DOCUMENT RESUME

ED 187 020		EA 012 697
AUTHOR	Bernhardt, Victoria L.	
TITLE	Projecting Student Enrollments: A Basic Step in Comprehensive School District Planning for Declining Enrollment.	
INSTITUTION	Eugene School District 4J, Oreg. Div. of Research, Development, and Evaluation.	
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.	
PUB DATE	Feb 80	
GRANT	NIE-G-78-0078	
NOTE	166p.; Not available in paper copy due to marginal legibility of original document.	
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.	
DESCRIPTORS	*Case Studies; *Declining Enrollment; Elementary Secondary Education; *Enrollment Projections; *Models; *Research Methodology	
IDENTIFIERS	Austin School District TX; *Eugene Public Schools OR; Philadelphia School District PA; Seattle Public Schools WA	

ABSTRACT

Implementing an enrollment projection methodology and a planning methodology in a school district is often a complex problem because many possibilities exist. The purpose of this study is to demonstrate that successful research techniques used by some school districts can instruct other districts about methods and aims to pursue or avoid in enrollment projection efforts. The four case studies explained in this document describe enrollment projection methodologies presently used in four metropolitan areas that are experiencing declining enrollments and drastic population shifts. The book also describes methodologies for projecting individual school enrollment and two enrollment projection methodologies that incorporate variables other than past enrollment trends. The latter procedures--land use adjustment and the balancing factor--are examples from the Eugene (Oregon) school district. (Author/LD)

PROJECTING STUDENT ENROLLMENTS:
A Basic Step In
Comprehensive School District Planning
For Declining Enrollment

Prepared by:
Victoria L. Bernhardt
Planning Department
Research, Development and Evaluation Division
Eugene Public School District 4J
Eugene, Oregon

NIE-G-78-0078

U.S. Department of Health, Education and Welfare
Patricia Roberts Harris, Secretary

National Institute of Education
Michael Timpane, Acting Director
Program on Educational Policy and Organization
Mark Tucker, Associate Director

February 1980

Acknowledgments

This document is the result of a cooperative and supportive effort of school district research and planning offices in Seattle, Washington, Philadelphia, Pennsylvania, Austin, Texas, and Eugene, Oregon. Preparation of this manual was based on information and research supplied by the following experts: Ms. Susan B. Franklin, Dr. Gary Beanblossom, and Ms. Margery Erickson from the Seattle Public School District; Dr. Thomas W. Pullum and Mr. Stephen N. Graham from the Center for Studies in Demography and Ecology, University of Washington; Dr. Michael H. Kean, Dr. William Herron, Ms. Francis Frank and Ms. Silvia Dicter from the School District of Philadelphia; Dr. Terry Bishop, Mr. Hugh Eckols, and Dr. Freida Hollcy from the Austin Independent School District; Mr. Robert Swank and Mr. James Carlson from the Lane County Council of Governments, Eugene; Dr. Larry Barber, Dr. Charles Stephens, Dr. Rose Hesse, and Ms. Audrey Wilhelm from the Eugene Public School District.

Contents

Tables

Figures

Chapter 1

Introduction

Introduction

For the past decade, student enrollments have declined steadily in school districts throughout the United States. By the fall of 1980 the national enrollment of entering students will likely be the smallest in ten years. This loss of students in expansion-oriented American public education has become one of the most compelling problems facing school district administrators today.

National Enrollment Trends

Between 1950 and 1970 elementary school enrollments grew from 22 million to 37 million students while secondary school enrollments more than doubled, from 6.5 million to nearly 15 million students. Public elementary and secondary school expenditures rose accordingly from $6 billion in 1950 to over $40 billion in 1970. By 1970, however, two decades of educational growth ended as elementary school enrollments began to decline. District budgets and federal funds for education grew strained as school tax rates and teacher salaries continued to escalate. Between 1970 and 1974, the nation experienced a loss of 2.4 million students enrolled in its public schools. A total decrease in enrollments of 3.4 million is expected between 1975 and 1982. Projections from the U.S. Bureau of Census indicate that enrollments will continue to decline through 1981-82. First grade enrollments will increase in 1981, as will enrollments in the higher grades in the succeeding years. As lower grade enrollments begin to increase, however, secondary enrollment will continue to decline through 1990.

Planning Around Decline

In a society unaccustomed to contraction, declining enrollments have seriously challenged many public school administrators who have enjoyed enrollment growth during their professional careers. Declining enrollments, however, coupled with diminishing resources, budget defeats, reductions in force, program closures, and restricted curriculums, have increasingly demanded that leadership be measured by the ability of administrators to cope with the long and short-range effects of this decline.

Planning around a declining enrollment requires much more resourceful school district management than that during an expanding enrollment. Decline cannot be construed as the reverse of expansion; the most recent program and staff additions, for instance, may not be the most expendable or least important. Yet a declining enrollment need not imply a corresponding drop in the quality of educational services. Enterprising and creative school administrators can develop better programs through necessary consolidation and can find effective uses for existing facilities. Enrollment decline can prove to be a crisis or an opportunity depending on the management's response.

The key to successful decision-making during declining enrollments is a comprehensive planning process by which facts and opinions are gathered, alternatives proposed, and decisions made that best perpetuate community and staff support. Comprehensive and effective planning implies long-term and system-wide planning as opposed to a short-range "crisis management" style. Comprehensive planning provides the opportunity to evaluate personnel and policy in times of rapid change and to ensure quality education despite decreasing resources and enrollments.

Successful school district planning for declining enrollment depends upon an accurate procedure for monitoring and predicting enrollment changes. Enrollment projections are the prime indicators of future demand for educational services, programs, staff, and facilities. The credibility of all planning decisions, of course, is directly linked to the accuracy of the projections.

Local Implications

The loss of over five million students within a ten year period clearly has severely affected school districts throughout the nation. Knowledge of this national trend is helpful, but does not provide adequate guidance for local planning.

Local declining enrollment patterns must be studied to develop appropriate strategies and procedures to respond to individual trends. Each school district, because of unique community needs, must develop its own strategies, determined by its educational goals and programs, community needs, financial resources, enrollment projections, and planning capability.

Purpose and Goals

This study is designed to disseminate valuable information about various enrollment projection methodologies used by school districts faced with declining enrollment and population shifts.

Implementing an enrollment projection methodology and a comprehensive planning methodology in a school district is often a complex problem because many possibilities exist. Many of the possible methods, however, may not be appropriate for an individual school district. The most useful approach to complex problems where several solutions are possible and one "right" method is not readily apparent, is the case study approach. Case studies presented in this study describe enrollment projection methodologies presently used in four metropolitan areas. All areas are experiencing declining enrollments and drastic population shifts. These four descriptions describe ways in which selected school districts around the country facing drastic population shifts and policy alterations carried out comprehensive planning. The case studies also describe methodologies for projecting individual school enrollment, a process often neglected in school enrollment-planning literature, but crucial for the appropriate allocation of school district resources.

Case studies also describe two enrollment projection methodologies that incorporate variables other than past enrollment trends. Both of these methodologies were designed to improve the accuracy of the enrollment projection methodology currently used by the districts. The modification attempt failed at one site and is currently being implemented at the other site. An outline of each methodology's development illustrates the steps and problems involved in setting up an enrollment projection methodology in two urban centers with specific problems.

This study hopes to stimulate planning for declining enrollment and population shifts and to emphasize the importance of accurate enrollment projection methodologies.

This study demonstrates that successful research techniques employed by various school districts can instruct other districts of methods and aims to pursue or avoid in enrollment projection efforts.

Participants

Four school districts from three distinct national regions were selected as field sites for the case studies. The sites - Eugene, Oregon, Seattle, Washington, Philadelphia, Pennsylvania, and Austin, Texas were selected for their unique enrollment shifts, and their cooperative participation. The sites vary in size and represent school districts that are actively planning for declining enrollments. Medium-to-large school districts were used because of established planning staff and procedures within each district's administration.

Overview

For the past decade, declining student enrollment has forced school district administrators throughout the nation to adjust to the frustrations of managing diminishing resources. In a society geared to expansion, planning around budget defeats, program closures, reductions in force, increasing loss of community support for public schools, and fewer course offerings has placed enormous psychological, financial and social/emotional pressures on school district administrators.

Planning for declining enrollment can be accomplished only when a school district can accurately monitor and predict enrollment changes. Enrollment projections are essential for staffing, budgeting, and facilities planning. Accurate enrollment projections provide reliable estimates for short-range and long-range planning to ensure quality educational program facilities, and personnel needs.

Very few documents have directly addressed the development of accurate individual school enrollment projection methodologies. Because the use of very small numbers invites random error, individual school projections are difficult to project with extreme accuracy. Chapters 4, 5, 6 and 7 describe how four large school districts responded to this difficulty of projecting small units (individual schools). These documentations are intended to advise and instruct other school districts around the country experiencing the same difficulties. Enrollment projection methodologies were investigated and documented in four urban centers in various geographic regions in the United States. The four districts, the Eugene Public School District, the School District of Philadelphia, the Austin Independent School District, and the Seattle Public School District are all experiencing declining enrollments and are actively planning for declining enrollment.

The methodologies utilized at each of the four districts consisted of two major phases: District-wide grade-level projections and individual school projections. The grade-level projections, acquired through the cohort survival methodology or a modification of it, are used to monitor the individual school projections.

In Eugene, the individual school enrollments are projected by grade level, for non-initial grades, by advancing the previous years' enrollment as the enrollment for the projected year. Initial grade enrollments (kindergarten, first grade, seventh grade and ninth grade) are projected by utilizing birth-to-kindergarten ratios for kindergarten and by soliciting verbal estimates from junior and senior high schools to approximate the number of students expected to enroll the next year. The individual school projections are subjectively adjusted so that they cumulatively produce the projected district total.

In Philadelphia, eight sub-district enrollments, as well as the total district enrollment, are projected and used to monitor individual school enrollment projections. Individual school enrollments are projected by using a school-to-sub-district proportional ratio and adjusting the projections to the sub-district and district totals.

Seattle school district is currently implementing a desegregation mandate. With no historical data to identify trends or the impact of desegregation, projections of individual school enrollment are based on student assignment data.

A computerized system known as the Student Resource Allocation Model (SRAM) has been developed and implemented in Austin to project district and individual school enrollments. SRAM utilizes the cohort survival methodology and displays projections for low, medium and high cohort survival ratios for the past ten years. It allows an option to include ratios that may better reflect outside variances affecting the district's student enrollment.

Two districts, Eugene and Seattle, have recently attempted to modify their existing enrollment projection methodologies. The Eugene modification tested three commonly used enrollment projection methodologies - cohort survival, regression and ratio - utilizing land use variables. A general model grew out of the field testing. The Seattle modification has been developed and is presently ready to be tested. This modification assigns a ratio value to the smallest indivisible unit (a student) that represents the probability that the student will stay in the district. This is based on residential, past enrollment, and assignment variables. Projections for individual schools are then made when the modification's simulation sub-program places the student in an attendance area. The technique utilizes the Markov Chain theory and represents an innovation in individual school enrollment projection methodologies.

The chapter that follows discusses the role of enrollment projection methodologies in school district decision-making and the importance of their accuracy.

Chapter 2

Utilization of Enrollment Projection Methodologies in School Districts with Declining Enrollment

Utilization of Enrollment Projection Methodologies in School Districts with Declining Enrollment

Comprehensive planning can often make the difference between crisis-oriented and effective school district management, especially in times of declining enrollment and drastic school population shifts. The first and most essential element of comprehensive district planning is an accurate means of predicting future enrollment. The projections are the basis for administrative planning decisions, and must achieve extreme accuracy to ensure that the most economical and appropriate decisions are made.

Enrollment Projection Methodologies

School district planners most often make enrollment projections for one to five years into the future. In school districts where long-range planning is utilized, district-wide grade-level enrollments are projected as far as 10 to 25 years into the future. Individual school enrollments are usually made annually since the small numbers involved are prone to random error in the enrollment projection procedures. In addition, the farther away from the actual enrollment data, the more inaccurate the projections become. The random erros increase for each projected year in an exponential fashion.

The most commonly used methods for projecting school district enrollment have utilized past trends to predict future trends. These methods have generally produced quite accurate predictions of enrollment for the district. At the individual school level, however, projections based on past trends must be adjusted either subjectively or through use of other methods to accommodate the small numbers that are subject to random error. In cities where enrollments are shifting drastically within the school district, past trends will probably not be helpful in projecting individual school enrollments.

The enrollment projection methodology most commonly used is <u>cohort survival</u>. Cohort survival assumes that a relatively consistent number of students pass from one grade to the next from year to year and that a percentage of such advancements can be calculated. On the basis of the preceding three to five years' "percentage of survival," the next year's enrollment can be projected.

Other methodologies commonly used around the country are the regression, ratio, and Markov methodologies, and a combination of two or more methodologies. An analysis of each of the methodologies can be found in TABLES A-1 through A-5 in Appendix A. Along with a description of the methodology, each table includes an explanation of how the methodology is calculated, its statistical model, data requirements, as well as a list of its advantages and disadvantages. Four methodologies are further explored, as actually used by school districts, in the following chapters.

Uses for Enrollment Projections

Because enrollment projections can accurately predict the number of students expected to enroll in the school district one to ten years into the future, school district administrators can continue to make more effective and advantageous management decisions despite enrollment decline. The four major areas that can be directly managed on the basis of enrollment projections are staffing, budgeting, facilities planning, and program offerings. Enrollment projections provide valuable information for decisions regarding the following:

1) The number of staff to hire, retain or dismiss. This

   a) Enables reassignment of staff to ensure retention of presently employed teachers whose classes are dwindling.

   b) Provides a basis to revise retirement plans and staff development activities.

   c) Permits accurate staff allocations to grade levels and individual schools to help regulate class size and provides information on which to base changes in student to staff ratios.

   d) Warns administrators and teachers of impending staff reductions.

   e) Enables the restructuring of administrative services and the number of administrators to retain or reassign.

   f) Aids in determining the number of non-certificated staff to hire (teacher aides, clerks, custodians, etc.).

2) Planning for funding.

   a) Since state aid and federal funding formulas are based primarily on the number of students enrolled in the district, knowledge of future enrollments allows administrators to estimate and budget for monies to be received from state and federal sources.

   b) Predictions can be made concerning the impact of declining enrollment on local educational support. Decisions can be made based on knowledge of community support and assumptions that declining enrollment may negatively affect a district's ability to pass tax and bond referenda.

   c) Enrollment projections anticipate fiscal crises and provide time to help legislate school funding independent of enrollment numbers.

3) Forecasting need for facilities:

   a) Enrollment projections help predict the need for the building, alteration, or closure of schools in the district.

   b) Enrollment projections help administrators decide whether to sell, rent, lease, or "mothball" buildings when immediate closure is necessary, as well as to determine which schools to close.

c) Knowledge of the number of students in each school attendance area enables planners to determine the most cost-effective busing routes. In terms of desegregation mandates, enrollment projections provide the number of minority/non-minority students in each attendance area to aid desegregation planning and busing proposals.

4) Planning for program offerings.

a) Knowledge of the number of students expected to enroll in schools in the next year can assist administrators in prioritizing different program offerings for elimination or cut-backs, such as extra-curricular programs, athletic programs, counseling, library services, foreign language, and low demand curricular courses.

b) Curriculum development and consultation needs can be planned for by knowing the number of students expected to enroll in schools in the next year. The number of enrollees can be an indicator of the need for curriculum changes.

c) On the basis of the number of students expected to enroll in schools in a district. the need for reorganization of grade structure can be realized and met.

d) New programs such as magnet programs, can be developed to encourage utilization of extra space in low enrollment areas.

Importance of the Accuracy of Enrollment Projections

The need for accuracy in projected student enrollments for allocation of state and federal funding is self-evident. Inaccuracy can not only cut a district short of funds but may cause the district to lose credibility with the funding agencies.

Mechanically speaking, extreme accuracy is particularly required in the initial grades of the first year's projections with almost every enrollment projection methodology. The initial grades and the first projected year provide the building block for projecting the next year's succeeding grade attendance and so on. By the time ten year projections have been accomplished, ten of the twelve grades of the last projected year will have been affected by the initial grades of the first year's projections.

Accurate enrollment projections are extremely important and most desirable to avoid over/under budgeting, staffing and purchasing.

Because projections deal with the unknown - the future conditions - accuracy cannot be realized until after most planning decision-making, and hiring for the successive school year has been completed. It is not until the actual enrollment counts have been collected in the fall that the school district administrator can judge the accuracy of the projections.

One method to "cushion" the blow of imprecision in enrollment projections is to create a "confidence interval". This "confidence interval" could be achieved by supplying high and low projections to surround the derived projections. Staffing, purchasing, etc., can be done according to the low projections to avoid over-staffing and over-purchasing; funding can be applied for on the basis of the medium and high projections.

Another method of protection against extreme inaccuracy is to compute all staff and facilities contracting for the district on the basis of a percentage of the projected enrollments. For example, in Eugene, Oregon, staffs are hired and facilities purchased for the upcoming year on the basis of 95 percent of the projected enrollment, allowing a 5 percent margin of error. If in the fall the enrollment count is the same or greater than the projected enrollment, additional teachers and facilities can be secured. District-level enrollment projections are seldom inaccurate by a 5 percent margin, so over-staffing should never be a problem utilizing this technique.

Chapter 3

A Model for the Inclusion of Land Use Variables in Short-term Enrollment Projections

A Model for the Inclusion of Land Use Variables in Short-Term Enrollment Projections

School districts have traditionally traced the decline of enrollment on a year-by-year basis. Few have systematically collected data on the variables in the community, referred to as land use variables, that correspond to enrollment decline. Even when this information was noted, the source was often simply building administrators explaining trends in their schools.

In the past few years, however, declining enrollment and the failure to predict it accurately have led to a reexamination of the traditional projection methodologies. Concommitant improvements in the accessibility of information from planning departments and census data have made the incorporation of land use information possible.

The methodology explained in this chapter explores these variables' relevance and attempts to utilize them in improving the traditional cohort survival, ratio, and regression techniques for projecting enrollment. The methodology adjusts the enrollment projections accomplished by traditional techniques on the basis of land use factors that describe enrollment-related differences within the school district. The experiment was conducted in Eugene, Oregon, based on methodology developed by James Carlson and Robert Swank from the Lane County Council of Governments, Eugene, Oregon. It is described here as a possible tool to be employed by similar school districts throughout the country.

Utilizing the enrollment projection technique described in Chapter 4, Eugene School District enrollment projections have in the past, consistently shown accuracy at the 99.5 per cent level, for both district and individual school projections. The individual school level projections, however, incorporate a high degree of subjective adjustment to allow the sum of the individual school projections to correspond to the district-level projections. Those subjective adjustments are usually made according to district administrators' insight into the expected changes in the attendance areas. The initial impetus of the work done in this chapter was to make an attempt to quantify the subjective adjustments and to describe a technique to systematically adjust the individual school projections to correspond to the district level projections. The former was attempted through exploration of land use variables that best explain attendance area changes and the latter by developing an equation known as a balancing factor.

Collection of Land Use Variables

Changes in neighborhoods are difficult for school district planners to trace. Information such as zone changes, building permits, and subdivisions is ordinarily not systematically received and compiled.

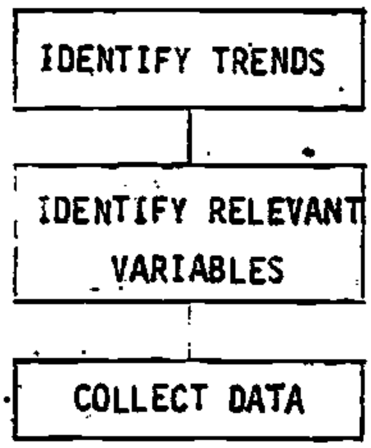
Information from the U.S. Census, which often gives information on changes in socio-economic status, racial composition, types of dwelling occupied, ages of housing, etc., is slightly more accessible. Most of this information is available through sources outside the school district, such as city planning departments, governmental statistics and research units, and assessors' offices. Most of the data in the reports produced by these agencies, however, are not broken down into units small enough to be applied directly to the school district's areas of interest. This difficulty in obtaining useable information on land use variables has discouraged most school districts from seeking this information.

