houses
English	5	400	2,000	40	25	50	2.0	2.3	4.6
Social Studies	5	400	2,000	40	25	50	2.0	2.3	4.6
Math	5	400	2,000	40	25	50	2.0	2.3	4.6
Science	5	400	2,000	40	25	50	2.0	2.3	4.6
Art	2	400	800	40	25	20	.8	.92	1.84
I.A./Home Arts	2	400	800	40	25	20	.8	.92	1.84
Physical Ed./ Health Ed.	4	400	1,600	40	25	40	1.6	1.84	3.68
Foreign Language	1	400	400	40	25	10	.4	.46	.92
Typing/ Commerce	1	400	400	40	25	10	.4	.46	.92
Music	1	400	400	40	25	10	.4	.46	.92
General Ed./ Clubs/Etc.	4	400	1,600	40	25	40	1.6	1.84	3.68
TOTALS	35					350	14.0	16.10	32.20

TABLE VI

Teaching Stations Needed For a Given Program For 3rd and 4th Year Students in a Middle School

Subject	(1) Number Periods Required Per Week	(2) Number Students	(3) Student Periods (1x2)	(4) Number Periods (pds/wk)	(5) Student Capacity Per Class (policy)	(6) Total Number Class Periods (3÷2)	(7) Total Number Teaching Stations (6÷5)	(8) Adjusted Number Teaching Stations	(9) Adjusted Number Teaching Stations 2 - Houses
English	5	400	2,000	40	25	50	2.0	2.3	4.6
Social Studies	5	400	2,000	40	25	50	2.0	2.3	4.6
Math	5	400	2,000	40	25	50	2.0	2.3	4.6
Science	5	400	2,000	40	25	50	2.0	2.3	4.6
Foreign Language	3	400	1,200	40	25	30	1.2	1.38	2.76
Art	2	400	800	40	25	20	.8	.92	1.84
Music	2	400	800	40	25	20	.8	.92	1.84
Practical & Home Arts	3	400	1,200	40	25	30	1.2	1.38	2.76
Physical Education/ Health Ed.	4	400	1,600	40	25	40	1.6	1.84	3.68
Commerce	1	400	400	40	25	10	.4	.46	.92
TOTALS	35					350	14.0	16.10	32.20

The total program needs as expressed in teaching spaces is combined in Table VII and compared to selected recently planned Middle Schools for the School District of Philadelphia. Inspection of the table reveals that all of the schools fall within a range of two classrooms of those required, and that only one school deviates as much as two classrooms in excess of requirements.

TABLE VII

Comparison Between Program Space Needs and Available Spaces in Selected Middle Schools

Subject	Program Needs	Turner Middle School	Mack Middle School	Ross Middle School	Meehan Middle School
General Purpose	31.28	40	40	36	32
Science	9.20	4	4	4	9
Art	3.68	3	4	3	3
I.A./H.E.	4.60	6	6	6	6
P.E./Health Education	7.36	6	6	6	6
Foreign Language	3.68	1	1	4	1
Commerce	1.84	2	2	2	2
Music	2.76	2	3	2	2
Large Group				4	4
Totals	64.40	64	66	67	65

Program Analysis

The Quincy School, which was constructed in 1848 in Boston, Massachusettes, served as a model for school design from that date until recent years. At that time, it was admitted that approximately 40% of the elibible pupils attended school and that a very small percentage of those who did attend completed the eighth grade program; even fewer students completed the senior high program. The result was that those who did manage to go to school composed a small group of the elite intelligencia. The group was a select one and the schools did not attempt to provide a comprehensive educational opportunity for all pupils. It was not necessary because of the composition of the student body.

Since that time, the role of education has changed and grown until the present time. It is now well recognized that one of our predominant national goals is to provide an opportunity for every pupil to develop, through education, to the highest level of his personal potential.

It was for this end that Dr. J. Lloyd Trump was commissioned in 1953 to study the schools across the country and determine ways and means of improving the quality of education offered to boys and girls. This commission, study, and the resultant reports have given impetus to the goal that educators have vocalized for many years; the individualization of instruction and the personalization of education.