For the communities in which reliable information is accessible, however, perhaps the most important tool in utilizing the methodology developed here is a good knowledge of the social, economic, and/or land use trends in the community. It is the first step toward incorporating land use variables into a projection methodology. Figure 1 illustrates a three-step process for the collection of land use information. The situation in Eugene illustrates this process, and the use of these variables in the projection methodology.

FIGURE 1

Process for Collecting

Land Use Information



Trends in Eugene, Oregon

Eugene, Oregon is located in the Willamette Valley, 110 miles south of Portland. Eugene is Oregon's second largest metropolitan area with a population of just under 100,000. The population is predominantly white and middle class. The population is less than five percent minority. Eugene grew most rapidly in the 1950s and 1960s, due mostly to migration from outside the state. This trend continued in the 1970s and the issue of growth continues to be central to local political campaigns and city and county government concerns.

Eugene has a strong neighborhood tradition. Neighborhoods are defined more by geography and periods of development than by ethnicity. In newer housing areas the population is distributed according to age and economic characteristics. Eugene may well illustrate the concept of neighborhood maturation, which postulates that a geographic area reflects the life-cycle of its occupants. Once a neighborhood is developed, families move in and produce children, and tend to remain in the same neighborhood. As time passes, however, the children progress through the local schools until the families in the neighborhood have fewer children living at home. A counter-trend to the neighborhood maturation concept is the "upward mobility" trend, in which a city is seen as a series of concentric circles of development. The outer fringes are the most desirable places in which to live and contain homes with higher land values. Families initially occupy less valuable homes near the center of the city, but move up and outward from the center as the life cycle progresses and they become more affluent.

Eugeneans seem to prefer single-family, detached homes. Statistics show that this type of home is preferred by families with children and that significantly fewer children live in apartments or other multiple-family dwellings.

Urban growth in the Eugene area has occurred mostly in concentric circles, pushing outward from the central city core. Considerable vacant land remains within the city limits around the outer fringes of the city. City and county governments have established an "urban growth boundary" that separates the residential zones outside the current city limits from agricultural and other lands in the county. This boundary has been rather rigorously enforced by both local governments.

In spite of this growth, declining fertility rates and differing rates of development within the metropolitan area have led to a declining enrollment in the Eugene School District since the late 1960's. A pattern of declining enrollments in schools located near the central city core and overcrowded schools nearer the outer fringes has emerged. The decline has been gradual and the schools with declining enrollment have encouraged diverse alternative programs to utilize their excess space. The strong neighborhood traditions in the central city have also enhanced and supported these uses of the school buildings. This combination of factors has prevented the necessity of attendance boundary adjustments, although students have been bused occasionally from overcrowded schools to less crowded schools.

In sum, urban development is still occurring on the vacant land on the outer fringes of Eugene. Little or no urban redevelopment is occurring in the central city area. Central city schools have declined in enrollment and schools on the fringes are often overcrowded. The homes on the fringes of the city frequently tend to be higher value homes. Neighborhoods on the fringes of the city contain varying average numbers of children, however, so some fringe schools are overcrowded and some are not.

Identification of Trends

In Eugene, four population trends seemed most significant.

1. Urban growth is still occurring at the fringes of the city.
2. Most families with children clearly prefer single-family detached dwellings.
3. Overcrowding in the fringe schools is not uniformly

distributed and some fringe areas contain homes with higher economic values.

4. Some neighborhoods' declining enrollment reflects "neighborhood maturation."

To identify trends in urban areas, several areas may be explored. Eugene, for example, has net in-migration. This is typical in most medium-sized cities, especially in the south and west. Other urban areas may have out-migration ("urban flight"). Neighborhood racial composition may be a strong factor in some cities, as might the caliber of housing available in the area, and the proximity of large low-income housing projects. A trend toward renovation of deteriorated neighborhoods might also be significant. Concepts such as neighborhood maturations, the "concentric circle" model of housing choice, and the economic value of homes and patterns of enrollment decline in individual schools should also be explored and examined.

Identification of Relevant Variables

Once potentially relevant trends have been identified, one can begin to locate relevant variables and data that reflect those trends. Relevant land use variables may be sought in measures which most directly reflect the trends. The most useable data should be easily related to attendance areas (or similar small geographic areas). This will require searching for sources of data that may be compiled by agencies other than the school district. Assessor's offices, planning departments, U.S. Census information, and local governmental research and/or statistics units are several likely sources of this data. A description of the potential sources of data identified for Eugene's four trends illustrates this process.

Eugene's in-migration and pattern of urban growth can be measured by several kinds of data. Variables reflecting the rate of general population growth would be one way to measure urban growth. Census data and surveys conducted by local governments could provide this data. One might also seek measures that could directly gauge the urban growth, including data related to the specific areas and types of growth occuring, such as public records of subdivisions, housing developments, zoning, and vacant land.

The preference of families for single family dwellings can be easily measured by noting the proportion of the housing stock that is single, rather than multi-family, and zoning patterns for single-family dwellings. This data could be obtained from zoning records, census data, and surveys.

The value of homes in specific areas can be measured by census data, housing surveys, assessed valuations, etc. Such data can also often be broken down into housing type, single-family, multi-family, etc.

"Neighborhood maturation" is apparently more difficult to measure. The age of a building, however, can usually be learned from assessment records of census summaries, as can the ages of heads of household from census data.

Collection of Data

After potential variables (and data) are identified and located, the data must be collected. This may eliminate certain variables, due to incomplete records, etc. The selected variables must always be directly related, however, to a fixed geographic area. This means that the data from an entire school district's geographic area must be dividable into subparts from which it makes sense to predict enrollment trends. The fixed geographic areas will, in many cases, be attendance areas of the district, although other geographic areas may be feasible. For instance, in a school district where many students are bused, it may be logical to utilize census tracts as the geographic base and rework school enrollment data to conform to census tract data. The remainder of this secion will briefly describe the relevance of the land use variables selected for Eugene. Tables 1, 2 and 3 provide a detailed description of each land use variable collected.

Six of the variables used in Eugene relate to its identified trends toward urban growth and preference for single-family dwellings. Each attendance area in the Eugene School District exhibits distinctly different potential for growth. Some attendance areas have very little vacant land and very few subdivisions, building permits, or similar indicators of future growth, while other attendance areas include large amounts of vacant land that demonstrate a certain growth potential. The necessary circumstances for growth in the Eugene area are closely related to two factors: 1) a residential designation in the comprehensive metropolitan plan for that area; and 2) appropriate zoning for that area. Since Eugeneans prefer single-family dwellings and single-family dwellings tend to house more children than do other dwelling types, one would select variables that reflect the amount of vacant land that could be developed into single-family dwellings. Table I describes in detail each variable's relevance and source of data. The following six variables were selected for Eugene:

1. Percent of total land area which is zoned for residential building.
2. Percent of total vacant land area.
3. Percent of all residential units which are single-family.
4. Net residential density (dwelling units per acre).
5. Number of vacant, residentially zoned acres.
6. Number of vacant, low density-zoned lots.

Variables were tested for relevance to the projection problem and three were selected for Eugene that best explain variance in attendence areas. These variables relate to the identified trend in which the value of homes influences the number of school-age children in that area. This trend is also reflected by the amount of vacant land. Some areas in Eugene are experiencing considerable growth but produce lower than expected numbers of children. The homes in these areas are generally of higher value than the norm for the Eugene area. The "concentric circle" model predicts that homes at the fringes would have higher values and

TABLE 1

Detailed Description of Variables Related to Urban Growth and Single Family Dwellings

1) Percent of Total Land Area which is Residential.

This percentage pertains to the zoning of the land in each attendance area. It gives an indication of the character of the attendance area (i.e., whether or not the area is predominantly residential). This figure also serves as a base for predicting what proportion of the vacant land in the area is likely to be residentially developed. In the Eugene area, this percentage was obtained from the Lane County Geographic Data System, which is a computerized data system used by local municipal planning departments.

2) Percent of Total Land which is Vacant.

This percentage provides an indication of the proportion of the land in each attendance area which has not been developed. It indicates the relative status of the area in terms of potential for further growth. An undeveloped area would be more likely to be in transition during the 15-year projection period. This data combined with the previous variable gives an indication of the residential development potential in each attendance area. In Eugene, this percentage was obtained from the Lane County Geographic Data System.

3) Percent of all Residential Units which are Single-family.

This percentage is a refinement of the first variable. This variable indicates the relative density of the residential units in each area (i.e., low density, or single-family vs. high density, or multi-family). Single-family units tend to have more students per household. When used to predict, it adds information about the potential for growth of single-family units in the area and it can provide a basis for estimating the number of school-age children.

4) Net Residential Density (Dwelling Units per Acre).

This figure describes the average number of dwelling units which currently exist. If one can assume that this will remain fairly constant, it can also represent an expected number of dwelling units on vacant land. This figure further contributes to the estimation of the potential for housing growth. The net residential density varies according to the zoning of the vacant land and can make single-family units more or less likely. The source of this data is the Lane County Geographic Data System.

5) Number of Vacant, Residentially Zoned Acres.

This figure represents the amount of vacant land which is also residentially zoned. This figure, in combination with net residential density and percent of residences which are single-family can give an indication of the potential for having growth. The source of this data is the Lane County Geographic Data System.

6) Number of Vacant, Low-density Lots

This figure reiterates some of the above variables and represents the actual number of vacant lots that are zoned for low-density (single-family or duplex) use.

that families strive to live in these areas by gradually moving outward as they progress upward on the income scale. Thus, the phenomenon of slightly lower numbers of children, but not significantly fewer children, may be explained by this model. Table II describes in detail each variable's relevance and the source of this data. The following three variables relating to this trend were selected in Eugene:

1. Average value of single-family units.
2. Percent of single-family assessed under $20,000.
3. Percent of single-family assessed over $40,000.

TABLE 2

Detailed Description of Variables Related to Value of Homes

1) Average Value of Single-family Units

This figure represents the mean value of the single-family units in this attendance area. This data gives an indication of the overall value of the housing type which is preferred by Eugene families for each school attendance area.

2) Percent of Single-Family Units Assessed under $20,000

This figure represents the lower income type homes in the Eugene area. One must remember that assessed value sometimes lags behind market values. Market values, if the data were available, may have been a better variable to use. This figure gives the proportion of single-family homes in the attendance area which could be considered to be low income.

3) Percent of Single-family Units Assessed over $40,000

This figure represents the average to the higher income range of homes in the Eugene area. Assessed value does lag behind market values for this variable also. This figure gives the proportion of single-family homes in the attendance area which can be considered to be average to high income.

Five variables were selected to reflect the neighborhood maturation trend. In Eugene, variables related to the age of buildings were found to measure this possible trend. The school enrollment records were incomplete, and the census tract data on age levels of residents and head of household was probably too old to reflect more immediate trends since most of Eugene's growth has occurred since the 1940s. Intervals of ten years were selected because 1950s and 1960s were major growth periods due to in-migration. The five variables were:

1. Percent of single-family units built prior to 1940.
2. Percent of single-family units built 1940-50.
3. Percent of single-family units built 1950-60.

4. Percent of single-family units built 1960-70.

5. Percent of single-family units built after 1970.

The final three selected variables sought to represent the number of children who will live in the attendance areas. To successfully employ land use information in enrollment projections, one must be able to determine a variable that would associate a number of school-age children to the number of homes in the attendance area. In an area like Eugene, the housing structure type influences the number of students living in the home. Thus, it is important to collect this information of housing structure types so that the preference for single-family dwellings can be incorporated. In other cities, an average number of students per home could possibly be utilized without this detailed analysis of the structure type. Information about the number of building permits was combined with the number of students per household to estimate future growth to be incorporated with the student data. Table III describes each variable's relevance in detail and mentions the source of data. The three variables are:

1. Average number of students per household.

2. Number of students by household by structure type.

3. Number of building permits by structure type by year.

TABLE 3

Detailed Description of Variables Related to Number of Students Living in Attendance Area

1) Average Number of Students per Household

This information gives a generalized average of the total number of students in the attendance area divided by the total number of homes in the attendance area. The number of students was obtained from school district enrollment records and the number of homes was obtained from the Lane County Geographic Data System.

2) Number of Students by Household by Structure Type

This information is a refinement of the average number of students per household. This information was generated by matching student addresses to individual parcel land use data to determine structure type of the address. Each structure type is assigned an average number of students per household. The computerized records of the school district were the source of home addresses. The Lane County Geographic Data System was the source of the individual parcel land use data.

3) Number of Building Permits by Structure Type by Year

This information is an indication of actual growth within each attendance area. When combined with the average number of students per household, it gives an indication of how many students might be expected to enter new homes in the area. This data was collected on a year-by-year basis. Actual occupancy of structures occurs somewhat after the building permit is issued. In Eugene, this happens approximately six months after the building permit is issued. The data was collected yearly to allow flexibility in determining whether to use an average over years or to use the most recent building permit figures. This information was obtained from the Eugene Building Permit File.

In summary, a three-step procedure can incorporate land use variables into an enrollment projection methodology. The first step identifies social, economic, and/or land use trends within the metropolitan area. The second step identifies relevant variables that seem to reflect those trends directly. The third step collects data on the identified variables for fixed geographic (attendance) areas. These variables were tested in Eugene for their value in generating short term enrollment projections. The next section outlines this methodology developed in Eugene for incorporating land use variables into enrollment projections.

<u>Inclusion of Land Use Variables in Short Term Enrollment Projections</u>

This section presents a model for incorporating land use variables in short-term enrollment projections. The model is described in both general terms for adaptability to school districts around the country and specific terms to describe the actual testing of the model in Eugene, Oregon.

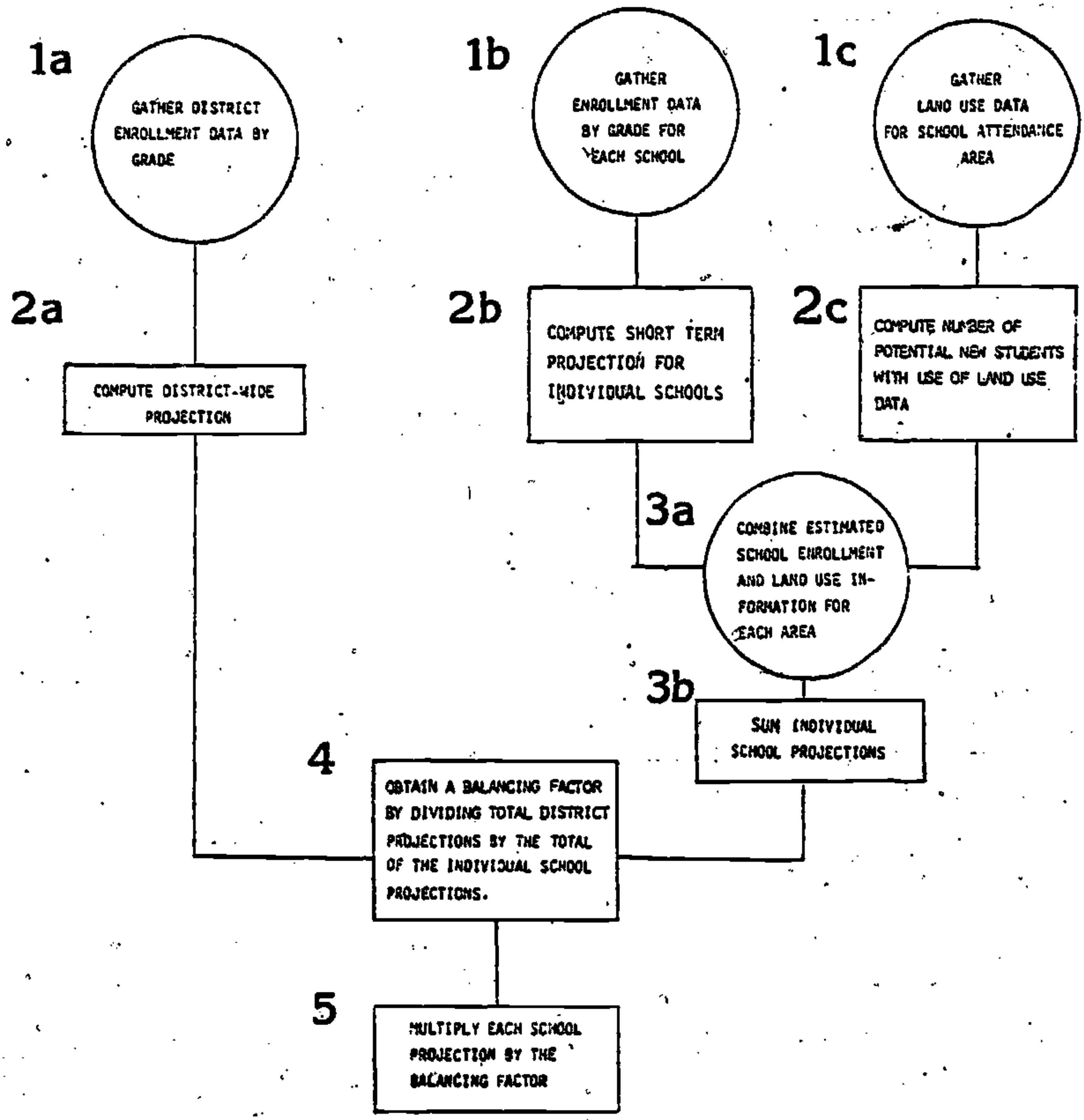
The model is based on a traditional enrollment projection technique adjusted by land use variable variations in attendance areas.

The general model used in this example of incorporating land use variables projects individual attendance areas on a year-by-year basis for three years.

Several decisions based on a knowledge of the trends in a specific urban area must first be made. The first decision must identify the traditional enrollment prediction methodology used to project district-wide enrollment. This existing district-wide projection is used as a monitoring device by which the individual attendance area projections are evaluated and adjusted. The second decision must choose an accurate projection technique for individual schools. The last decision must select a land use variable that is an immediate indicator of urban growth or declining populations. This variable must be convertible to an estimate of the number of new students projected for a year. The converted land use variable is summed with the individual school enrollment projections, and the total is "balanced to" the district-wide projection. The concept of balancing is a systematic means of adjusting each individual school's inflated projection to correspond to the more accurate district level projection. The balancing factor is calculated by dividing the district enrollment projection by the sum of the individual school enrollments which reflects the amount of inflation produced by the individual school projections. The balancing factor multiplied times the projected individual school enrollments provides individual school projections which sum to the district projection.

The remainder of this section contains a step-by-step explanation of the general model and a description of the testing of the methodology in Eugene. Figure II displays the steps used to incorporate land use variables in projecting school enrollment one to three years into the future.

Figure 2
Steps Used for Incorporating Land Use Variables in Projecting School Enrollment One to Three Years into the Future



An explanation of the steps illustrated in Figure 2 (left hand column), and the application of the procedure to Eugene elementary schools (right hand column), are provided below.

General Model

Step 1. Gather Data

1a. At the district level collect data for each grade. Summary enrollment data should be collected for the total number of students by grade in the district. For the most accurate predictions, the time period should be no less than three years. Decisions must be made to include or exclude groups (such as special education) which may inordinately skew the data.

1b. At the individual school level, collect enrollment data.

Summary enrollment data should be collected for the total number of students by grade for each school for a period of no less than three years.

Eugene Example

1a. Actual enrollments were gathered for grades 1 to 6 for the 1970 to 1978 school years for the school district. In this example 1970-1975 enrollment data was used to project 1976, 1977 and 1978 enrollments.

1b. Actual enrollments were gathered for grades 1 to 6 for the 1970 to 1978 school years by individual school. In this example 1970-1975 enrollment data was used to project 1976, 1977 and 1978 enrollments.

Table 4 shows the format used for Steps 1a and 1b.

TABLE 4

Sample of 1970 to 1977 Summary Enrollment Data by Grade Level for Adams Elementary School

Year	KIN	1st	2nd	3rd	4th	5th	6th	Other	Total
1970	0	62	65	84	77	67	63	0	418
1971	0	66	58	67	76	75	68	0	410
1972	0	49	60	52	54	68	68	0	351
1973	0	55	47	52	51	58	65	0	328
1974	67	26	38	48	51	55	55	0	340
1975	34	27	31	40	45	47	46	0	270
1976	100	61	47	49	55	55	62	3	432
1977	92	68	55	45	56	49	55	2	422
TOTAL	293	414	401	437	465	474	482	5	2,971

General Model

1c. For the individual school attendance area, collect land use data for the time period.

Land use variables should represent the most immediate indicators of urban growth or declining population which can then be translated into the number of new students projected for a year.

Eugene Example

1c. For each of Eugene's 23 school geographic areas, land use data for 1976, 1977 and 1978 were gathered and tested. The variables with the most explanatory power were chosen. They are the number of building permit applications broken down by structure type (i.e., single-family dwelling, multiple-family dwelling, and duplex) and the average number of students per structure type. The number of building permit applications was obtained from the Lane County geographic Data System. Table 5 shows this data for the years 1976, 1977 and 1978.

TABLE 5

Number of Building Permits Applied for by Structure Type and Attendance Area for 1976, 1977 and 1978

Elementary School	1976			1977			1978		
	SF	DP	MF	SF	DP	MF	SF	DP	MF
Adams	5			2			9		
Bailey Hill	75	0	4	198	5	82	63	4	
Condon	5		20	4	2		5		
Crest Drive	15	1		11			9	2	
Dunn	6	4		11		6	11	2	6
Edgewood	5		5	32		5	49		
Edison	10			11	1		8	3	
Fox Hollow	3		2	13			14		
Gilham	22	2	2	38	12		54	20	
Harris	18			29			19	2	
Laurel Hill	50			14	2		6		
Lincoln			51			71	2	2	356
McCornack	15	4	40	7		14			
Magladry	31	2		20	2		22	2	
Meadowlark	20	0	20	25	7	16	37	2	20
Parker	26		20	39	4		33	2	
Patterson	2		86	4	2	13	8		5
Washington	24	4	2	30	11		62		
Westmoreland	22	0		64	2	215	85	6	
Whiteaker			28	4	2	4	1	2	119
Willagillespie	28	6	8	75	28	277	63	8	65
Willakenzie	3		12	6		12	11		
Willard	13		3	4	2	4	2		

SF = Single-Family DP = Duplex MF = Multi-Family

30

Eugene Example (con't)

1c. The average number of students per structure type was computed for each geographic area (shown on Table 6). These numbers were based on enrollment data and on information provided through the property tax assessment records collected on September 30, 1977. The student enrollment data was geocoded by home address and matched with individual parcel file data to determine housing structure type. An average number of students for each structure type was computed for each attendance area. In this study, it was assumed that the average number of students per structure type for each attendance area was constant and would vary little over the years.

TABLE 6

Average Number of Students
by Structure Type and Attendance Area

Elementary School	Single Family	Duplex	Multi-Family
Adams	.1528	.1124	0.0
Bailey Hill	.5107	.0909	.3636
Condon	.1797	.0227	.0044
Crest Drive	.2354	.0833	0.0
Dunn	.2040	.0462	.0556
Edgewood	.3912	.2381	.0345
Edison	.1589	.0778	.1351
Fox Hollow	.4026	.1341	.1481
Gilham	.2090	.1667	.2500
Harris	.1931	.1351	.1250
Laurel Hill	.1830	.0588	.0526
Lincoln	.0958	.0443	.0119
McCornack	.3344	.0938	.3529
Magladry	.2702	.2353	.2619
Meadow Lark	.2625	.1587	.1677
Parker	.2830	.1250	.0153
Patterson	.1485	.1489	.0320
Washington	.2619	.2250	0.0
Westmoreland	.2090	.1579	.1503
Whiteaker	.1393	.1467	.0908
Willagillespie	.2360	.1974	.0625
Willakenzie	.2365	.2500	.0463
Willard	.1540	.0556	.0633

Step 2. Computations

2a. Use the district enrollment data gathered in Step 1a in an enrollment projection procedure to estimate short-term enrollment for the district.

Use the enrollment projection procedure known to be the most accurate. It is important to strive for accuracy in this projection since the individual school projections will be balanced to this total.

2a. The cohort survival methodology based on 1970 to 1975 enrollment data was used to estimate the school district enrollment for the 1976, 1977 and 1978 school years. This methodology has been the most accurate district-wide enrollment projection technique for Eugene in the past. Accuracy levels have varied from .46 to 1.48% for one year projections. Table 7 shows the actual enrollment, district-wide projections for 1976, 1977, and 1978 and percent accuracy. It is apparent from Table 7 that the farther out one makes predictions, the less accurate the predictions become.

TABLE 7

District Cohort Survival Estimates, Actual Enrollment and Percent of Accuracy for 1976, 1977 and 1978

Year	Actual Enrollment	Projected Enrollment	# of Students Not Estimated by Projection Technique	Percent of Accuracy
1976	6184	6074.58	-109.42	1.77%
1977	6178	6359.25	+181.25	2.93%
1978	6297	6535.13	+238.13	3.78%

2b. Use the school level enrollment data (gathered in Step 1b) to estimate individual school enrollment using an enrollment projection equation.

Choose an accurate projection technique for individual schools. Three techniques for projecting individual school enrollments are explored in this chapter and described in Appendix A. They are the cohort survival, regression, and ratio methodologies.

2b. For each school attendance area, 1976, 1977 and 1978 enrollments were projected by three different methods in order to assess the best means of estimation. Fortunately in this example we are able to compare the projected enrollments with the actual enrollments to obtain a more vivid picture of each projection's accuracy. The three approaches are discussed below:

Regression - A linear regression was used to predict each school's 1976, 1977 and 1978 enrollment using the past five years enrollment data. Table 8 presents the enrollments estimated by the regression methodology as well as the actual enrollments for each school for the 1976, 1977 and 1978 school years. Differences in actual and predicted enrollments, the percent of prediction, and the standard error of estimate for each year also appear in Table 8. The farther out the projection, the less the percent of accuracy. However, on the individual school basis, the first year provided three schools with a percent of accuracy between 95 to 100%. The next two years, 5 and 6 schools, respectively, fell into the 95 to 100% accuracy range.

TABLE 8

1976, 1977 and 1978 Individual School Enrollment Projections for Grades 1 to 6, Estimated by Regression Procedures

Elementary School	Actual Enrollment			Projected Enrollment			Difference Between Actual & Projected			Percent of Prediction		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	329	323	396	217	191	158	112	-137	-238	66	58	40
Bailey Hill	362	398	461	375	432	488	13	34	27	96	92	95
Condon	241	245	239	220	243	263	-21	-2	24	91	99	91
Crest Drive	211	235	242	252	275	294	41	40	52	84	85	82
Dunn	227	195	199	208	208	202	-19	13	3	92	94	98
Edgewood	424	421	414	383	402	414	-41	-19	0	90	96	100
Edison	293	286	351	230	235	237	-63	-51	-114	78	82	68
Fox Hollow	171	189	155	216	236	254	45	47	99	79	80	61
Gilham	296	281	281	331	358	380	35	77	99	89	78	74
Harris	229	234	236	179	166	146	-50	-68	-90	78	71	62
Laurel Hill	123	98	111	99	85	65	-24	-13	-46	80	87	58
Lincoln	161	170	191	146	146	140	-15	-24	-51	91	86	73
McCornack	345	338	368	407	473	540	62	135	207	85	72	62
Maplewood	158	162	157	148	163	176	-10	1	19	94	99	89
Meadow Lark	365	381	333	411	425	431	46	44	63	89	90	85
Parker	249	240	232	234	235	230	-15	-5	-2	94	[illegible]	99
Patterson	214	262	256	232	244	253	18	-18	-3	92	93	99
Washington	404	403	432	393	405	409	-11	2	-23	97	99.5	95
Westmoreland	368	318	273	360	376	385	-8	58	112	98	85	71
Whiteaker	192	224	193	158	149	137	-34	-75	-56	82	66	71
Willagillespie	302	318	342	283	294	299	-19	-24	-43	94	92	87
Willakenzie	251	218	225	274	283	288	23	65	63	92	77	78
Willard	269	234	210	321	337	347	52	103	137	84	69	60
							D = -4.7	8.0	10.4			
DISTRICT TOTAL	6184	6178	6297	6077	6361	6536	S = 41.8	60.9	93.3	98	97	96

Cohort Survival - Five years of enrollment data were used in predicting 1976, 1977 and 1978 short-term enrollments for individual schools in the Eugene school district by means of the cohort-survival methodology. Cohort survival projections (1976, 1977 and 1978) for each school appear in Table 9 along with each school's actual enrollments for the three years. Differences between the predicted and actual enrollment, the percent accuracy of prediction and the standard error of estimates for each year also appear in Table 9. For the three years of projections, 10, 7 and 4 schools fell into an accuracy range of 95-100%.

TABLE 9

1976, 1977 and 1978 Individual School Enrollment Projections for Grades 1 to 6, Estimated by the Cohort Survival Methodology

Elementary School	Actual Enrollment			Projected Enrollment			Difference Between Actual & Projected			Percent of Prediction		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	329	329	396	205	185	164	-124	-143	-232	62	56	41
Bailey Hill	362	398	461	346	363	373	-16	-35	-88	96	91	81
Condon	241	245	239	249	285	302	8	40	63	97	86	79
Crest Drive	211	235	242	225	238	243	14	3	1	94	99	99
Dunn	227	195	199	213	207	207	-14	12	8	94	94	96
Edgewood	424	421	414	420	451	485	-4	30	71	99	93	85
Edison	293	286	351	346	386	442	53	100	-91	85	74	79
Fox Hollow	171	189	155	187	199	207	16	10	52	91	95	75
Gilham	296	281	281	295	313	311	-1	32	30	99	90	90
Harris	229	234	236	196	204	207	-33	-30	-29	86	87	88
Laurel Hill	123	98	111	108	102	99	-15	4	-12	88	96	89
Lincoln	161	170	191	167	175	180	6	5	-11	96	97	94
McCornack	345	338	333	370	414	433	25	76	100	93	82	77
Magladry	158	162	157	135	145	147	-23	-17	-10	85	90	94
Meadow Lark	365	381	368	371	389	400	6	8	32	98	98	92
Parker	249	240	232	247	251	246	-2	11	14	99	96	94
Patterson	214	262	256	234	244	247	20	-18	-9	91	93	96
Washington	404	403	432	396	422	442	-8	19	10	98	96	98
Westmoreland	368	318	273	401	418	438	33	100	165	92	76	62
Whiteaker	192	224	193	176	175	175	-15	-49	-18	92	78	91
Willagillespie	302	318	342	269	280	292	-33	-38	-50	89	88	85
Willakenzie	251	218	225	241	240	241	-10	22	16	96	91	93
Willard	269	234	210	277	271	255	8	37	45	97	86	82
							D = 4.8	7.8	10.4			
DISTRICT TOTAL	6184	6178	6297	6074	6357	6536	σ = 33.2	51.2	75.4	98	97	96

Ratio - 1975 enrollment data for each school was used to obtain 1976, 1977 and 1978 individual school enrollment projections. With the ratio methodology, the proportion of district enrollment each school possessed was calculated by dividing the 1975 individual school enrollments by the 1975 district total. The resulting proportion was then multiplied by the 1976, 1977 and 1978 district-wide projections to estimate each year's individual school projections. Individual school enrollment projections and actual enrollments for 1976, 1977 and 1978 by means of the ratio methodology are displayed in Table 10 along with the percent of prediction and the standard error of estimates for each year. The ratio methodology provided 10, 7 and 6 schools with 95-100% accuracy predictions one year, two years, and three years into the future.

TABLE 10

1976, 1977 and 1978 Individual School Enrollment Projections for Grades 1 to 6, Estimated by the Ratio Methodology

Elementary School	Ratio of 1975 District Enrollment		Actual Enrollment			Projected Enrollment			Difference Between Actual & Projected			Percent of Prediction		
	1975 Enrollment	Proportion of District	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	236	3.88	329	328	396	236	247	254	-93	-81	-142	72	75	64
Bailey Hill	342	5.63	362	398	461	342	358	368	-20	-40	-93	94	90	80
Condon	234	3.85	241	245	239	234	245	252	-7	0	13	97	100	95
Crest Drive	231	3.80	211	235	242	231	242	248	20	7	6	91	97	98
Dunn	225	3.70	227	195	199	225	235	242	-2	40	43	99	83	82
Edgewood*	401	6.60	424	421	414	401	420	431	-23	-1	17	94	99	96
dison	297	4.89	293	286	35[illegible]	297	311	320	4	25	-31	99	92	91
ox Hollow	196	3.22	171	189	155	196	20[illegible]	210	25	16	55	87	92	74
ham	312	5.13	296	281	281	312	326	335	16	45	54	95	86	84
ris	205	3.37	229	234	236	205	214	220	-24	-20	-16	90	91	93
rel Hill	114	1.88	123	98	111	114	120	123	-9	22	12	93	82	90
oln	164	2.70	161	170	191	164	172	176	3	2	-15	98	99	92
nack	341	5.61	345	338	333	341	357	367	-4	19	34	99	95	91
dry	137	2.25	158	162	157	137	143	147	-21	-19	-10	87	88	94
Lark	370	6.09	365	381	368	370	387	398	5	6	30	99	98	92
	248	4.08	249	240	232	248	259	267	-1	19	35	99	93	87
on	232	3.82	214	262	256	232	243	250	18	-19	-6	92	93	98
on	403	6.63	404	403	432	403	422	433	-1	19	1	99	96	99
land	395	6.50	368	318	273	395	413	425	27	95	152	93	77	54
	178	2.93	192	224	193	178	186	191	-14	-38	-2	93	83	99
spi	272	4.47	302	313	342	272	284	292	-30	-34	-50	90	89	85
e	252	4.15	251	218	225	252	264	271	1	46	46	99	82	83
	294	4.84	269	234	210	294	308	316	25	74	106	92	76	66
									μ = -4.6	8.0	10.4			
	6079	100.0	6184	6178	6297	6079	6361	6536	σ = 25.6	38.9	59.8	98	97	96

2c. Compute an estimate of the number of new students projected in each attendance area by use of land use variables collected in Step 1c.

After obtaining the land use variable which is the best predictor of urban growth or decline, establish a factor which will translate the urban growth indicator into the number of new students expected for the projected year.

2c. The number of building permit applications for 1976, 1977 and 1978 in each school's geographic area was multiplied by the average number of students per dwelling unit by structure type and area to obtain an estimate of the number of new students to be expected in each geographic area in 1976, 1977 and 1978. Table 11 displays, for each year, the number of building permits applied for, the average number of students per dwelling unit, and the expected number of new students for 1976, 1977 and 1978 for each schools attendance area. From this table, the growth areas in Eugene can be easily detected. Schools such as Bailey Hill, Gilham, Westmoreland, and Willagillespie might be expected to have improved projections when land use variables are added to the methodology.

TABLE 11

Number of Building Permits Applied for by Structure Type, Average Number of Students per 100 Dwelling Units by Structure Type, and the Estimated Number of New Students for Each Year

Elementary School	Number of Building Permits Applied for by Structure Type and Year									Average Number of Students per Dwelling Unit			Estimated Number of Students Added by Land Use				
	1976			1977			1978										
	SF	DP	MF	SF	DP	MF	SF	DP	MF	SF	DP	MF	1976	1977	1976-77	1978	1976-78
Adams	5	0	0	2	0	0	9	0	0	.1528	.1124	--	1	0	1	1	2
Bailey Hill	75	0	4	198	5	82	63	4	0	.5107	.0909	.3636	40	131	171	33	204
Condon	5	0	20	4	2	0	5	0	0	.1797	.0227	.0044	1	1	2	1	3
Crest Drive	15	1	0	11	0	0	9	2	0	.2354	.0833	--	4	3	7	2	9
Dunn	6	4	0	11	0	6	11	2	6	.2040	.0462	.0556	1	3	4	3	7
Edgewood	5	0	5	32	0	5	49	0	0	.3912	.2381	.0345	2	13	15	19	34
Edison	10	0	0	11	1	0	8	3	0	.1589	.0778	.1351	2	2	4	2	6
Fox Hollow	3	0	2	13	0	0	14	0	0	.4026	.1341	.1481	2	5	7	6	13
Gilham	22	2	2	38	12	0	54	20	0	.2990	.1667	.2500	7	13	20	19	39
Harris	18	0	0	29	0	0	19	2	0	.1931	.1351	.1250	3	6	9	4	13
Laurel Hill	50	0	0	14	2	0	6	0	0	.1830	.0588	.0526	1	3	4	1	5
Lincoln	0	0	51	0	0	71	2	2	356	.0958	.0443	.0119	1	1	2	5	7
McCornack	15	4	40	7	0	14	0	0	0	.3344	.0938	.3529	20	7	27	--	27
Magladry	31	2	0	20	2	0	22	2	0	.2702	.2353	.2619	9	6	15	6	21
Meadowlark	20	0	20	25	7	16	37	2	20	.2625	.1587	.1677	9	10	19	13	32
Parker	26	0	20	39	4	0	33	2	0	.2830	.1250	.0153	8	12	20	10	30
Patterson	2	0	86	4	2	13	8	0	5	.1485	.1489	.0320	3	1	4	1	5
Washington	24	4	2	30	11	0	62	0	0	.2619	.2250	--	7	10	17	16	33
Westmoreland	22	0	0	64	2	215	85	6	0	.2090	.1579	.1503	5	46	51	19	70
Whiteaker	0	0	29	4	2	4	1	2	119	.1393	.1467	.0908	3	1	4	11	15
Willagillespie	29	6		75	28	277	63	8	65	.2360	.1974	.0625	8	41	49	21	70
Willakenzie	3	0	12	6	0	12	11	0	0	.2365	.2500	.0463	1	2	3	3	6
Willard	13	0	3	4	2	4	2	0	0	.1540	.0556	.0633	2	1	3	--	3

SF = Single-Family   DP = Duplex   MF = Multi-Family

Step 3. Combine Projected Individual School Enrollment and Land Use Information

3a. Add each individual school's enrollment projection (Step 2b) to the estimated number of new students in each school's attendance area (2c).

This is a simple summing procedure (i.e., add individual school projections to estimated number of new students.)

3a. For all three enrollment projection methodologies the estimated number of new students was simply added to each school projection. Table 12 displays the estimated number of new students to be added by land use and the projected enrollment with and without land use for the regression, cohort survival and ratio methodologies. These figures systematically overestimate the district-wide projection totals.