Among the problems that Dr. Trump publicized was the rigidity of the school day and the concommitant lack of means of adjusting this rigid scheduling to be adjusted to meet individual needs.

The school day, as traditionally scheduled, is broken down into seven or eight equal periods of time with no regard for the learning tasks to be accomplished or for the learning potential of individual pupils. The week repeats this one day mode and each week is a redundancy of the one past and the one to come.

Given this set of variables; (1) a limited number of pupils; (2) a standard curriculum which does not seek to be comprehensive; and (3) a rigid school day, scheduling is a relatively easy process whereby an administrator simply divides the number of minutes in the day by the desired number of class periods and the number of pupils by the class periods available. The result is a schedule which can attain a high degree of utilization of a facility.

As more variables are added, the scheduling problem becomes more complicated. For example, when schools began to offer electives it became obvious that all classes could not be the same size, simply because not all pupils "elected" to take the same courses. It is easy to see that as the curricular offerings become more broadly based in the attempt to individualize the comprehensive educational opportunity for all pupils, there will be a lower degree of utilization of a given facility. Even though every class space is occupied every period of the day, the classroom in which German IV is taught, for example, is utilized at a lesser rate than is one in which World History is taught simply because fewer pupils take German IV.

These additional variables plus the added incentive of individualized opportunity have created the need for a different kind of schedule in the

upper schools. Modular or flexible scheduling has been developed to meet this need.

It must be remembered that flexible scheduling is not an end product, but a means or tool for implementing individualization of instruction. Obviously, if a school day contains 21 segments rather than eight, more varied combinations of time are possible. Thus, the potential for matching the educational task with an appropriate time segment is enhanced. The combination of the variables now recognized, (1) the learning task; (2) the pupil's personal ability; (3) the teacher's design for instruction; and (4) the ability to manipulate time constraints, have definite implications for facility and/or space:

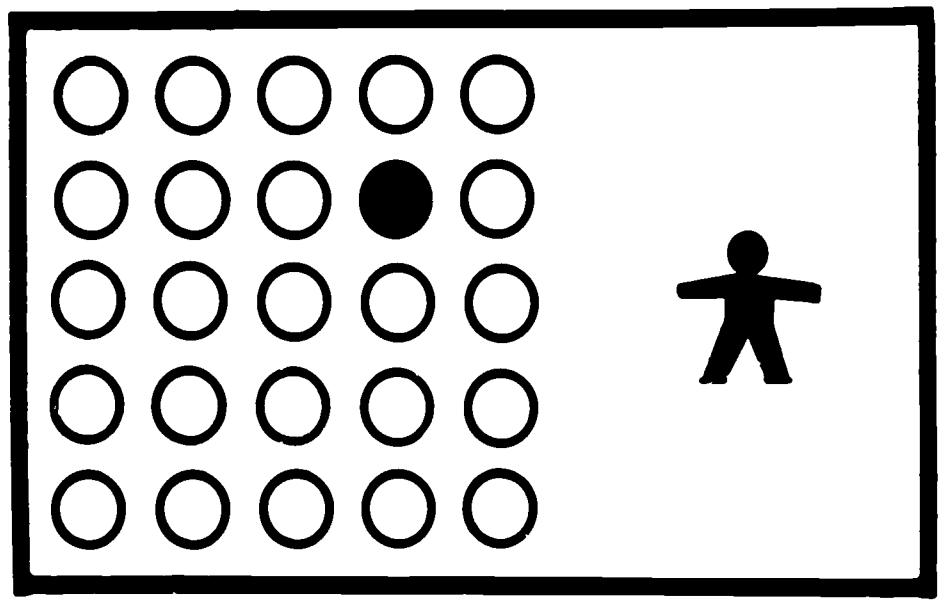
1. The subject periods are overlapping, therefore requiring unrostered spaces.

2. The learning resources which are available must be increased, therefore requiring more space for both their use and their storage.

3. The activity oriented individualized program requires more space per student than does a sedintary program.

THE DIFFERENCE BETWEEN THE TWO APPROACHES TO INSTRUCTION AND SCHEDULING MAY BE DEPICTED GRAPHICALLY.