TABLE 12

Estimated Number of New Students to be added by Land Use, and the Projected Enrollment With and Without Land Use for Regression, Cohort Survival and Ratio

				REGRESSION						COHORT SURVIVAL						RATIO					
...ntary	# of Students added by Land Use			Proj. Enrollment w/o Land Use			Proj. Enrollment w/ Land Use			Proj. Enrollment w/o Land Use			Proj. Enrollment w/ Land Use			Proj. Enrollment w/o Land Use			Proj. Enrollment w/ Land Use		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
	1	1	2	202	163	125	203	164	127	208	183	161	209	184	163	236	247	254	237	248	256
Hill	40	171	204	350	368	386	390	539	590	350	359	366	390	530	570	342	358	368	382	529	572
	1	2	3	205	207	208	206	209	211	252	282	297	253	284	300	234	245	252	235	247	255
ive	4	7	9	235	234	232	239	241	241	228	235	239	232	242	248	231	242	248	235	249	257
	1	4	7	194	177	160	195	181	167	216	205	203	217	209	210	225	235	242	226	239	249
	2	15	34	357	342	327	359	357	361	425	446	476	427	461	510	401	420	431	403	435	465
	2	4	6	214	200	187	216	204	193	350	382	434	352	386	440	297	311	320	299	315	326
	2	7	13	201	201	201	203	208	214	189	197	203	191	204	216	196	205	210	198	212	223
	7	20	39	309	305	300	316	325	339	299	309	305	306	329	344	312	326	335	319	346	374
	3	9	13	167	141	115	170	150	128	198	202	203	201	211	216	205	214	220	208	223	233
	1	4	5	92	72	51	93	76	56	109	101	97	110	105	102	114	120	123	115	124	128
	1	2	7	136	124	111	137	126	118	169	173	177	170	175	184	164	172	176	165	174	183
	20	27	27	379	403	427	399	430	454	375	409	425	395	436	452	341	357	367	361	384	394
	9	15	21	138	139	139	147	154	160	137	143	144	146	158	165	137	143	147	146	158	163
	9	19	32	383	362	341	392	391	373	376	385	393	385	404	425	370	387	398	379	406	430
	8	20	30	218	200	182	226	220	212	250	248	242	258	268	272	248	259	267	256	279	297
	3	4	5	216	208	200	219	212	205	237	241	243	240	245	248	232	243	250	235	247	255
	7	17	33	366	345	323	373	362	356	401	417	434	408	434	467	403	422	433	410	439	466
	5	51	70	336	320	304	341	371	374	406	413	430	411	464	500	395	413	425	400	464	495
	3	4	15	147	127	108	150	131	123	178	173	172	181	177	187	178	186	191	181	190	206
	8	49	70	264	250	236	272	299	306	272	277	287	280	326	357	272	284	292	280	333	277
	1	3	6	255	241	228	256	244	234	244	238	237	245	241	243	252	264	271	253	267	272
	2	3	3	299	287	274	301	290	277	280	268	251	282	271	254	294	308	316	296	311	319

3b. Add the individual schools estimated projections from Step 3.

This sum results in a new estimated district total enrollment which needs to be balanced to the district level projection.

3b. For each method of projecting enrollment, a sum was obtained to represent a new district total which needs to be balanced to the more accurate district level projection. Table 13 shows the estimated district totals for each projection methodology with and without land use variables as well as the projected district total that was used as the control total.

TABLE 13

Estimated District Totals for Regression, Cohort Survival, and Ratio Methodologies With and Without Land Use Information

	REGRESSION 1976	1977	1978	COHORT SURVIVAL 1976	1977	1978	RATIO 1976	1977	1978
District Total w/o Land Use	5663	5416	5165	6149	6286	6419	6074	6357	6536
District Total w/ Land Use	5803	5874	5819	6289	6744	7073	6219	6819	7190
District-wide Projection	6075	6359	6835	6075	6359	6835	6075	6359	6835

Step 4. Obtain a Balancing Factor

4a. Divide the school district enrollment projection estimated in Step 2a by the sum of the individual school enrollment projections from Step 3b to obtain the balancing ratio.

This ratio represents the proportion by which the individual schools' estimated total over/under estimated the district total. Figure 3 displays the formula for obtaining the balancing ratio.

4a. For the ratio, cohort survival and regression methodology, the sum of the 1976, 1977 and 1978 individual school projections with land use was divided by each year's district enrollment projection to obtain the ratio which represented the proportion by which each school's projection overestimated the district total for that year. The balancing ratio for each methodology incorporating land use appear on the bottom line of Tables 14, 15 and 16.

44

Figure 3

Formula for Calculating the Balancing Ratio

$$\frac{P_c}{\Sigma P_i} = \frac{P_c}{[P_i + (BP_{ij} * AS_{ij})]}$$

where

i = individual areas

j = structure type

P_c = enrollment projection for the school district

ΣP_i = sum of the individual area enrollment estimates

P_i = enrollment estimate for the individual school

BP_{ij} = building permit activity in attendance area i over the projected period of time by structure type j

AS_{ij} = average number of students per dwelling unit in attendance area i by structure type j

$P_i + (BP_{ij} * AS_{ij})$ = enrollment projection estimate for each individual school

4ɔ

TABLE 14

1976, 1977 and 1978 Individual School Enrollment Projections
for Grades 1-6, Estimated by Regression with Land Use

Elementary School	Actual Enrollment			Projected Enrollment			Difference Between Actual & Projected			Percent Accuracy of Prediction		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	329	328	396	213	178	143	-116	-150	-253	65	54	36
Bailey Hill	362	398	461	408	584	666	46	186	202	89	68	70
Condon	241	245	239	216	226	237	- 25	- 19	- 2	90	92	99
Crest Drive	211	235	242	250	261	271	- 39	26	29	85	90	89
Dunn	227	195	199	204	196	188	- 23	1	- 11	90	99	94
Edgewood	424	421	414	376	386	405	- 48	- 35	- 9	89	92	98
Edison	293	296	351	226	221	217	- 67	- 65	-134	77	77	62
Fox Hollow	171	139	155	213	225	240	42	36	85	80	84	65
Gilham	296	281	281	331	352	381	35	71	100	89	80	74
Harris	229	234	236	178	162	144	- 51	- 74	- 92	78	69	61
Laurel Hill	123	98	111	97	82	63	- 26	- 16	- 48	79	84	57
Lincoln	161	170	191	143	136	133	- 18	- 34	- 58	89	80	67
McCornack	345	333	333	418	466	510	73	128	177	83	73	65
Maygladry	158	162	157	154	167	180	- 4	5	23	97	97	87
Meadow Lark	365	381	368	410	412	419	45	31	51	89	92	88
Parker	249	240	232	237	238	238	- 12	- 2	6	95	99	97
Patterson	214	262	256	229	230	230	15	- 32	- 26	93	88	90
Washington	404	403	432	390	392	400	- 14	- 11	- 32	97	97	93
Westmoreland	368	318	273	357	402	420	- 11	84	147	97	79	65
Whitaker	192	224	193	157	142	138	- 35	- 82	- 55	82	63	72
Willagillespie	302	318	342	285	324	344	- 17	6	2	94	79	99
Willakenzie	251	218	225	268	264	263	17	46	38	93	83	86
Willard	269	234	210	315	314	311	46	80	101	85	75	68
							$\bar{d}$ = -4.7	7.8	10.5			
DISTRICT TOTAL	6184	6178	6297	6077	6361	6536	σ = 44.3	72.7	101.2	98	97	96
BALANCE FACTOR	1.0469	1.0826	1.1230									

TABLE 15

1976, 1977 and 1978 Individual School Enrollment Projections
for Grades 1-6, Estimated by Cohort Survival with Land Use

Elementary School	Actual Enrollment			Projected Enrollment			Difference Between Actual & Projected			Percent Accuracy of Prediction		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	329	328	396	202	173	151	-127	-155	-245	61	83	38
Bailey Hill	362	398	461	377	500	527	15	102	66	96	80	87
Condon	241	245	239	244	268	277	3	23	38	99	91	86
Crest Drive	211	235	242	224	228	229	13	- 7	- 13	86	97	95
Dunn	227	195	199	210	197	194	- 17	2	- 5	93	99	97
Edgewood	424	421	414	412	435	471	- 12	14	57	97	97	88
Edison	293	296	351	340	364	407	47	78	56	86	79	86
Fox Hollow	171	189	155	185	192	200	14	3	45	92	98	78
Gilham	296	281	281	296	310	318	0	29	37	100	91	88
Harris	229	234	236	194	199	200	- 35	- 35	- 36	85	85	85
Laurel Hill	123	98	111	106	99	94	- 17	1	- 17	86	99	85
Lincoln	161	170	191	164	165	170	3	- 5	- 21	98	97	89
McCornack	345	338	333	382	411	418	37	73	85	90	82	77
Maygladry	158	162	157	141	149	152	- 17	- 13	- 5	89	92	97
Meadow Lark	365	381	368	372	381	393	7	0	25	98	100	94
Parker	249	240	232	249	253	251	0	13	19	100	95	92
Patterson	214	262	256	232	231	229	18	- 31	- 27	92	88	89
Washington	404	403	432	394	409	431	- 10	6	- 1	98	99	99
Westmoreland	368	318	273	397	438	462	29	120	189	92	73	59
Whitaker	192	224	193	175	167	173	- 17	- 57	- 20	91	75	90
Willagillespie	302	318	342	270	307	330	- 32	- 11	- 12	89	97	96
Willakenzie	251	218	225	237	227	225	- 14	- 9	0	94	96	100
Willard	269	234	210	272	256	235	3	22	25	99	91	89
							$\bar{d}$ = -4.7	7.9	10.4			
DISTRICT TOTAL	6184	6178	6297	6075	6319	6517	σ = 33.6	55.2	74.7	98	97	96
BALANCE FACTOR	.9660	.9429	.9239									

40

TABLE 16

1976, 1977 and 1978 Individual School Enrollment Projections
for Grades 1-6, Estimated by Ratio with Land Use

Elementary School	Actual Enrollment			Projected Enrollment			Difference Between Actual & Projected			Percent Accuracy of Prediction		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	329	328	396	232	231	233	- 97	- 97	-163	70	70	59
Bailey Hill	362	398	461	373	493	520	11	95	59	97	80	89
Condon	241	245	239	230	230	232	- 11	- 15	- 7	95	94	97
Crest Drive	211	235	242	230	232	234	19	- 3	- 8	92	99	97
Dunn	227	195	199	221	223	226	- 6	28	27	97	87	88
Edgewood	424	421	414	394	406	423	- 30	- 15	9	93	96	98
Edison	293	286	351	292	294	296	- 1	8	- 55	99	98	84
Fox Hollow	171	189	155	193	198	203	22	9	48	89	95	76
Gilham	296	281	281	312	323	340	16	42	59	95	87	83
Harris	229	234	236	203	208	212	- 26	- 26	- 24	87	89	90
Laurel Hill	123	98	111	112	116	116	- 11	18	5	91	84	96
Lincoln	161	170	191	161	162	166	0	- 8	- 25	100	95	87
McCornack	345	338	333	353	358	358	8	20	26	98	94	93
Magladry	158	162	157	143	147	153	- 15	- 15	- 4	91	90	97
Meadow Lark	365	381	368	370	379	391	5	- 2	23	99	99	94
Parker	249	240	232	250	260	270	1	20	38	99	92	86
Patterson	214	262	256	230	230	232	16	- 32	- 24	93	88	91
Washington	404	403	432	401	409	424	- 3	6	- 8	99	99	98
Westmoreland	368	318	273	391	433	450	23	115	177	94	73	61
Whiteaker	192	224	193	177	177	187	- 15	- 47	- 6	92	79	97
Willagillespie	302	318	342	274	311	329	- 28	- 7	- 13	90	98	96
Willakenzie	251	218	225	247	249	252	- 4	31	27	98	88	89
Willard	269	234	210	289	290	290	20	56	80	93	80	72
DISTRICT TOTAL	6184	6178	6297	6078	6359	6517	μ = -4.6 σ = 25.7	7 44.	10.4 60.5	98	97	96
BALANCE FACTOR	.9768	.9325	.9089									

Step 5. <u>Adjust each School's Projection by the Balancing Ratio</u>

5a. Multiply each school's projected enrollment obtained in Step 3a by the balancing factor obtained in Step 4 to obtain an adjusted enrollment projection for each individual school.

When multiplied by the balancing ratio, the individual school enrollments can be made to balance to the district level projections obtained in Step 2a.

5a. The balancing ratio obtained for each of the methodologies was multiplied by each methodology's individual school's estimated enrollments for 1976, 1977 and 1978. The adjusted predictions appear in Tables 14, 15, and 16 along with the balancing ratios. As occurred in each methodology with land use included, each methodology without land use included, once balanced, decreased in accuracy the farther out the projection. In the regression methodology 4, 4, and 4, schools fell into a 95-100% accuracy range for each of the three years. In the cohort survival methodology 9, 10, and 6, schools fell into this range, and in the ratio methodology, 11, 8 and 8 schools fell into this range for each of the three years, respectively.

Discussion

The previous sections have outlined the general steps in developing a model incorporating land use variables for projecting individual school enrollments and explained how the methodology was applied in Eugene, Oregon. The following sections will discuss how to select a methodology for projecting individual school enrollments and the relative effectiveness of this particular methodology in Eugene.

Selecting a Methodology for Projecting Individual School Enrollments

Individual school enrollments are difficult to project with extreme accuracy using only a statistical enrollment projection methodology due to 1) the small numbers which make them statistically vulnerable to random error, and 2) the multitude of factors that alter individual school enrollments, such as new housing, rezoning of land, open enrollment and alternative schools. District-level enrollment projections, on the other hand, are easily projected with accuracy using past enrollment trends.

On the basis of the statistical enrollment projection methodology, individual school enrollments, totalled, will exceed the accurate district-level projection. The sources of inflation are most often compensated for by subjective adjustments to the projected numbers. In order to know which school to subtract from or add to, school district administrators take into account variables in the attendance areas that cause enrollment alterations.

Incorporating land use variables into the enrollment projection methodology is one method for attempting to quantify the subjective adjustments. To most accurately project individual school enrollment using the model developed in this chapter, one must first start with an accurate enrollment projection methodology.

When selecting a methodology for individual school level student enrollment projections, the best way to judge a methodology's applicability to a particular district for a future year is to apply the methodology to actual enrollment data to predict one or two past years' enrollment. One can then see how well the methodology would have projected the past years' enrollment and if unacceptable, another methodology can be tested. This technique also allows for the creation of statistics for comparing two or more methodologies.

There are four types of information (not mutually exclusive) to take into account when judging the relative efficiency of a projection methodology. Those four pieces of information are outlined below:

1) Percent of accuracy of the prediction

The percent of accuracy of the prediction, calculated for each school, represents the percentage of enrollment the particular enrollment projection methodology actually projected in each school for a given year or years. This figure is found by dividing the projected student enrollment by the actual enrollment for a school.

To evaluate the methodology on the basis of this data, a standard of acceptable accuracy for individual school projections must be selected. One may decide that an enrollment projection methodology must be able to predict 95% of the total population of any school - 95% then becomes the standard for acceptance.

2) Difference Between Actual and Projected

The difference between the actual and projected enrollment is found by subtracting the projected enrollment for each school from the actual enrollment of each school for the past year or years. The resulting number refers to the number of students over or under-estimated by the methodology for each school.

Again, a criterion must be established in order to evaluate this data. One suggested criterion, 20 to 30 students per school, is equal to the pupil-teacher ratio. This is a good criterion to use since an over or under-estimation by 20 to 30 students would require staffing alterations.

3) Standard Error of Estimate

The standard error of estimate ($\hat{\sigma}$), when used in the context of school enrollment projections, is the average amount of deviation between the actual and projected enrollments. The $\hat{\sigma}$ shows the margin of error to be expected in the individual school's projected enrollment, as a result of the imperfect validity of the methodology. The $\hat{\sigma}$ is calculated by multiplying the standard deviation of the criterion scores times the square root of one minus the square of the validity coefficient. The smaller the standard error, the more accurate the projection methodology. This provides an indication of the technique's average estimated accuracy for projecting enrollment of all schools in the district. The smaller the standard error, the more accurate the projection methodology.

4) Estimated Mean of the Population Error

When balancing to a projected district total (not the actual enrollment total) biasing will result. This bias is systematic and is found by summing the difference between the actual and projected individual school enrollments and dividing by the number of schools in the district. The bias is considered the estimated population mean for the projections.

When assessing the four types of information, with different enrollment projection methodologies, it soon will become clear that no one technique will provide the best prediction for all individual schools. On the basis of the four pieces of statistical information, one can select a methodology that meets the needs of the school district or one can design a methodology that incorporates more than one methodology (See Appendix A, Table A-5) known as a combination methodology. The combination methodology allows for the selection of a methodology for homogeneous areas (schools) in the district.

The following section will illustrate how the relative efficiency of three enrollment projection methodologies was judged in Eugene.

Relative Efficiency of Three Enrollment Projection Methodologies in Eugene Oregon

Researchers from the Eugene School district made an attempt to discover an enrollment projection methodology that would accurately project individual school enrollments in Eugene one to three years into the future. A major concern, in addition to a valid projection methodology, was to be able to quantify the subjective adjustments that have to be made for individual school projections to sum to the district level projection, found to be accurate within a .5% error range. In the past, individual school enrollments in Eugene have been estimated by projecting the present year's grade enrollments for each school as the grade enrollment for the next grade and year and by making telephone checks with each school principal to validate the grade projections. Kindergarten and first grade enrollments were then projected on the basis of birth rates five and six years prior to the years being projected. With this technique, only one year could be projected with accuracy.

The exploration commenced by taking three commonly used enrollment projection methodologies - cohort survival, ratio and regression - and examining their usefulness in the school district. A procedure was developed (based on research accomplished in conjunction with Lane County Council of Government researchers) that enabled a numerical means of balancing the individual school projections to sum to the district-level projection. This procedure has become known as the balancing procedure. The balancing procedure produces a ratio-factor that, when multiplied by the individual school enrollments, allows the sum of the school enrollments to equal the district-level projection. (The balancing factor is calculated by dividing the district-level enrollment projection by the sum of the individual school enrollment projections). In addition, a land-use factor was developed to enable adjustments to the individual school projections on the basis of those land-use variables known to cause alterations in the year-to-year enrollments of individual schools in Eugene.

The methodologies and land-use factors were tested by using actual data. 1970 to 1975 elementary school enrollments were used to project 1976, 1977 and 1978 school years. Actual enrollments for the projected years were then compared to each year's projected enrollments to judge each methodology's relative efficiency for use in Eugene. The three techniques were evaluated with and without the land use variable adjustments in terms of the four pieces of statistical information described in the preceeding section. It was discovered that no one methodology without or with land use variables was able to provide the best prediction for all schools in the district. It was also discovered that the land use variable adjustment improved the prediction accuracy of some schools and not of others. That which follows is a discussion of the three methodologies' relative efficiency in terms of 1) the percent accuracy, 2) differences between actual and projected enrollment, 3) the standard error of estimate and 4) the mean of the population error.

1) The Percent Accuracy of the Prediction

Table 17 shows the percent of prediction accuracy for the regression cohort survival, and ratio methodologies with and without land use variables. An examination of this table reveals that several possible sources of variation were still unaccounted for. The effects of the open enrollment policy and alternative schools which serve as magnets for enrollment were uncontrolled. The results of the methodologies' application to Eugene schools should, therefore, be evaluated in the context of these potential sources of error. As might be expected, the accuracy of prediction is lower in the second and third year projections. The three methodologies are relatively close in terms of percent accuracy of predictions, both with and without land use information. The accuracy of individual school projections was the focus in evaluating the methodologies. To evaluate the individual school projections, a range of 95 to 100% accuracy was selected and the number of schools within this range was determined for each technique.

Regression - The regression methodology was the least accurate of the three methodologies in terms of the percent of prediction accuracy. The addition of land use information decreased the accuracy of the regression methodology. Without the land use variables included, 3, 5 and 6 schools fell within the 95 - 100% range for each of the three years of projections. With the land use variables included, 4 schools fell into this range in each of the three years of projections.

Cohort Survival - Land use variables increased the accuracy of the cohort survival in the second and third years of projection. Without the land use information included, 10, 7 and 4 schools were accurate within the 95 to 100% prediction range for the three projection years. With land use information included 9, 11, and 6 schools fell into this limit.

Ratio - The ratio methodology found 10, 6 and 5 schools falling within the 95 to 100% prediction range without the inclusion of land use, and 11, 8 and 8 schools with land use.

TABLE 17

The Percent Accuracy of Prediction for all three Methodologies
With and Without Land Use Information for 1976, 1977 and 1978

Elementary School	WITHOUT LAND USE									WITH LAND USE								
	REGRESSION Percent Accuracy of Prediction			COHORT SURVIVAL Percent Accuracy of Prediction			RATIO Percent Accuracy of Prediction			REGRESSION Percent Accuracy of Prediction			COHORT SURVIVAL Percent Accuracy of Prediction			RATIO Percent Accuracy of Prediction		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Adams	66	58	40	62	56	41	72	75	64	65	54	35	61	83	38	70	70	59
Bailey Hill	96	92	95	96	91	81	94	90	80	89	68	70	96	80	87	97	80	89
Condon	91	99	91	97	86	79	97	100	95	90	92	99	99	91	86	95	94	97
Crest Drive	84	85	82	94	99	99	91	97	98	85	90	89	86	97	95	92	99	97
Dunn	92	94	98	94	94	96	99	83	82	90	99	94	93	99	97	97	87	88
Edgewood	90	96	100	99	93	85	94	99	96	89	92	98	97	97	88	93	96	98
Edison	78	82	68	85	74	79	99	92	91	77	77	62	86	79	86	99	98	84
Fox Hollow	79	80	61	91	95	75	87	92	74	80	84	65	92	98	78	89	95	76
Gilham	89	78	74	99	90	90	95	86	84	89	80	74	100	91	88	95	87	83
Harris	78	71	62	86	87	88	90	91	93	78	69	61	85	85	85	87	89	90
Laurel Hill	80	87	58	88	96	89	93	82	90	79	84	57	86	99	85	91	84	96
Lincoln	91	86	73	96	97	94	98	99	92	89	80	67	98	97	89	100	95	87
McCornack	85	72	62	93	82	77	99	95	91	83	73	65	90	82	77	98	94	93
Magladry	94	99	89	85	90	94	87	88	94	97	97	87	89	92	97	91	90	97
Meadow Lark	89	90	85	98	98	92	99	98	92	89	92	88	98	100	94	99	99	94
Parker	94	98	99	99	96	94	99	93	87	95	99	97	100	95	92	99	92	86
Patterson	92	93	99	91	93	96	92	93	98	93	88	90	92	88	89	93	88	91
Washington	97	99.5	95	98	96	98	99	96	99	97	97	93	98	99	99	99	99	98
Westmoreland	98	85	71	92	76	62	93	77	54	97	79	65	92	73	59	94	73	61
Whiteaker	83	66	71	92	78	93	93	83	99	82	63	72	91	76	90	92	79	97
Willagillespie	94	92	87	89	88	85	90	89	85	94	79	99	89	97	96	90	98	96
Willakenzie	92	77	78	96	91	93	99	82	83	93	83	86	94	96	100	98	88	89
Willard	84	69	60	97	86	83	92	76	66	85	75	68	99	91	89	93	80	72
MEAN	88	85	78	92	88	85	94	89	86	87	82	77	92	90	86	94	89	88

2) Difference Between Actual and Project Enrollment

Table 18 displays the difference between the actual and projected enrollment in terms of the number of students over or under-estimated at each school by the three methodologies, without and with the land use factor.

As in the case of the percent of prediction accuracy, more schools' enrollments were over or under-estimated the farther out the projection. A criterion of 30 students was used since the student-teacher ratio in Eugene elementary schools generally varies from 20 to 30 students per pupil. Thus, if an individual projection is over or under-estimated by more than 30 students, the school would need to adjust staff positions accordingly. The number of schools projected within a plus or minus 30 student-range is tallied below for each methodology.

Regression - Again, the regression methodology provided the fewest number of schools within the chosen criterion range. Without land use information, 12, 10 and 8 schools were projected within 30 students for the three projected years. Land use information decreased the accuracy of the projections to 11, 8 and 8 schools being projected within a 30 student range for each of the three projected years.

Cohort survival - Land use variables were able to add schools within the 30 student range in the second and third projection years for the cohort survival methodology. Without land use, 18, 13 and 12 schools were projected within 30 students for the three years. With land use, 18, 15 and 13 schools were projected within 30 students for the three projected years.

Ratio - The ratio methodology projected all but one school within 30 students for the first projected year. For the second and third projected years, 14 and 11 schools were projected within 30 students without land use and 15 and 15 schools were projected within 30 students with land use.

3. Standard Error of Estimate

The average estimated accuracy of each of the methodologies was determined by means of the standard error of estimate (σ), as shown on the bottom of Table 18.

Regression - The average amount of deviation between the actual and projected enrollment (σ) for the regression methodology was 41.8, 60.9 and 93.3 for the three projected years without land use and 44.3, 72.7 and 101.2 with land use.

Cohort Survival - Without land use, the cohort survival methodology provided a standard error of estimate of 33.2 for the first year, 51.2 for the second year, and 75.4 for the third year. No significant

TABLE 18

The Difference Between Actual Enrollment and Projected Enrollments for all three Methodologies With and Without Land Use Information for 1976, 1977 and 1978

WITHOUT LAND USE

Elementary School	Regression: Difference Between Actual & Projected 1976	1977	1978	Cohort Survival: Difference Between Actual & Projected 1976	1977	1978	Ratio: Difference Between Actual & Projected 1976	1977	1978
Adams	-112	-137	-238	-124	-143	-232	-93	-81	-142
Bailey Hill	13	34	27	-16	-35	-88	-20	-40	-93
Condon	-21	-2	24	8	40	63	-7	0	13
Crest Drive	41	40	52	14	3	1	20	7	6
Dunn	-19	13	3	-14	12	8	-2	40	43
Edgewood	-41	-19	0	-4	30	71	-23	-1	17
Edison	-63	-51	-114	51	100	-91	4	25	-31
Fox Hollow	45	47	99	16	10	52	25	16	55
Gilham	35	77	99	-1	32	30	-16	45	54
Harris	-50	-68	-90	-33	-30	-29	-24	-20	-16
Laurel Hill	-24	-13	-46	-15	4	-12	-9	22	12
Lincoln	-15	-24	-51	6	5	-11	3	2	-15
McCornack	62	135	207	25	76	100	-4	19	34
Magladry	-10	1	19	-23	-17	-10	-21	-19	-10
Meadow Lark	46	44	63	6	8	32	5	6	30
Parker	-15	-5	-2	-2	11	14	-1	19	35
Patterson	18	-18	-3	20	-18	-9	18	-19	-6
Washington	-11	2	-23	-8	19	10	-1	19	1
Westmoreland	-8	58	112	33	100	165	27	95	152
Whiteaker	-34	-75	-56	-16	-49	-18	-14	-38	-2
Willagillespie	-19	-24	-43	-33	-38	-50	-30	-34	-50
Willakenzie	23	65	63	-10	22	16	1	46	46
Willard	52	103	137	8	37	45	25	74	106
$\bar{x}$	-4.7	8.0	10.4	4.8	7.8	10.4	-4.6	8.0	10.4
σ	41.8	60.9	93.1	33.2	51.2	75.4	25.6	38.9	59.8

WITH LAND USE

Elementary School	Regression: Difference Between Actual & Projected 1976	1977	1978	Cohort Survival: Difference Between Actual & Projected 1976	1977	1978	Ratio: Difference Between Actual & Projected 1976	1977	1978
Adams	-116	-150	-253	-127	-165	-245	-97	-97	[illegible]
Bailey Hill	46	186	202	15	102	66	11	95	59
Condon	-25	-19	-2	3	23	38	-11	-15	-7
Crest Drive	39	26	29	13	-7	-13	19	-3	-8
Dunn	-23	1	-11	-17	2	-5	-6	28	27
Edgewood	-48	-35	-9	-12	14	57	-30	-15	9
Edison	-67	-65	-134	47	78	56	-1	8	-55
Fox Hollow	42	36	85	14	3	45	22	9	48
Gilham	35	71	100	0	29	37	16	42	59
Harris	-51	-74	-92	-35	-35	-36	-26	-26	-24
Laurel Hill	-26	-16	-48	-17	1	-17	-11	18	5
Lincoln	-18	-34	-68	3	-5	-21	0	-8	-25
McCornack	73	128	177	37	73	85	8	20	25
Magladry	-4	5	23	-17	-13	-5	-15	-16	-4
Meadow Lark	56	-31	51	7	0	25	5	-2	23
Parker	-12	-2	6	0	13	19	1	20	38
Patterson	15	-32	-26	18	-31	-27	16	-32	-24
Washington	-14	-11	-32	-10	6	-1	-3	6	-8
Westmoreland	-11	84	147	29	120	189	23	115	177
Whiteaker	-35	-32	-55	-17	-57	-20	-15	-47	-6
Willagillespie	-17	6	2	-32	-11	-12	-28	-7	-13
Willakenzie	17	46	38	-14	-9	0	-4	31	27
Willard	46	80	101	3	22	25	20	56	80
$\bar{x}$	4.7	7.8	10.5	-4.7	7.9	10.4	-4.6	7.9	10.4
σ	44.3	72.7	101.2	33.6	55.2	74.7	25.7	44.2	60.5

difference resulted in the standard error of estimate when land use information was added. For the first projected year, the standard error of estimate was 33.6. For the next two years, respectively, the standard error of estimate was 55.2 and 74.7.

Ratio - The ratio methodology yielded the smallest standard error of estimate for the three projected years with and without land use variables. Without land use, the standard error of estimate for each of the three years was 25.6, 38.9 and 59.8. With land use, the standard error of estimate was 25.7 for the first projected year, 44.2 for the second year, and 60.5 for the third year.

4. Mean of the Population Errors

The amount of bias inherent in the methodologies was judged by estimating the mean of the population error. The amount of bias was almost identical for the three methodologies.

Regression - Without land use information, the mean of the population errors for the regression methodology was estimated at -4.7 for the first projected year, 8.0 for the second year and 10.4 for the third year. With land use, the mean of the population errors for the respective three years was 4.7, 7.8 and 10.5.

Cohort survival - The mean of the population error for the third projected year was 10.4 with and without land use information, for the cohort survival methodology. For the first projected year, the average amount of bias was -4.7 without land use and 4.8 with land use, and for the second projected year, the bias was 7.8 without land use and 7.9 with land use.

Ratio - The first and third projected years yielded an identical estimated population mean with and without land use information, -4.6 and 10.4, respectively for the ratio methodology. The estimated population mean for the second projected year improved only slightly with the inclusion of land use. The mean went from 8.0 to 7.9.

Conclusions of the Testing of Three Enrollment Projection Methodologies in Eugene.

Three enrollment projection methodologies - cohort survival, regression and ratio - were tested for application to elementary school enrollment projections in the Eugene School District. Past enrollments were projected to enable comparisons of actual versus projected enrollments. During the testing of the methodologies' utility to 23 Eugene elementary schools, four major findings resulted; 1) no one methodology provided the best prediction for all schools, 2) adding a land use variable adjustment improved the overall accuracy of one methodology - the ratio methodology, 3) the land use variable adjustment improved the prediction accuracy of some schools and decreased the prediction accuracy of other schools, and

4) until all variations within an attendance area can be controlled for, no methodology will be able to accurately project enrollments in Eugene without subjective adjustments. Those uncontrolled variables greatly affecting Eugene elementary school enrollments are open enrollment, alternative schools, and transfers.

A major development of the exploration, which has application for school districts throughout the country, is the balancing procedure. The balancing procedure allows quantitative adjustments to be made to the projected individual school enrollments on the basis of a ratio representing the sum of the school projections to the district level projections. This ratio enables the individual school projections to add to the projected district-level projection, known to be accurate.

In Eugene, new housing was determined as the most influential land use factor that has caused enrollment changes for individual schools in the past. This factor was quantified into the number of new students to be expected in any attendance area by using the number of building permits applied for times the expected number of school age children for each type of dwelling unit. The influence of the land use adjustment factor was predicted to affect four schools; Bailey Hill, Gilham, Westmoreland, and Willagillespie schools. Each had 35 or more additional students projected due to additional home-building in their attendance areas. The regression predictions for each of these schools were not improved by the addition of land use factors. Three of the four schools, Bailey Hill, Gilham and Willagillespie, did show improved predictions when land use information was included in the cohort survival and ratio methodologies. The improvement is progressively evident as the projections are carried out into the third year. Westmoreland school showed markedly reduced prediction accuracy in the second and third years of prediction. Westmoreland school, not an alternative or magret school, however, does have a fairly high transfer rate for the district.

None of the three methodologies with or without land use variables was able to predict 95 to 100% of the enrollments of half of Eugene's 23 elementary schools. With the land use adjustment, the ratio methodology was able to project 95 to 100% of the enrollments in 11,8 and 8 schools for the three years of projections making it the best predictor in this exploration. The regression methodology, by far provided the worst predictions. The regression methodology, however, showed improved prediction accuracy without land use and stable prediction accuracy with land use in the second and third year projections. This might indicate that the regression methodology would be a strong candidate for use with long-range projections.

The ratio methodology yielded the most schools projected within a 30 student criterion. All but one school was projected within 30 students, with and without the land use factor adjustment, for the first year's projection using the ratio method.

The testing of the three methodologies showed that the methodologies, with and without land use, were equally biased in terms of the population error distribution. The average amount of deviation between the predicted and actual enrollments was smallest for the ratio methodology and second smallest for the cohort survival methodology.

Both Tables 17 and 18 identify a school whose enrollment is not well predicted by any of the methods used. Adams school, an alternative school which functions as a strong magnet school for all portions of the district, is predicted most accurately by the ratio methodology without land use (72%, 75%, and 64%, respectively) and least accurately by the cohort survival technique (62%, 56%, and 41% respectively). The methodologies under-estimated Adams enrollment for 1976 by 93 students (ratio, without land use) to 127 students (cohort survival, with land use).

Because of the poor results of methodologies' application to the 1976, 1977, and 1978 school years in Eugene, no new methodology was adopted. The procedure for testing the relative efficiency of the methodologies is considered valid and quite informative. Without the control of all sources of variation, however, particularly open enrollment, transfers, and alternative schools, no methodology will be able to project individual school enrollments with 95% accuracy or greater, partially due to the very small enrollments at each of these schools.

The results of this study suggest that a mixed model methodology-design may be most feasible in Eugene. Schools with known factors that can be related to a particular methodology could be grouped accordingly. Those schools that are most affected by new building activity could form one group. Another group may include those schools most affected by open enrollment and alternative programs. The most appropriate enrollment projection methodology could then be applied to each of the homogeneous subgroups for the best predictions.

Conclusions

Three procedures which were developed to improve the prediction accuracy in individual school enrollment projections have been identified and developed in this chapter. They are 1) the land use adjustment procedure 2) the balancing factor procedure, and 3) procedures for selecting an enrollment projection methodology. The procedures have been explained and illustrated through the Eugene example. General conclusions and recommendations for testing the procedures in areas other than Eugene have resulted in this exploration.

Two of the three procedures, 1 and 2 above, were developed to enable a quantification of subjective adjustments made to individual school enrollment projections. The first, the land-use adjustment procedure was designed to enable an adjustment to projections based on residential area changes. The procedure, however, can not effectively work in a school district until all major land-use sources causing enrollment variations have been identified and converted into a number of new students to be expected in each attendance area. The same variable may not be most appropriate for all schools. Several variables should be tested before a few are selected and applied to an enrollment projection methodology. The best way to test the variables is to apply the land use factors to past enrollment data and visualize how the factors were able to project past years.

The balancing factor procedure is one that could cut down on the hassles of adjusting projected individual school enrollments so they sum to the projected district total. The balancing factor provides a uniform procedure for smoothing the projected enrollments, inflated, due to small numbers and rounding errors. The closer the balancing factor is to one, the better the indication that an accurate enrollment projection methodology has been utilized. The balancing factor should be used after all other adjustments have been made.

The procedure for selecting an enrollment projection methodology, described earlier, is a comprehensive and valid procedure for enabling a thorough view of a methodology's predictive power for a school district. It also allows for a comparative analysis of two or more methodologies. It is important to apply the methodologies to past data to see how they would have projected past years' enrollments, and not just apply them to future years. The actual enrollments of the past years provide concrete evidence of the methodology's credibility. Again, before an enrollment projection methodology can be utilized with 95% or better accuracy, all sources of variation must be identified and controlled for. Most common enrollment projection methodologies do not have the capability to project new student enrollments beyond that of past trends.

Chapter 4

The Eugene Public School District

Enrollment Projection Methodology

The Eugene Oregon Public School District
Enrollment Projection Methodology

Eugene School District 4J

The city of Eugene comprises the largest sector of what is known as School District 4J. The district covers 155 square miles and includes portions of nearby towns of Springfield and Coburg, Oregon. Within its boundaries, are four high schools, eight junior high schools, and thirty-one elementary schools. The high school locations determine the administrative regions established by the school district. Within these individual regions are several attendance areas enclosing each elementary school. In addition to a traditional public school system, 4J's jurisdiction includes an alternative education program at all grade levels. Approximately 20,000 students are enrolled in the district. The approximate breakdown for each school level is as follows: Kindergarten-6th, 10,000; 7th-9th, 5,000; and 10th-12th, 5,000.

The Eugene School District employs about 1,250 full time equivalent (FTE) professsional staff. They include school administrators, board of education officers, teachers, social workers, and health staff. The total number of teachers in both traditional and alternative schools is 1,032.5 FTE. Each teacher serves an average of 18.4 pupils. The Board intends to maintain this student-teacher ratio, and has recommended that the budget for the school year be adjusted accordingly. Teacher salaries range from $11,400 to $22,600 per annum. Over 65 per cent of the teachers hold graduate degrees.

The Division of Research, Development and Evaluation (RD&E) in the Eugene school system is annually responsible for providing enrollment projections on the basis of which administrators must make decisions concerning utilization of district facilities, personnel, programs, and educational services. Each year, RD&E's five-year projections are also updated.

The following study describes the enrollment projection methodology currently used in Eugene School District 4J.

Eugene Student Enrollment Projection Methodology

Enrollment projections in Eugene Public School District 4J are based on a combination of the cohort survival, regression, and apportionment methodologies. Grade-level projections using the cohort survival methodology are made for five years into the future and have long been accurate at the 99.5% level for the first projected year. The regression methodology is used to project district first grade enrollments on the basis of births in the city six years prior to the year being projected. District kindergarten enrollments are projected by dividing past kindergarten to past first grade enrollments for five previous years, and multiplying the average of these ratios times the projected first grade enrollment. Individual school enrollment projections are made on a yearly basis, by grade level, by advancing the past year's grade enrollment for each school as the projected year's projected enrollment for the next grade. In the cases of entering grades (i.e., seventh and tenth grades), enrollments are projected via telephone checks with linking-school administrators to verify the number of students registered to attend the respective schools. While this methodology provides quite accurate results, it is very time-consuming and requires a great deal of subjective manipulation. Chapter 3 reveals the attempt to adopt a new methodology for Eugene individual school projections. None of the common enrollment projection methodologies - cohort survival, regression, and ratio - were able to project individual schools more accurately than the existing method. The method described in this chapter, therefore, is still operational.

The following describes, in detail, the steps taken to attain grade-level enrollment projections for the 1978 to 1983 school years, and school level enrollment projections for the 1978-79 school year. Actual data have been used to illustrate the process.

Grade-Level Projections

Eugene grade-level enrollments were projected for the 1978 to 1983 school years using the cohort survival methodology. The eight steps taken in making projections are explained and illustrated below.