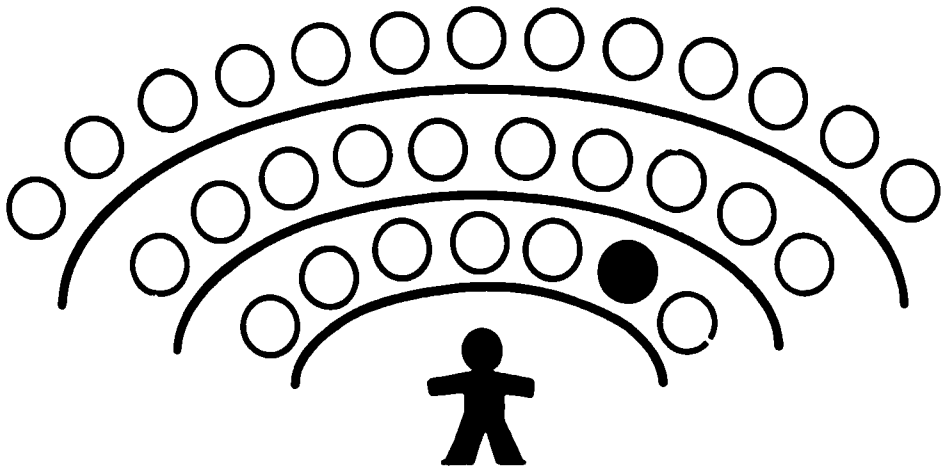
ONE HOUR OF TRADITIONAL SCHEDULING



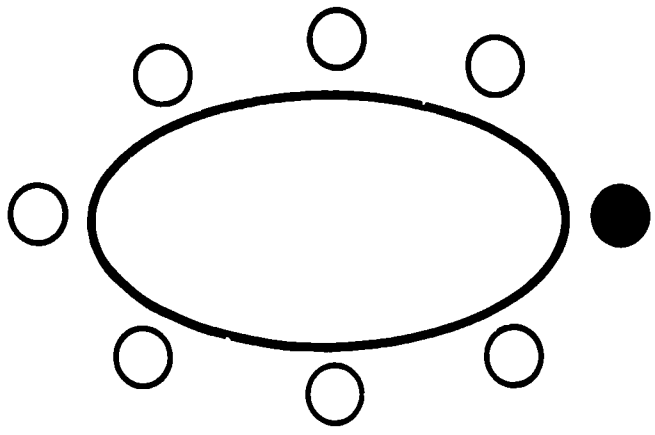
or

60 MINUTES

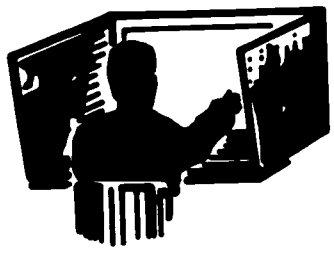
LARGE GROUP DISSEMINATION 20 MINUTES



SMALL GROUP DISCUSSION 20 MINUTES



INDIVIDUAL APPLICATION 20 MINUTES



While it is possible to group the modules together in different combinations to provide the appropriate time blocks, the illustration serves to point out that a single pupil may be involved in a number of activities during the same time period in which he previously was sitting in one chair in one room. Another pupil may or may not occupy the space that is vacated with the change of task. Certainly, the rate of utilization of spaces, and therefore the capacity of the building, is reduced as more personalized attention is given to a broader base of variables or as the variables are changed.

Summary

The capacity of a given facility is a product of the rate of utilization of the individual spaces and the rate of utilization is a product of the educational program plus the methodology for implementing that program. Optimum capacity is that capacity at which the educational program can best afford each individual pupil the opportunity to develop to the limit of his potential at a rate which is appropriate to his ability. Optimum capacity may be deviated from to any degree desired on a continum point zero to beyond maximum capacity by altering the variables that constitute the educational program.

The choice of capacity then is simply one of determining what the educational program shall be and the extent to which that program shall be offered to all pupils.