Step 1. Collection of Past Enrollment

Total enrollment by grade level was gathered for five years prior to 1978. One common date for each school year was used. In this example, as Table 19 displays, 1973-74, 1974-75, 1975-76, 1976-77 and 1977-78 enrollments were gathered by grade level for September 30 of each year.

TABLE 19

1973-1977 Student Enrollments By Grade Level
For Eugene School District
(Based On September 30 Data)

Grade	1973-74	1974-75	1975-76	1976-77	1977-78
K		1,295	1,456	1,381	1,258
1	1,592	1,457	1,599	1,657	1,549
2	1,540	1,512	1,467	1,623	1,636
3	1,527	1,515	1,530	1,479	1,581
4	1,588	1,454	1,538	1,496	1,446
5	1,673	1,574	1,491	1,465	1,456
6	1,885	1,644	1,571	1,473	1,442
7	1,870	1,902	1,643	1,587	1,487
8	1,901	1,895	1,859	1,635	1,546.5
9	1,706	1,860	1,826	1,839	1,579
10	1,754	1,676	1,803	1,884	1,833
11	1,683	1,673	1,597	1,694	1,714
12	1,387	1,494	1,485	1,470	1,560
<u>Special Programs</u>					
Elementary	55	75	65	90	94.5
Junior High	42	45	40	79	56.5
Senior High	41	45	40	35	50
TOTAL	20,244	21,223	21,010	20,887	20,288.5

Step 2. Formation of Cohort Survival Ratios for Grades Two through Twelve

A cohort survival ratio matrix, based on the past five years enrollment data, was established by dividing the number of students in a given grade on a given year by the number of students enrolled in the next lower grade for the preceding year. For example, the cohort survival ratio for grade progession 7-8 for the school year 1975-76 was created by dividing grade 8 enrollment for the 1976-77 school year by grade 7 enrollment for the 1975-76 school year (i.e., 1635 ÷ 1643 = .9951). The resulting value indicated that 99.51% of the total number of seventh graders in 1975-76 advanced to eighth grade in 1976-77. Table 20 incorporates the cohort survival ratios calculated for the years 1973 to 1978. (The cohort survival ratio indicates growth, decline, or stability on a year-to-year basis. A value of 1 indicates no change in enrollment from one year to the next, while a value less than 1 reflects a decline and a value greater than reflects an increase in enrollment.

TABLE 20

Survival Ratios for Each Year by Grade Level

Grade Progression	1973-74	1974-75	1975-76	1976-77	1977-78
K - 1					
1 - 2	.9497	1.0069	1.0150	.9873	.9761
2 - 3	.9837	1.0120	1.0082	.9741	.9976
3 - 4	.9521	1.0501	.9778	.9777	1.0082
4 - 5	.9911	1.0254	.9525	.9733	.9779
5 - 6	.9826	.9981	.9879	.9843	1.0082
6 - 7	1.0090	.9994	1.0102	1.0095	1.0049
7 - 8	1.0133	.9774	.9951	.9754	.9926
8 - 9	.9784	.9636	.9892	.9670	.9858
9 - 10	.9824	.9693	1.0318	.9967	1.0431
10 - 11	.9332	.9529	.9395	.9103	.9111
11 - 12	.8877	.9071	.9205	.9221	.8681

Step 3. Calculation of Average Survival Ratios

After the five years of cohort survival ratios were created, five averages were formed for each grade level. Those five values represent the average survival ratios for: 1) the five-year period, 2) the last four years, 3) the last three years, 4) the four years with the largest survival ratio values, and 5) the three years with the largest survival ratio values.

Table 21 displays Eugene's survival ratios as averaged in these five ways. The five year averages were created by adding the survival ratios for the 1973-74, 1974-75, 1975-76, 1976-77, and 1977-78 school years across each given grade level and by dividing the sum by 5. For the four-year and the three-year averages, summing began with the 1974-75 and 1975-76 enrollments, respectively. To obtain the highest four-year average for the same grade interval, the highest four values were summed (i.e., 1.0069 + 1.0159 + .9873 + .97610 = 3.9853)and divided by 4 (i.e., 3.9853 ÷ 4) to produce the average ratio value of .9963. The highest three-year average was created similarly to obtain the three year average of 1.0031.

TABLE 21

Average Survival Ratios

Grade Progression	Five Year Average	Last Four Year Average	Last Three Year Average	Highest Four Year Average	Highest Three Year Average
K - 1					
1 - 2	.9870	.9963	.9928	.9963	1.0031
2 - 3	.9951	.9980	.99[illegible]	1.0004	1.0059
3 - 4	.9862	.9947	.9879	.9947	1.0004
4 - 5	.9840	.9823	.9679	.9919	.9981
5 - 6	.9922	.9946	.9935	.9946	.9981
6 - 7	1.0066	1.0060	1.0082	1.0084	1.0096
7 - 8	.9908	.9851	.9877	.9946	1.0003
8 - 9	.9768	.9764	.9807	.9801	.9845
9 - 10	1.0047	1.0102	1.0239	1.0135	1.0239
10 - 11	.9294	.9285	.9203	.9342	.9419
11 - 12	.9011	.9045	.9036	.9094	.9166

Step 4. Calculation and Selection of 1978-1983 Enrollments

After the ratio averages were calculated, the best projection was determined by which ratio provided the best prediction for the previous years, by grade level. By computing an average, three-to-five year trends were distinguished. Table 22 displays the actual enrollments for the 1977-78 school year by grade level, and five columns of projected enrollments for each grade level obtained by multiplying each of the survival ratio averages (appearing in parentheses) by the 1977-78 actual enrollments. The ratios that yielded the most accurate predictions for 1978-79 school year enrollments for each grade are indicated by an asterisk. The multiplication was done diagonally. For example, the first-to-second grade five-year average ratio (9870) was multiplied by the 1977-78 first grade enrollment to arrive at the second grade projection of 1,529. The 1978-79 projections were then multiplied by the best survival ratios to produce the 1979-80 projections and so on until the 1983 projections were calculated.

TABLE 22

Grade Level Enrollments Projected for 1978-83 Based On Five Ratio Averages

Grade	Actual Enrollment 1977-78	Projection Based On Five Year Ratio Average (In Parenthesis)		Projection Based On Last Four Year's Ratio Average		Projection Based On Last Three Year's Ratio Average		Projection Based On Highest Four Year Average		Projection Based On Highest Three Year Average		Enrollment Projections 1978-79	1979-80	1980-81	1981-82	1982-83
K	1,258	--		--		--		--		--						
1	1,549	(.9870)*		(.9963)		(.9928)		(.9963)		(1.0031)						
2	1,636	(.9951)	1,529	(.9980)*	1,543	(.9933)	1,538	(1.0004)	1,543	(1.0059)	1,654	1,529				
3	1.581	(.9862)	1,628	(.9947)	1,633	(.9879)	1,625	(.9947)	1,637	(1.0004)*	1,646	1,633	1,526			
4	1,446	(.9840)	1,559	(.9823)*	1,573	(.9679)	1,562	(.9919)	1,573	(.9981)	1,582	1,582	1,634	1,527		
5	1,456	(.9922)	1,423	(.9946)	1,420	(.9935)	1,400	(.9946)	1,434	(.9981)*	1,443	1,420	1,554	1,605	1,500	
6	1,442	(1.0066)	1,445	(1.0060)*	1,448	(1.0082)	1,447	(1.0084)	1,448	(1.0096)	1,453	1,453	1,417	1,551	1,602	1,497
7	1,487	(.9908)	1,452	(.9851)	1,451	(.9877)	1,454	(.9946)*	1,454	(1.0003)	1,456	1,461	1,462	1,426	1,560	1,612
8	1,547	(.9768)	1,473	(.9764)	1,465	(.9807)	1,469	(.9801)	1,479	(.9845)*	1,487	1,479	1,443	1,454	1,418	1,552
9	1,579	(1.0047)	1,511	(1.0102)	1,510	(1.0239)	1,517	(1.0135)	1,516	(1.0239)*	1,523	1,523	1,456	1,421	1,431	1,396
10	1,833	(.9294)	1,586	(.9285)	1,595	(.9203)*	1,617	(.9342)	1,600	(.9419)	1,617	1,617	1,559	1,491	1,455	1,465
11	1,714	(.9011)*	1,704	(.9045)	1,702	(.9036)	1,687	(.9094)	1,712	(.9166)	1,727	1,687	1,488	1,435	1,372	1,339
12	1,560		1,544*		1,550		1,549		1,559		1,571	1,544	1,520	1,341	1,293	1,236

* Indicates survival ratio that best predicts grade enrollments for 1978-79.

Step 5. Formation and Calculation of First Grade Enrollment

The number of first grade students expected to enroll in the school district in 1978, 1979, 1980, 1981, and 1982 was calculated with a regression equation, using the actual number of first graders enrolled in the district for the previous five years, and the number of births in Lane County six years prior to each year of actual enrollments. The equation used for the projections was $\hat{Y} = b_0 + b_{y \cdot x}(X - \bar{X})$. $\hat{Y}$ represents the value being predicted (i.e., 1978 first grade enrollment), $b_{y \cdot x}$ represents an index of the relationship between birth rate and actual enrollment, b_0 represents the overall mean of the actual enrollments, X represents the number of births six years prior to the year of the projected enrollment and $\bar{X}$ represents the average number of births over the six years.

The $b_{y \cdot x}$ variable was calculated by multiplying the correlation between birth rate and actual enrollment by the ratio of the standard deviation of the actual enrollments to the standard deviation of the birth rate data

$$\text{(i.e., } b_{y \cdot x} = r_{xy} \cdot S_y/S_x = -.7187 \left[\frac{74.3317}{183.3925}\right] = -.2913\text{).}$$

The resulting $b_{y \cdot x}$ in this case was -.2913, indicating a slight negative relationship between the two variables. The $b_{y \cdot x}$, as a multiplier of $(X-\bar{X})$'s(number of births for six previous years minus the average number of births for the preceding five years), adjusted the influence of the number of births by the amount to which the birth rate variation was accounted for in the variance of the actual enrollments (or Y's). The birth rate six years prior to the projected year and the average first grade enrollment for the last five years were placed in the regression equation to predict an enrollment for each year. In this example, the average first grade enrollment for the past five years was 1,570.80. That number added to the dev[illegible]ion number of births in Lane County six years earlier was multi[illegible] by the regression coefficient to obtain the number of fi[illegible] graders the district could expect in 1978 ($Y' = 1{,}570.80 + (-.2913)(3738 - 3783.60) = 1584$).

Table 23 shows the data used to project first grade enrollments for 1978 to 1982 as well as the actual projections.

67

TABLE 23

Data Used to Estimate First Grade Enrollment for the 1973-82 School Years

Year	Number Of Births Lane County (X)	XY	Year	Number Of First Graders (Y)	Year	Projected Number Of First Graders
1967	3,965	6,312,280	1973	1,592		
1968	3,983	5,303,231	1974	1,457		
1969	3,683	5,892,315	1975	1,599		
1970	3,564	4,905,548	1976	1,657		
1971	3,721	5,763,829	1977	1,549		
1972	3,738	4,814,606	1978	1,387	1978	1,584
1973	3,324				1979	1704
1974	3,362				1980	1,694
1975	3,577				1981	1,631
1976	3,635				1982	1,614

Step 6. Formation and Calculation of Kindergarten Enrollment

Kindergarten enrollment is the most difficult grade level to predict accurately in Eugene. Kindergarten was not added to the Eugene public school system until the 1974-75 school year, and many private kindergartens remain available in the city.

Kindergarten enrollments are best estimated on the basis of first grade enrollments--projected and actual. Once first grade enrollments have been projected, an average cohort survival ratio can be used in a reverse direction to estimate each year's kindergarten enrollment. Table 24 illustrates the process.

To establish an inverted cohort survival ratio for a given year, one must divide the previous year's kindergarten enrollment by the given year's actual (or projected) first grade enrollment. For example, the ratio of .8787 for 1976-77 was obtained by dividing the 1975-76 kindergarten enrollment (1456) by the 1976-77 first grade enrollment (1657). To compute the 1978-79 ratio, the <u>projected</u> first grade enrollment was divided into the 1977-78 actual kindergarten enrollment (1,258/1,584 = .7942). To project the 1978-79 kindergarten enrollment, an average of the four previous year's cohort ratios was computed (average = (.8099 + .8787 + .9015 + .7942) ÷ 4 = .8436) and multiplied by the projected 19/8-79 first grade enrollment. This average incorporates the first four year's data as well as the existing year's\` projected first grade enrollment. In the past, the most accurate kindergarten projections two to five years into the future have resulted when an average ratio based on four years of actual data is used rather than when a new average is established based on estimates.

TABLE 24

Data Used to Project 1978 to 1982 Kindergarten Enrollments

	Actual Enrollment				Projected Enrollment				
Grade	1974 to 1975	1975 to 1976	1976 to 1977	1977 to 1978	1978 to 1979	1979 to 1980	1980 to 1981	1981 to 1982	1982 to 1983
K	1,295	1,456	1,381	1,258	1,336	1,437	1,429	1,376	1,362
First	1,457	1,599	1,657	1,549	1,584	1,704	1,694	1,631	1,614
Ratio		.8099	.8787	.8915	.7942	.8436			

Step 7. Collation of Projections

With the information calculated in the previous steps, a completed projection matrix was created and enrollment projections obtained for the 1978-79, 1979-80, 1980-81, 1981-82 and 1982-83 school years. For each grade level and year, an enrollment was projected by multiplying the most accurate survival ratio (see Step 4 and Table 22) by the corresponding grade level enrollment for the previous year. Thus, enrollments are calculated diagonally.

Table 25 shows the actual enrollment by grade for the 1977-78 school year and the survival ratio selected in Step 4. For grades 2-12, each year's enrollment was projected by multiplying the previous year's previous grade enrollment by the survival ratio for the previous year. For example, the projected 1978-79 third grade enrollment was derived by multiplying the 1977-78 second grade enrollment by the second to third grade survival ratio (1636 x .9980 = 1633). The same procedure was used to compute projections for all grades between 2 and 12.

To complete the grade level enrollment projections, a sum of grade level projections produces a district sum for the year.

TABLE 25

Projected Enrollments for the 1978-79 to 1982-83 School Years

Grade	1977-78 Actual Enrollment	Survival Ratio	1978-79	1979-80	1980-81	1981-82	1982-83
K	1,258	---	1,336	1,437	1,429	1,376	1,362
1	1,549	.9870	1,584	1,704	1,694	1,631	1,614
2	1,636	.9980	1,529	1,563	1,682	1,672	1,610
3	1,581	1.0004	1,633	1,526	1,560	1,679	1,669
4	1,449	.9823	1,582	1,634	1,527	1,561	1,680
5	1,456	.9981	1,420	1,554	1,605	1,500	1,533
6	1,442	1.0060	1,453	1,417	1,551	1,602	1,497
7	1,487	.9946	1,451	1,462	1,426	1,560	1,612
8	1,547	.9845	1,479	1,443	1,454	1,418	1,552
9	1,579	1.0239	1,523	1,456	1,421	1,431	1,396
10	1,833	.9203	1,617	1,559	1,491	1,455	1,465
11	1,714	.9011	1,687	1,488	1,435	1,372	1,339
12	1,560	---	1,544	1,520	1,341	1,293	1,236
TOTAL	20,028		19,338	19,763	19,616	19,550	19,565

Step 8. Estimation of Special Education Program Enrollments

Projections of special education program enrollments, made in conjunction with the Eugene School District Director of Special Education, were estimated for only a year or two into the future because funding for special education programs varies annually. Special education enrollment projections depend largely on a reliable procedure for identifying special education students.

TABLE 26

1973-1977 Enrollments and Projected Enrollments for Elementary, Junior High and Senior High Special Education Programs

Special Programs	Past Enrollment 1973-74	1974-75	1975-76	1976-77	Projected Enrollment 1977-78	1978-79	1979-80
Elementary	55	75	65	90	94.5	111	137
Junior High	42	45	40	79	56.5	51	59
Senior High	41	45	40	35	50	35	36
TOTALS	138	165	145	204	201	197	232

Step 9. Individual School Projections

Individual school enrollments in Eugene are projected one year at a time by grade level. Projections of more than one year into the future have proven quite inaccurate, due to the very small numbers which lend themselves to random error. 1978-79 grade enrollments (with the exception of kindergarten and first grade) for each school were projected by advancing the 1977-78 enrollments for each grade as the projected enrollment for the next grade. Projected seventh grade and tenth grade enrollments were adjusted on the basis of a telephone interview with school building administrators to verify the number of students registered to attend each grade. The following sections describe the steps involved in projecting enrollments for elementary, junior high, and senior high schools.

Elementary School Projections

Elementary School enrollment projections for 1978-79 used actual enrollment data from the 1977-78 school year adjusted by enrollment trends from the previous two years and the 1978-79 projected grade totals obtained in the grade-level projections. The elementary enrollment projections also incorporated two apportionment techniques to estimate kindergarten and first grade enrollments.

The procedure of projecting elementary enrollments is outlined below. Tables 27, 28 and 29 illustrate the process. Throughout this section, 1975-76, 1976-77 and 1977-78 enrollments have been used to project 1978-79 elementary school enrollments.

Second through sixth grade enrollments were calculated by projecting 1977-78 first through fifth grade enrollments at each school as 1978-79 second through sixth grade projections. These raw projections were then adjusted on the basis of the 1978-79 projected district grade level enrollments and enrollment trends for each school. Table 27 displays the past three years enrollment data for fourth grade through sixth grade, the projected enrollments, and the adjusted projections for each school. A total[1] for the projected enrollments also appears as does the recommended adjustment factor for grade-level projections, which is the difference between the projected and the previously calculated district grade level projections.

---

[1] Projected 1978 grade total appearing in Table 27 may vary from those in Table 25 because of special education students included in the individual school projections.

TABLE 27

Fourth, Fifth and Sixth Grade Past Enrollments and 1978-79 Projections for Eugene Elementary Schools

School	Fourth Grade Enrollment 1975	1976	1977	Projected 1978	Adjusted Projections	Fifth Grade Enrollment 1975	1976	1977	Projected 1978	Adjusted Projections	Sixth Grade Enrollment 1975	1976	1977	Projected 1978	Adjusted Projections	Total Enrollment 1975	1976	1977	Projected 1978
Adams	45	40	44	32	33	47	38	36	44	44	46	50	37	36	35	270	289	281	340
Aubrey Park	96	95	79	95	95	85	88	93	79	78	94	84	92	93	93	648	573	584	597
Bailey Hill	54	58	58	69	70	59	59	58	58	58	72	52	62	58	57	458	393	421	455
Coburg	40	25	33	27	26	34	29	30	33	32	26	24	30	30	29	207	176	186	178
Condon	21	16	14	19	18	10	17	11	14	13	21	8	17	11	10	140	119	122	138
Crest Drive	40	32	40	34	35	38	39	38	40	40	50	38	44	38	37	278	234	259	273
Dunn	32	37	35	23	22	43	32	41	35	34	38	44	25	41	40	264	243	208	219
Edgewood	64	73	60	86	85	74	71	77	60	59	71	76	70	77	75	444	445	442	446
Edison	20	25	23	34	33	26	21	29	23	22	20	32	33	29	28	182	177	186	187
Fox Hollow	30	27	25	32	31	27	25	31	25	24	42	22	27	31	30	220	184	197	203
Gilham	54	41	49	56	55	39	45	41	49	48	61	40	39	41	40	312	296	306	319
Harris	30	38	43	39	38	28	28	42	43	42	35	34	29	42	41	244	244	24[illegible]	258
Howard	78	63	69	81	80	69	70	62	69	68	72	68	64	62	61	519	466	457	497
Laurel Hill	23	16	17	13	12	22	20	11	17	16	15	20	19	11	10	129	131	1[illegible]3	108
Lincoln	25	21	32	34	33	24	24	22	32	31	18	14	18	22	21	197	179	184	206
McCornack	60	57	59	59	58	51	68	60	59	58	53	61	53	60	59	341	345	328	337
Magladry	23	28	32	26	25	22	28	25	32	31	29	28	26	25	24	137	158	162	156
Meadow Park	64	63	47	75	74	64	63	58	47	46	67	58	56	68	67	412	395	412	442
Parker	43	44	44	39	37	35	37	42	44	43	30	37	37	42	41	289	266	256	265
Patterson	42	24	38	48	48	37	25	33	38	38	33	24	22	33	32	282	233	282	343
River Road	64	73	60	53	52	64	64	72	60	59	62	84	62	72	71	495	470	426	458
Santa Clara	74	69	54	66	65	55	74	62	54	53	66	49	75	62	61	444	408	411	413
Silver Lea	68	64	46	65	64	62	68	60	46	45	71	64	70	60	59	469	426	394	399
Spring Creek	97	66	74	66	65	75	94	54	74	73	74	73	93	54	53	532	475	450	449
Twin Oaks	36	38	36	41	40	43	39	36	35	46	47	37	39	38	38	261	243	234	235
Washington	62	67	64	82	81	64	61	68	64	63	82	63	61	68	67	474	438	435	458
Westmoreland	52	61	54	60	59	58	32	45	54	53	54	68	36	45	44	461	402	344	389
Whiteaker	27	24	33	41	40	29	28	31	33	32	18	21	32	31	30	217	211	245	268
Willagillespie	40	47	51	49	48	45	47	48	51	50	49	45	48	48	47	372	354	343	364
Willakenzie	37	51	41	33	32	44	31	37	41	40	43	42	30	37	36	293	264	238	271
Willard	56	48	38	38	37	51	49	45	38	37	56	54	46	45	44	330	282	249	242
Eastside	20	26	22	20	21	17	15	14	22	21	18	20	16	14	20	134	129	116	125
Magnet Arts	19	20	20	33	25	29	18	18	20	25	17	16	18	18	25	151	141	144	150
Trad. Altern.	--	15	12	13	15	24	17	13	12	17	22	12	18	13	17	46	93	96	100
TOTAL	1538	1492	1446	1581	1553	1491	1465	1456	1446	1428	1571	1472	1442	1456	1442	10652	9882	9761	10288
Projected 1978 Grade Total				1553					1428					1442					
Adjustments				-28					-22					-14					

As previously explained, kindergarten and first grade student enrollments are the most difficult to project for the Eugene Public Schools. First grade enrollments are projected first and kindergarten is projected on the basis of the first grade projections. Two methods are used to make these initial first grade projections. The projected first grade enrollments are compromised and adjusted according to the district-level first grade enrollment projections on the basis of the past year's trend for first grade. Table 28 displays the ratios used in this method of projecting 1978-79 first grade enrollments for the individual schools.

The first set of ratios in Table 28 the past first grade to kindergarten ratios, are calculated by dividing the 1976 and 1977 first grade enrollments by the 1975 and 1976 kindergarten enrollments, respectively, and multiplying the average of the two ratios times the 1977 kindergarten enrollment for each school.

The second set of ratios in Table 28 the district apportionment ratios, were calculated by dividing the 1975, 1976, and 1977 first grade enrollments for each school by the 1975, 1976, and 1977 districtwide first grade enrollments. The average of the resulting three ratios was then multiplied by the projected 1978-79 district first grade enrollments.

The adjusted projections best reflect past trends and the expected future enrollments for first grade in the district. The necessary adjustment factor appears at the bottom of the table.

7

TABLE 28

First Grade To Kindergarten Ratios and Apportionment Ratios Used to Project 1978-79
First Grade Enrollments For Individual Schools

SCHOOL	Past First - Kindergarten Enrollment Ratios: 1976 (1st) to 1975 (K)	1977 (1st) to 1975 (K)	Average	Projected 1978	District Apportionment Ratios: 1975	1976	1977	Average	Projected 1978 First Grade	Adjusted Projections
Adams	1.1471	1.1000	1.1236	103	.0169	.0236	.0355	.0253	41	53
Awbrey Park	2.2553	3.8636	3.0595	141	.0725	.0640	.0549	.0638	101	83
Bailey Hill	.6983	2.4194	1.5589	70	.0319	.0489	.0484	.0431	68	73
Coburg	1.2400	2.4444	1.8422	31	.0169	.0187	.0142	.0166	26	20
Condon	.6250	.9474	.7862	32	.0113	.0151	.0116	.0127	20	16
Crest Drive	.8085	1.5652	1.1869	57	.0206	.0229	.0232	.0222	35	34
Dunn	1.0256	2.1250	1.5753	39	.0206	.0242	.0219	.0222	35	30
Edgewood	1.4186	2.8095	2.1141	89	.0457	.0368	.0381	.0402	64	57
Edison	.9167	1.9231	1.4199	45	.0219	.0199	.0161	.0193	31	23
Fox Hollow	1.2083	2.5385	1.8734	28	.0213	.0175	.0213	.0200	32	31
Gilham	--	--	--	38	.0313	.0344	.0297	.0318	50	44
Harris	1.1282	2.2667	1.6975	44	.0244	.0266	.0219	.0243	38	32
Howard	1.111	2.1579	1.6345	106	.0544	.0483	.0529	.0519	82	79
Laurel Hill	1.8000	2.8750	2.3375	33	.0138	.0163	.0148	.0150	24	20
Lincoln	1.0909	1.8889	1.4899	40	.0244	.0217	.0219	.0227	36	32
McCornack	--	--	--	--	.0319	.0314	.0368	.0334	53	55
Magladry	--	--	--	--	.0113	.0163	.0168	.0148	23	24
Meadow Lark	1.4286	2.0333	1.7310	107	.0394	.0362	.0394	.0383	61	59
Parker	1.1463	2.1765	1.6614	52	.0263	.0284	.0239	.0262	42	35
Patterson	1.0400	3.3684	2.2042	88	.0306	.0314	.0413	.0344	54	62
River Road	.6308	1.2400	.9354	93	.0388	.0495	.0400	.0428	68	59
Santa Clara	1.4222	2.7273	2.0748	106	.0450	.0386	.0387	.0408	65	58
Silver Lea	.8391	1.5500	1.1946	47	.0425	.0441	.0400	.0422	67	60
Spring Creek	.9667	2.2121	1.5894	91	.0469	.0350	.0471	.0430	68	70
Twin Oaks	.9737	2.2308	1.6023	48	.0219	.0223	.0187	.0210	33	24
Washington	.9014	1.7353	1.3184	64	.0438	.0386	.0381	.0402	64	57
Westmoreland	.9394	2.0294	1.4844	76	.0525	.0374	.0445	.0448	71	65
Whiteaker	1.0769	2.0526	1.5648	66	.0250	.0254	.0252	.0252	40	37
Willagillespie	.6300	.9808	.8054	40	.0313	.0380	.0329	.0341	54	49
Willakenzie	.7561	2.1304	1.4433	58	.0244	.0187	.0316	.0249	39	47
Willard	1.0833	2.4615	1.7724	51	.0244	.0236	.0207	.0229	36	30
Eastside	--	--	--	--	.0175	.0127	.0136	.0146	23	21
Magnet Arts	--	--	--	--	.0188	.0199	.0155	.0181	29	25
Trad. Alt.	--	--	--	--		.0133	.0084	.0109	17	17
TOTAL	1.1374	1.2313	1.1844	1,883					1,584	84
Adjustments				-399					-100	

Table 29 displays two sets of ratios used to project 1978 kindergarten enrollments for the individual schools, along with the adjusted projections.

The first set of ratios are the apportionment ratios, calculated by dividing the 1975, 1976 and 1977 school kindergarten enrollments by the 1975, 1976 and 1977 district-wide kindergarten enrollments, respectively. The average of the three ratios was then multiplied by the projected 1977 district-wide kindergarten enrollment to project each school's 1978 enrollment.

The second set of ratios in Table 29 are the kindergarten to first grade ratios, calculated by dividing each school's 1975, 1976 and 1977 kindergarten enrollments by its 1975, 1976 and 1977 first grade enrollments, respectively, and calculating an average. The average ratios were multiplied by the 1978 projected first grade enrollments for each school to obtain the 1978 projected kindergarten enrollments.

The last column of Table 29 shows the 1978 projections adjusted to reflect past trends and to balance to the projected district kindergarten enrollments. The adjustment needed for each ratio technique appears at the bottom of Table 29.

76

TABLE 29

Apportionment and Kindergarten to First Grade Ratios Used To Project 1978-79 Kindergarten Enrollments for Eugene Elementary Schools

SCHOOL	Apportionment Ratios and Projections				Projected	Kindergarten To First Grade Ratios				Projected	Adjusted
	1975	1976	1977	Average	1978	1975	1976	1977	Average	1978	Projections
Adams	.0234	.0362	.0731	.0442	59	1.2593	1.2821	1.6727	1.4047	74	88
Awbrey Park	.0323	.0159	.0366	.0203	38	.4052	.2075	.5412	.3846	32	45
Bailey Hill	.0797	.0224	.0358	.0460	61	2.2745	.3827	.6000	1.0857	79	44
Coburg	.0172	.0065	.0135	.0124	17	.9259	.2903	.7727	.6630	13	16
Condon	.0275	.0138	.0326	.0246	33	2.2222	.7600	2.2778	1.7533	28	40
Crest Drive	.0323	.0167	.0382	.0291	39	1.4242	.6053	1.3333	1.1209	38	46
Dunn	.0268	.0116	.0199	.0194	26	1.1818	.4000	.7353	.7724	23	24
Edgewood	.0295	.0152	.0334	.0260	35	.5890	.3443	.7119	.5484	31	41
Edison	.0247	.0094	.0254	.0198	26	1.0286	.3939	1.2800	.9008	21	31
Fox Hollow	.0165	.0094	.0119	.0126	17	.7059	.4483	.4545	.5362	17	14
Gilham	--	--	.0302	.0302	40	--	--	.8261	.8261	36	37
Harris	.0268	.0109	.0207	.0195	26	1.000	.3409	.7647	.7019	22	25
Howard	.0495	.0275	.0517	.0429	57	.8276	.4750	.7927	.6984	55	63
Laurel Hill	.0103	.0058	.0111	.0091	12	.6818	.2963	.6087	.5289	11	13
Lincoln	.0227	.0130	.0215	.0191	26	.8462	.5000	.7941	.7134	23	26
McCornack	--	--	--	--		--	--	--	--		
Magladry	--	--	--	--		--	--	--	--		
Meadow Lark	.0288	.0217	.0493	.0333	44	.6667	.5000	1.0164	.7277	43	60
Parker	.0282	.0123	.0246	.0217	29	.9762	.3617	.8378	.7252	25	30
Patterson	.0343	.0138	.0318	.0266	36	1,0204	.3654	.6250	.6703	42	39
River Road	.890	.0362	.0787	.0680	91	2.0968	.6098	1.5968	1.4345	26	95
Santa Clara	.0309	.0159	.0405	.0291	39	.6250	.3438	.8500	.6063	35	49
Silver Lea	.0598	.0290	.0310	.0399	53	1.2794	.5479	.6290	.8188	49	38
Spring Creek	.0412	.0239	.0453	.0368	49	.8000	.5690	.7808	.7166	50	55
Twin Oaks	.0261	.0094	.0238	.0198	26	1.0857	.3514	1.0345	.8239	22	29
Washington	.0488	.0246	.0509	.0414	55	1.0143	.5313	1.0847	.8768	50	62
Westmoreland	.0453	.0246	.0405	.0368	49	.7857	.5484	.7391	.6911	45	49
Whiteaker	.0268	.0138	.0334	.0247	33	.9750	.4524	1.0769	.8348	31	41
Willagillespie	.0687	.0377	.0397	.0487	65	2.000	.8254	.9804	1.2686	62	48
Willakenzie	.0282	.0167	.0318	.0256	34	1.0513	.7419	.8163	.8698	41	39
Willard	.0247	.0094	.0231	.0191	26	.9231	.3333	.9063	.7209	22	28
TOTAL					1141						121.
Adjustments					+74						

79 80

Junior High School Projections

During the 1978-79 school year, nine junior high schools served grades seven, eight, and nine in Eugene School District 4 J.

1978 projections for grades eight and nine followed the procedures used in projecting grades two through six, whereby 1977 enrollments for the preceeding grade level became the initial 1978 projections. Those projections were adjusted to the district-wide eighth and ninth grade 1978 projected enrollments on the basis of the past two years' enrollment trends. Projections for seventh grade required more subjective judgment to accurately apportion sixth graders from 31 elementary schools into the nine seventh grade schools that allow for open enrollment.

The first step in projecting 1978 seventh grade enrollment for each school was to inquire at the 31 elementary schools how many sixth grade students were planning to attend each junior high school. Adjustments were made to the "telephone projections" to correspond to the projected 1978 district seventh grade enrollment.

Table 30 incorporates 1976 and 1977 enrollments for grades seven, eight and nine, the projected 1978 enrollment, and the adjusted projections for each school.

81

TABLE 30

Student Enrollments and 1978 Enrollment Projections for

Eugene Junior High Schools

SCHOOL	Seventh Grade Enrollment 1976	Seventh Grade Enrollment 1977	Seventh Grade Enrollment Projected 1978	Eighth Grade Enrollment 1976	Eighth Grade Enrollment 1977	Eighth Grade Enrollment Projected 1978	Eighth Grade Enrollment Adjusted Projections	Ninth Grade Enrollment 1976	Ninth Grade Enrollment 1977	Ninth Grade Enrollment Projected 1978	Ninth Grade Enrollment Adjusted Projections	Total Junior High Enrollment 1976	Total Junior High Enrollment 1977	Total Junior High Enrollment Projected 1978
Jefferson	195	197	161	204	183	197	193	216	196	183	174	615	576	528
Kelly	209	190	205	200	191	190	185	231	213	191	183	640	594	573
Kennedy	192	[illegible]	178	185	200	204	210	238	201	200	199	615	605	585
Madison	239	213	255	245	231	213	202	260	221	231	219	745	665	676
Monroe	148	127	101	157	148	127	125	166	133	148	141	472	408	367
Opportunity Center	--	--	--	15	7	10	23	21	22	7	27	36	29	50
Roosevelt	260	247	246	256	251	247	235	274	231	251	240	790	729	724
Spencer Butte	159	164	146	186	147	164	155	213	174	147	139	558	485	440
Cal Young	187	145	162	187	190	145	142	206	186	190	182	580	521	486
Horizons	--	--	--	--	--	--	--	16	4	4	5	16	4	5
Junior High Total	1589	1487	1452	1637	1548	1497	1473	1841	1581	1548	1509	5067	4616	4434
Adjustment						-24								

63

TABLE 31

Student Enrollments, Apportionment Ratios and 1978 Enrollment
Projections for Eugene Senior High Schools

SCHOOL	Tenth Grade Enrollment			Eleventh Grade Enrollment					Twelfth Grade Enrollment					Total Senior High Enrollment		
	1976	1977	Adjusted Projections	1976	1977	Average Ratio	Projected 1978	Adjusted Projections	1976	1977	Average Ratio	Projected 1978	Adjusted Projections	1976	1977	Projected 1978
Churchill	443	476	386	421 (.0833)	424 (.0830)	.0832	403	451	362 (.0717)	391 (.0765)	.0741	359	390	1226	1291	1227
North Eugene	492	470	430	443 (.0877)	447 (.0875)	.0876	424	443	348 (.0689)	399 (.0781)	.0735	356	408	1206	1316	1281
Sheldon	373	365	316	361 (.0715)	346 (.0677)	.0696	337	346	330 (.0653)	317 (.0620)	.0637	308	318	1065	1028	989
South Eugene	504	455	375	419 (.0829)	445 (.0871)	.0850	412	436	388 (.0768)	407 (.0796)	.0782	379	408	1311	1307	1219
Opportunity Center	26	20	30	--	--	--	--	--	--	--	--	--	--	26	20	30
Action	29	37	27	28 (.0055)	46 (.0090)	.0073	35	30	25 (.0049)	37 (.0072)	.0061	29	26	82	120	83
Horizons	176	10	9	22 (.0044)	7 (.0014)	.0029	14	6	17 (.0034)	11 (.0022)	.0028	14	10	56	28	25
Total Senior High	1884	1833	1573	1694	1715		1625	1712	1470	1562		1445	1560	5052	5110	4845
Adjustment							+87					+115				

84 85

Senior High School Projections

Five senior high schools served Eugene during the 1978-79 school year.

Using a procedure similiar to that of the seventh grade projections, 1978 tenth grade enrollment was projected by inquiring at the nine junior high schools which of the five senior high schools its ninth graders planned to attend.

Eleventh and twelfth grade enrollments for 1978-79 were projected by using a school-to-district apportionment ratio. Table 31 displays the 1976 and 1977 enrollments, the apportionment ratios (shown in parentheses, calculated by dividing each school's 1976 and 1977 eleventh and twelfth grade enrollments by the district-wide senior high school 1976 and 1977 enrollments), the average apportionment ratios, the 1978 projected enrollments for each school (calculated by multiplying the average apportionment ratio by the projected 1978 senior high school enrollment), and the adjusted projections for each grade level by school.

Calculation Time and Approval Process

The Eugene School District enrollment projection methodology, described in this chapter, requires approximately two weeks of the District Research Specialist's time to perform the actual calculations and make adjustments to individual school projections so that they sum to the projected district total.

The three-step approval process takes one to two months. Once the calculations have been made, individual school projections are sent to principals in Eugene's 43 schools for review. Because the district total projection is known to be extremely accurate, if principals decide they should have more students than what the projections estimate, they must be able to identify a school to take students away from. No principal likes declining enrollments. Even though a principal is willing to say his/her school should have more students, when forced to negotiate with another principal for a few more students, the principal will usually stay with the initial projections.

Upon approval by the individual school principals, the projections are sent to the four regional superintendents where the same process is used. If a regional superintendent feels that region will have more students than projected, he/she must be able to identify a region to subtract from and must negotiate with that regional superintendent directly. When closure is accomplished with the regional superintendents, the projections are presented to the District Superintendent and School Board at the same time. With Board approval, the projections become an official document of the Eugene School District.

Summary

Enrollment projections in Eugene School District 4J are based on a combination of methodologies for the two level process.

On the district-wide level, second through twelfth grade enrollments are projected using the cohort survival methodology based on at least five years of past enrollment data. First grade enrollments are projected using births six years prior to the year being projected in a regression methodology. Kindergarten enrollment, the most difficult grade level to project in Eugene, is calculated on the basis of the first grade projections. A kindergarten to first grade ratio is calculated for past years and averaged. The average ratio is then multiplied by the projected first grade enrollment to achieve the projected kindergarten enrollment. All grade level projections are adjusted to add to the district total projection.

On the individual school level, projections are more manual. Grades 2 through 12, for each school, are projected by advancing the previous year's enrollment as the projected enrollment for the next grade of the projected year. Projected seventh grade and tenth grade enrollments are adjusted once school building administrators verify the number of students, from these grades, registered to attend their respective school. One method used for projecting kindergarten and first grade enrollments for the individual schools is the apportionment method. With the apportionment method, the numbers of past first graders and kindergartners for each school are divided by the number of first graders and kindergarteners in the district for past years. The average of past ratios is multiplied by the projected district first grade and kindergarten enrollments to acquire the first and kindergarten enrollments for each school.

The total amount of time needed to perform projection calculations and to gain approval by the school board and superintendent is approximately two and a half months.

Eugene's district total enrollment projections have been found to be up to 99.5 percent accurate. With this common knowledge, when regional superintendents and/or individual school principals disagree with the projections for their attendance areas, they must be able to identify another attendance area to make projection adjustments to if they want their numbers altered. This procedure has worked very effectively for Eugene in the past. With School Board and Superintendent approval, the enrollment projections are adopted as an Eugene School District 4J official document.