High School Analysis

Capacities and utilization rates for high schools can be developed in much the same manner as for middle schools.

Comparable data on student stations and student period stations for a typical high school are presented for analysis in Table VIII. A total of 24,003 student period stations are available for utilization in any one day. This figure is translated into 4,000 students if it is possible to ignore educational goals and roster the facility 100% of the time.

Since all students cannot be lock-stepped from one room to another at precise time intervals, and since teaching spaces are not totally interchangeable, there will be some of the time when certain spaces or parts of the school will not be utilized and there will be times when these spaces will be utilized 100% of the time with possibly 100% capacity. In order to compensate for peaks of program demand, as well as other factors mentioned earlier, a utilization factor is applied to school facilities. A common utilization factor or rate is 85%.

An 85% utilization rate would reduce the total student period stations to 20,402 or a student capacity of 3,400. By increasing the general purpose classroom capacity to 30 students, a total of 4,291 students could be placed in the facility, or 3,648 students at 85% utilization.

The non-rostered areas provide an entirely different problem in trying to ascertain utilized capacity. Here the assumptions made about the type of program are more tenuous because the program direction is such that the utilization of these spaces, by their very nature, will and should vary from day to day according to the needs of the program. For example, if it is assumed that generally the non-rostered areas will be utilized about 15% of the time, these areas would provide an additional 9,152 student period

TABLE VIII

STUDENT STATIONS AND STUDENT PERIOD STATIONS
FOR A TYPICAL HIGH SCHOOL
Assume Facilities Available for 7 Periods
Per Day, Students Rostered Six Periods

Rostered Areas	Student Cap.	No. of Units	Total Student Stations	Periods Available	Total Student Period Stations Per Day
G. P. Classrooms	25	50	1,250	7	8,750
R. E. Classrooms	18	8	144	7	1,008
Language Labs	25	8	200	7	1,400
Science Labs	25	9	225	7	1,575
Business Labs	25	13	325	7	2,275
Art Labs	25	4	100	7	700
Speech & Drama	25	2	50	7	350
Home Economics Labs	25	7	175	7	1,225
Technology Labs	25	8	200	7	1,400
Music-Instrumental	75	1	75	7	525
Choral	75	2	150	7	1,050
Driver Education)	60	1	60	7	420
Health Education Lab)	80	1	80	7	560
Gym-Main)	40	8	320	7	2,240
Communication Labs	25	2	50	7	350
Reading Labs	25	1	25	7	175
Sub-Totals		125	3,429		24,003
Non-Rostered Areas					
a. Large Group					
Instructional Area (Aud)	120	7	840	7	5,880
Instructional Area (Aud)	200	3	600	7	4,200
Theater	640	1	640	7	4,480
b. Small Group					
Conference Rooms	15	2	30	7	210
Music Ensemble Rooms	5	2	20	7	140
Stage Craft	20	1	20	7	140
Remedial Gym	20	1	20	7	140
c. Individual Areas					
Learning Center	60	4	240	7	1,680
Individual Science Project	2	8	40	7	280
Music Practice	2	10	20	7	140
I.M.C.	120	1	120	7	840
Computer Study Spaces	25	2	50	7	350
Sub-Totals		42	2,640		18,480
d. Student Dining	1,150	1	1,150	3	3,450
e. Recreation (P.E. Activity)	40	2	80	3	240
Grand Total		167	6,069		42,483

stations which is translatable into 1,525 students each rostered for a six period day. However, it is doubtful that these areas will regularly be used to the full capacity of each space. At the present time, the existing schools in the School District of Philadelphia do not generally contain the numbers or types of spaces being planned for new programs in the new schools.

Staff Deployment

As mentioned earlier in the report, deployment of staff may be a factor that effects the utilization of facilities. Lack of sufficient staff in terms of numbers alone could decrease the utilization of facilities. Additionally, the type of staff competencies could either facilitate or hinder utilization of class facilities. For example, in most middle schools, three Industrial Arts teaching spaces are specified. These three teaching spaces could be utilized eight periods per day, making a total of 24 class periods and a total of 120 classroom periods per week. This is at full 100% utilization, assuming students can be successfully rostered in all 120 class periods. Typically, teachers in the middle school teach five class periods per day or 25 periods per week. Three Industrial Arts teachers would teach 75 periods and four teachers would cover 100 class periods per week. The four teachers would, therefore, cover only 83% of the total available 120 class periods. To add the fifth Industrial Arts teacher would overstaff this particular complex by five periods per week. The same calculations could be completed for the teaching staff in any discipline. In the area of Humanities and Sciences, there can be some assignment of teachers to teach outside of their major area of preparation. However, this practice is limited by both available personnel and personnel policies of the School District.

Deployment of teachers and staffing of activities in the high school has the same effect upon utilization as in the middle school. The staffing problems are more acute because of the higher degree of specialization of the staff. Whereas, in the middle school program there may be some possibilities of teachers instructing classes outside their area of major specialization, this option is limited in the high school. When Federal and State subsidies are provided for certain courses, fully certified teachers are required.

Assuming that students could successfully be rostered in each period in each shop in a high school, it might then seem possible to staff these areas in such a way that classes could be held in the shops the full number of periods in each day. Some shop courses, however, require a double or triple period which restrict the rostering options available. Curriculum demands for the 10th and 11th grades in automotive repair shop courses in particular, call for a double period and in the 12th grade a triple period. Thus, in automotive shops, an 85% utilization (6 periods of the regularly scheduled 7 periods) is the highest rate possible.

Time Factors

Utilization of the facilities can also be increased by extending the teaching day. At the present, the middle and junior high schools operate on a 40 period week, eight period day; the high schools normally operate on 35 period week, seven period day. If the teaching day were extended to a 9 or 10 period day, the rate of utilization could be increased above 100%.

Table IX illustrates the increases that could be affected in both a middle and high school when the teaching day is extended. The table was developed with certain underlying assumptions such as; (a) students will continue to be rostered for a six period high school and seven period middle school program; (b) the program would remain basically the same as is presently developed; and (c) there are still factors such as staff, program selection, and space availabilities that prevent the school from being utilized more than 85% at any one time. The high schools presently operate on a seven period day. The facilities in the new high schools, if utilized for seven periods would produce 24,003 student period stations (capacity x number of facilities x number of periods per week) or a capacity of 4,000 students. (Refer to Table VIII). If an 85% utilization factor is applied, a total of 20,403 student period stations is available or a capacity of 3,400 students. Table IX illustrates the number of student period stations available at 7, 8, 9, and 10 periods per day. The student period stations are then reduced by an 85% utilization factor and transposed into number of students that can be accommodated. The table also indicates that the percent of utilization can be increased by increasing the number of periods per day and still allow a margin of flexibility - (85% utilization) at any one time. Thus, a typical high school can be rostered for a 10 period (extended school day), for example, 8:30 a.m. to 4:00 p.m. with 50 minute modules, and thereby increase the percent of utilization to 121% and still maintain an 85% utilization factor.

TABLE IX

High School and Middle School Capacities and Percentage of Utilization for Various Instructional Periods Per Day

Number of Periods Per Day	Student Period Stations @ 100%	Student Period Stations @ 85%	Number of Students Accommodated @ Six Period Roster	Percent of Utilization
High School				
7	24,003	20,402	3,400	-
8	27,432	23,317	3,886	96
9	30,861	26,231	4,371	109
10	34,290	29,146	4,857	121
Middle School				
8	13,556	11,522	1,646	-
9	16,218	13,785	1,969	102
10	18,020	15,317	2,188	113

Likewise, the typical middle school can be rostered for 10 periods per day and thereby increase the utilization and still maintain a margin of flexibility.

Concommitantly, with the increase in utilization in the overall facility, the capacity for the middle school could be increased to 113% of the programmed capacity of 1,650 or 2,188 students. Likewise, the student capacity of a high school could be increased 121% of the programmed capacity so that 4,857 students could be accommodated.

SUMMARY

To answer the general question of how many students can be housed in the new Middle and High School of the School District of Philadelphia, an analysis of the spaces presently planned in these facilities was made. This data was further extended to determine the student period stations which may be available for rostering students. Total student period stations can more easily be used to determine general capacity and rate of utilization because this statistic is more amenable to dissection that either number of students or number of teaching spaces. Additional analyses were made using total student period stations in both rostered and non-rostered areas and various rates of utilization.

A suggested program was developed for the Middle School outlining certain time allocations for various subject matter areas. These time allocations for each student were projected into space needs for the entire four years covered by the Middle School. The space needs for the developed program were then compared to presently planned facilities.

From the above analyses of time, space, capacities, and program, several conclusions concerning the utilization of school facilities were derived:

I - *Capacities of schools can be increased by raising the average class size (pupil-teacher ratio).* Such a procedure does not, however, address itself to a desirable or optimal class size. Table X is a summary of obtainable

capacities of Middle and High Schools with various class capacities and ratesof utilization. The summary also presents capacities based on an application of the planning guide of 50% additional student spaces in an individual modular scheduling program.

TABLE X

Teaching Stations	Class Size	Utilization Rate	School Capacity: Conventional Rostering	School Capacity: Conventional Rostering w/ Non-Rostered Areas Included	School Capacity: Modular Scheduling Rostered and Non-Rostered Areas
Middle School					
64	25	85	1,646	1,813	1,600
64	25/30*	85	1,691	1,858	1,645
64	30	85	1,820	1,987	1,675
64	25	90	1,743	1,910	1,666
64	25/30*	85	1,788	1,955	1,711
64	30	90	1,928	2,095	1,774
High School					
125	25	85	3,400	3,806	3,438
125	30	85	3,638	4,044	3,580
125	25	90	3,600	4,006	3,640
125	30	90	3,863	4,269	3,790

II - Non-rostered areas within the Middle and High School may account for increased student body capacities. The utilization of these areas, however, cannot be defined until the educational program is further delineated and may well differ from school to school. Efficient utilization, to a point, will result from experience on the part of the school staff in utilizing these areas.

III - In order for the rate of utilization not to have an undue and limiting influence upon the extent and type of educational program, decisions

* Based upon the assumption that the 5th grade (approximately ¼ of the pupils) is organized as a self-contained classrooms with the standard elementary classroom capacity of 30 pupils per class.

concerning type of program should proceed all other decisions. The educational program should determine the appropriate rate of utilization and therefore the optimum capacity.

IV - The rate of utilization of any existing facility is the product of: (1) certain internal capacities and (2) type of program in operation of the facility. These two factors can be broken down further into the following components:

1. Internal Capacities
   a. Total school capacity
   b. Program, track, or sequence capacity in terms of either staff, students or facilities
   c. Individual class and laboratory capacity
2. Educational Program
   a. Instructional techniques
   b. Grouping patterns
   c. Scope and complexity of subject matter offered
   d. Specialized facilities such as shops, gym labs and cafeterias
   e. The time available for the school day. i.e., the length and number of periods per day and length of the school day

V - Innovative educational programs which stress an individualized process, demand more student stations than do traditional programs. These program demands have an effect upon the rate of utilization of the total facility. If it were possible to section the student body into groups and closely roster these groups from one teaching area to another,

a high rate of utilization could be obtained. Such a procedure, however, is the antithesis of the type of quality educational program needed for the urban student. To implement "individualized instruction" for urban youth, the need for flexible space is paramount. A high utilization rate would probably cause inhibiting effects on individualized instruction.

REFERENCES

1 - The School District of Philadelphia, Capital Improvement Program - 1969-1972 Philadelphia: May 27, 1968

2 - School Planning Department, A Report on Space Utilization, Philadelphia: The School District, August, 1967

3 - J. Lloyd Trump, Secondary School Curriculum Improvement, Boston: Allyn and Bacon, Inc., 1968

4 - Educational Facilities Laboratory, Computer Scheduling Educational Reform, New York: 1966

5 - Alan L. Knight, Davis, MacConnell, Ralston Associates, Washington, D.C.: August 16, 1968

6 - J. Lloyd Trump, Images of the Future, National Association of Secondary School Principals, Washington, D.C.: 1959