Chapter 5

The School District of Philadelphia Enrollment Projection Methodology

The School District of Philadelphia
Enrollment Projection Methodology

School District of Philadelphia

The School District of Philadelphia, the fourth largest public school system in the nation, serves almost one-quarter-million students, approximately two-thirds of which are minorities. The School District serves all pupils within the city of Philadelphia. No other public school districts exist within the municipality, although a large parochial school system, serving almost 100,000 students, and numerous other private and independent religious schools also serve the city.

The School District employs almost 30,000 full and part-time personnel, including over 12,500 teachers, more than 55 percent of whom possess graduate degrees. Teachers' salaries range from $12,000 to almost $30,000 per annum. Over 37 percent of the teaching staff are minorities. The average elementary school class contains 29.5 students.

School attendance has remained relatively steady at about the 85 percent mark. Yet while enrollment has declined, additional numbers of prekindergarten pupils are being served in various supplemental programs.

The Office of Research and Evaluation (ORE) services the research, evaluation, testing, and measurement requirements of the School District. ORE is responsible for determining the District's short and long range student enrollment projections.

The Philadelphia School District's enrollment projections are used for planning by many District offices, including the Division of Subsidies (to determine reimbursement), the District's Planning Office (to develop the State-mandated School District long range plan), the Offices of Budget and Finance (to develop the following year's budget proposal), and business divisions such as Purchasing and Personnel (to determine resource allocations), as well as many major non-School District agencies.

The School District of Philadelphia's enrollment projection methodology is described below.

Philadelphia Student Enrollment Projection Methodology

Enrollment projections for the School District of Philadelphia are calculated annually, based upon a combination of a modified grade progression ratio technique and a district proportion technique.

Similar to Eugene, Philadelphia school district level enrollment projections, based on a modified grade progression ratio technique, are extremely accurate. With this insight, district-level enrollments are projected annually with confidence, and the smaller units of projection (district grade level, sub-district, and school) are adjusted to this total. Sub-district (the District is divided into eight administrative sub-districts) and district grade-level enrollments are projected, and adjusted to sum to the district total. Individual school enrollments are then projected and adjusted to sum to the sub-district totals.

The School District of Philadelphia uses four years of past enrollment data to capture enrollment trends for the grade progression ratios which are used in projecting the district enrollment, and the district grade-level student enrollments. A kindergarten to births five years prior to the projected year ratio, and a first grade to births six years prior to the projected year ratio are used to project kindergarten and first grade enrollments, respectively, on the district level. Sub-district and individual school student enrollments are projected on the basis of proportional ratios. Sub-district grade-level to district grade-level proportional ratios are utilized in calculating the sub-district enrollments, by grade, while an individual school to sub-district proportional ratio is used to project individual school enrollments within each of the sub-districts.

That which follows is a description of the process used to project enrollments for the district by grade, sub-district, and individual school.

Grade-Level Projections

District grade-level enrollment projections for the School District of Philadelphia are obtained through a modified grade progression ratio technique for all grade levels except kindergarten and first grade, for which a birth rate ratio is used.

Philadelphia used an eleven-step process to project grade level enrollments for the 1978-79 school year. A description of the process follows, using actual data to illustrate each step.

Step 1. Collection of Past Enrollment

The modified grade progression methodology incorporates up to four years of past enrollment data. In addition to student enrollments for kindergarten through grade twelve, student enrollments for the three special programs are shown in Table 32 on the following page.

Step 2. Formation of Grade Progression Ratios for Grades Two through Twelve

To determine the 1978 enrollment projections, grade progression ratios were formed by grade level for three year progressions: 1974 to 1975, 1975 to 1976, and 1976 to 1977. Each ratio was established by dividing one grade's enrollment for a particular year by the previous grade's enrollment for the prior year. For example, the sixth-to-seventh grade progression ratio for 1976 to 1977 was formed by dividing the November 1976 sixth grade enrollment into the November 1977 seventh grade enrollment (18,980/18,290 = 1.038). The first three columns of Table 33 show the grade progression ratios for the years 1974 to 1976, 1975 to 1976, and 1976 to 1977.

TABLE 32

November Enrollments for 1974 to 1977

Grade	November 1974	November 1975	November 1976	November 1977
K	22,479	22,493	21,572	19,123
1	19,288	18,[illegible]30	19,205	18,076
2	18,592	17,564	17,313	17,738
3	18,981	18,161	17,068	16,955
4	19,171	18,509	17,686	16,554
5	19,697	18,626	18,038	17,412
6	19,583	19,399	18,290	17,869
7	20,165	19,532	19,431	18,980
8	19,885	19,359	18,826	18,799
9	20,961	21,426	21,527	22,174
10	24,188	24,543	24,673	24,202
11	16,956	16,869	17,049	17,257
12	13,797	13,452	13,175	13,461
Post Graduate	71	65	70	41
Ungraded	1,946	2,139	2,463	2,854
Special	11,765	11,979	11,617	11,727
TOTAL	267,525	263,046	258,003	253,222

TABLE 33

Grade Progression Ratios for 1974 to 1977
and Two & Three Year Averages

Grades	1974 to 1975	1975 to 1976	1976 to 1977	Three Year Average	Two Year Average
1-2	.911	.915	.924	.917	.920
2-3	.977	.972	.979	.976	.976
3-4	.975	.974	.970	.973	.972
4-5	.972	.975	.985	.977	.980
5-6	.982	.982	.991	.985	.986
6-7	.997	1.002	1.038	1.012	1.020
7-8	.960	.964	.967	.964	.966
8-9	1.077	1.112	1.178	1.122	1.145
9-10	1.171	1.152	1.124	1.149	1.138
10-11	.697	.695	.714	.703	.704
11-12	.793	.781	.790	.788	.786

Step 3. Calculation of Average Grade Progression Ratios.

After the three successive years of grade progression ratios were established, three-year and two-year average grade progression ratios were calculated. Columns 4 and 5 of Table 33 show the averages calculated for the 1978-1979 projections.

Step 4. Calculation and Selection of Enrollments for Grade Two through Twelve

Enrollment projections must be flexible. Because populations fluctuate within numerous neighborhoods in Philadelphia, a strictly statistical model could not be used effectively. Instead, a mixed ratio model with subjective adjustments has provided Philadelphia's most accurate projections. The mixed ratio model allows for the selection of grade progression ratios that best accommodated changes occurring at each particular grade level in the school district.

Table 34 shows estimated enrollments for ratios based on two, three, and four years of past data (i.e., the 1976-77 ratios, the two-year, and the three-year average ratios).

The 1978 projected enrollments for a particular grade level were calculated by multiplying the grade progression ratios by the previous grade's 1977 enrollment, as illustrated in Table 34. The ratios used to obtain each projection are shown in parentheses. These ratios were multiplied by the 1977 enrollments (found on the same line) to obtain the estimate appearing on the line directly beneath. For example, one of the grade six enrollment projections for 1978 was determined by multiplying the three-year average grade ratio by the 1977 fifth grade enrollment (sixth grade projected enrollment for 1978 = .986 (17,412) = 17,168). After the enrollments for each grade were multiplied by the three ratios, the resulting projections were investigated as to their feasibility for projecting 1978-79 enrollments in terms of recent district policy changes, grade reorganization, and new information regarding drop-outs/ins. The projections based on the 1976-77 grade progression ratios most accurately forecasted enrollment for the district for the 1978-79 school year.

Step 5. Formation of Kindergarten and First Grade Ratios

Kindergarten and first grade enrollments in Philadelphia have traditionally been projected by computing a ratio of the actual number of kindergartners and first graders in recent years to the number of births in the city five and six years prior. Ratios and averages were determined for three years prior to the year being projected, and multiplied by the number of births five and six years prior to the year being projected. The 1978-1979 projections used ratios based on 1974, 1975, and 1976 enrollments and their averages. Table 34 displays the number of enrollments and births for the four years and the ratios formed on the basis of those numbers as well as the two, three, and four year averages.

TABLE 34

Enrollment Projections by Grade Level
Based on Three Grade Progression Ratios

	1976-77 Enrollment	1976-77 Ratios and Projections		Two-Year Average Ratios and Projections		Three-Year Average Ratios and Projections	
1	18,076	(.924)		(.920)		(.917)	
2	17,738	(.979)	16,702	(.976)	16,630	(.976)	16,576
3	16,356	(.970)	17,366	(.972)	17,312	(.973)	17,312
4	16,554	(.985)	16,446	(.980)	16,480	(.977)	16,497
5	17,412	(.991)	16,306	(.986)	16,223	(.985)	16,173
6	17,869	(1.038)	17,255	(1.020)	17,168	(1.012)	17,151
7	18,980	(.967)	18,548	(.966)	18,226	(.964)	18,083
8	18,799	(1.178)	18,354	(1.145)	18,335	(1.122)	18,297
9	22,174	(1.124)	22,145	(1.138)	21,525	(1.149)	21,092
10	24,202	(.714)	24,924	(.704)	25,234	(.703)	25,478
11	17,257	(.790)	17,280	(.786)	17,038	(.788)	17,014
12	13,461		13,633		13,564		13,598

TABLE 35

Data and Ratios Used in Projecting
1978-79 Kindergarten and First Grade Enrollments

Enrollments			Births		Ratios
1974	K	22,479	(1969)	33,863	.664
	1	19,288	(1968)	34,963	.552
1975	K	22,493	(1970)	34,564	.651
	1	18,930	(1969)	33,863	.559
1976	K	21,572	(1971)	31,541	.684
	1	19,205	(1970)	34,564	.556
1977	K	19,123	(1972)	27,923	.685
	1	18,076	(1971)	31,541	.573

Average Ratios

Four Years		Three Years		Two Years	
K	.671	K	.673	K	.684
1	.560	1	.563	1	.564

Step 6. Calculation and Selection of Enrollments for Kindergarten and First Grade

On the basis of the ratios formed in Step 5, and the number of births in 1973 and 1972, enrollments for kindergarten and first grade were projected for the 1978-79 school year. Table 36 displays the projections calculated by using the ratios and the number of births. The first four ratios were multiplied by the number of births in 1973 for the kindergarten projections, and the second four by the number of births in 1972 for the first grade projections. The kindergarten and first grade ratios and projections seemed to best represent changes taking place in the district.

TABLE 36

1978-79 Enrollment Projections for Kindergarten and First Grade

Ratios		Number of Births	Kindergarten Projections
1977	.685	25,599	17,535
Two Year Average	.684		17,510
Three Year Average	.673		17,288
Four Year Average	.671		17,177
			First Grade Projections
1977	.575	27,923	16,000
Two Year Average	.564		15,749
Three Year Average	.563		15,721
Four Year Average	.560		15,637

Step 7. Projection of the Total Number of Students for the District

A total district enrollment was also projected independently of the grade-level projections. The total district enrollment was projected by using an average ratio of the past district enrollments divided by the previous year's enrollment. (see Table 37) The ratios were calculated and multiplied by the 1977 district enrollment to arrive at three projected district enrollments for 1978-79. Table 37 shows past enrollment data, the calculated ratios, and the projections for 1978-79.

In collaboration with the two other agencies that also compute enrollment projections for the district--The Philadelphia City Planning Commission and the Pennsylvania Economy League--the School District of Philadelphia adjusted the lowest projection of 248,461 to a figure of 246,850. The three agencies made the adjustment to accurately reflect the enrollment trend in the district, new policy changes, the trend in birth rate, and the sum of the grade level enrollment projections. This approach has resulted in very accurate district level enrollment projections in the past.

TABLE 37

Past Enrollment Data, Ratios and 1978-79 Projections for the District

Year	Enrollments	Ratios	1978-79 Projected Enrollment
1974	267,525		
		.9833	
1975	263,046		
		.9808	
1976	258,003		
		.9815	248,537
1977	253,222		
		Two Year Average .9812	248,461
		Three Year Average .9819	248,639

Step 8. Calculation and Selection of Special Program Enrollments

Three types of special programs within the School District of Philadelphia require independent enrollment projections. Those programs are the ungraded classrooms, post graduate programs, and special education programs. Since each of these programs is ungraded, only the total enrollment is projected. Table 38 shows four recent year's enrollments and two types of proportional ratios, established by 1) dividing the program enrollments by the district total enrollment, and 2) dividing a year's enrollment by the previous year's enrollment.

The 1978-79 special program enrollments were calculated by multiplying the proportional ratios by the projected district total established in Step 7. On the basis of the ratios and calculated projections enrollment estimates were established.

The projections that reflected the upper bounds for the Special Education Program and the lower bounds for the Ungraded Program were selected because of facility limitations and financial formulas related to each program.

TABLE 38

Enrollments, Ratios and Projections for
1978 Special Program Enrollments

ENROLLMENTS

	1974	1975	1976	1977
Post Graduate	71	65	70	41
Ungraded	1,946	2,139	2,463	2,854
Special Education	11,765	11,979	11,617	11,727
District Total	267,525	263,046	256,003	253,222

PROGRAM TO DISTRICT RATIOS

	1974	1975	1976	1977	Two Year Average	Three Year Average	Four Year Average
Post Graduate	.0003	.0002	.0003	.0002	.0003	.0002	.0003
Ungraded	.0073	.0081	.0095	.0113	.0104	.0096	.0090
Special Education	.0440	.0455	.0450	.0463	.0456	.0456	.0452

YEAR PROGRESSION RATIOS

	1974-75	1975-76	1976-77	Two Year Average	Three Year Average
Post Graduate	.9155	1.0769	.5857	.8313	.8594
Ungraded	1.0992	1.1515	1.1587	1.1551	1.1365
Special Education	1.0182	.9698	1.0095	.9897	.9992

PROJECTIONS - PROGRAM TO DISTRICT RATIOS

	1977	Two Year Average	Three Year Average	Four Year Average
Post Graduate	49	74	49	74
Ungraded	2,790	2,567	2,370	2,222
Special Education	11,429	11,256	11,256	11,158

PROJECTIONS - YEAR PROGRESSION RATIOS

	1977	Two Year Average	Three Year Average
Post Graduate	49	34	35
Ungraded	3,307	3,297	3,244
Special Education	11,838	11,606	11,718

Step 9. Adjustments to the Projections

Upon completion of preliminary Steps 1 through 8, the 1978-79 grade level projections were adjusted to reflect the district total enrollment projection determined in Step 7.

Table 39 reflects the preliminary projections for each grade level and its necessary adjustments. As shown in the Table, a difference of 37 students separated the projected district enrollment total and the sum of the grade-level projections. Because the district level projection has always resulted in extremely accurate projections in the past, the grade level projections were adjusted to add to the district level projection, and appear in the adjusted projections column of Table 39.

TABLE 39

Preliminary and Adjusted Projections by Grade Level for 1978-79

	Enrollments				Projections	Adjusted Projections
Grade	1974-75	1975-76	1976-77	1977-78	1978-79	1978-79
K	21,675	22,395	22,000	19,700	17,177	17,000
1	19,125	18,615	18,665	18,400	16,000	16,025
2	18,695	17,827	16,920	17,520	16,702	16,700
3	18,950	18,195	17,275	16,850	17,366	17,365
4	19,550	18,300	17,790	16,650	16,446	16,450
5	19,785	19,376	17,830	17,265	16,306	16,305
6	19,945	19,009	19,205	17,575	17,255	17,255
7	20,160	19,954	19,385	18,525	18,548	18,545
8	19,865	19,665	18,835	18,755	18,354	18,355
9	21,050	20,925	21,050	20,955	22,145	22,150
10	25,400	23,551	25,095	24,830	24,924	24,930
11	17,650	16,567	17,090	17,170	17,280	17,280
12	13,875	13,915	13,140	13,335	13,633	13,640
Post Graduate	71	65	70	41	49	50
Ungraded	1,946	2,139	2,463	2,854	2,790	3,000
Special Education	11,765	11,979	11,617	11,727	11,339	11,800
TOTAL	267,525	263,046	258,003	253,222	246,813	246,850

Step 10. Projections by Sub-District

Enrollment projections were also prepared for the eight administrative sub-districts of the School District of Philadelphia. The 1978-79 sub-district projections were calculated by a proportional technique whereby each past grade level enrollment for a sub-district is divided by the past grade level enrollment for the district. The resulting proportional ratio is then multiplied by the projected district grade level enrollment to arrive at the projected grade level enrollment for each sub-district.

The steps taken to compute the 1978-79 sub-district enrollment projections are described below, displayed as a continuation of Steps 1 through 9.

Table 40 incorporates past enrollment data used to project 1978 student enrollments by grade level for Sub-District 1.

TABLE 40

1974 to 1977 Student Enrollments for Sub-District 1

Grade	1974	1975	1976	1977
K	3237	3378	3249	2958
1	3292	3192	3241	2992
2	3044	2935	2945	2959
3	3118	2902	2854	2812
4	3162	3035	2872	2777
5	3304	3037	2951	2792
6	3189	3260	2989	2912
7	3171	3152	3232	3085
8	3119	3007	2956	2973
9	3350	3291	3102	3204
10	3776	3645	3750	3364
11	2351	2498	2469	2631
12	1843	1703	1814	1770
Special Education	1580	1723	1704	1593
Post Graduate	0	0	0	0
Ungraded	125	136	67	97
TOTAL	41861	40894	40195	38924

For each sub-district, proportional grade ratios were formed based on enrollments for the years 1974 to 1977. Each ratio was established by dividing sub-district grade level enrollments by the district enrollment for that grade level. For example, the ratio needed to project Sub-District 1 third grade enrollment for a particular year was calculated by dividing third grade enrollment for Sub-District 1 by the third grade enrollment for the district for that same year. (e.g., 1974 third grade Sub-District 1 proportional ratio - 1974 sub-district third grade enrollment/1974 district third grade enrollment - 3118/18,981 = .164).

Average ratios were also established for the most recent two and three years. For Sub-District 1, the ratios and average ratios are shown in Table 41.

TABLE 41

Sub-District 1 Proportional Ratios
for 1974 to 1977 and Two and Three Year Average Ratios

Grade	1975	1976	1977	Two Year Average	Three Year Average
K	.150	.151	.155	.153	.152
1	.169	.169	.166	.168	.168
2	.167	.170	.167	.169	.168
3	.160	.167	.166	.167	.164
4	.164	.162	.168	.165	.164
5	.163	.164	.160	.162	.162
6	.168	.163	.163	.163	.165
7	.161	.166	.163	.165	.163
8	.155	.157	.158	.158	.157
9	.154	.144	.144	.144	.147
10	.149	.152	.139	.146	.147
11	.148	.145	.152	.149	.148
12	.127	.138	.131	.135	.132
Special Education	.144	.147	.136	.142	.142
Post Graduate	0	0	0	0	0
Ungraded	.064	.027	.034	.031	.042
Sub-District	.155	.156	.154	.155	.155

1978 enrollment projections for the sub-districts were calculated by multiplying the proportional ratios by the projected 1978-79 district grade level enrollments. For example, Sub-District 1 third grade enrollment was projected by multiplying the projected 1978 District third grade enrollment by the 1977 ratio established in Table 41, (2,812/16,955) x 17365 = .166 x 17365 = 2880).

Three sets of projections were made for each sub-district grade level for 1978 on the basis of three ratios similar to those appearing in Table 41 for Sub-District 1. A compromise of projections was made for each particular grade level to reflect policy changes, grade alterations in the sub-districts, and so the grade projections would sum to the sub-district total. The three sets of projections and the adjusted projections appear in Table 42.

TABLE 42

Projected and Adjusted Enrollments for Sub-District 1
Based on One Year, Two Year, and Three Year Average Proportional Ratios

Grade	Projected Enrollment: One Year	Two Year Average	Three Year Average	Adjusted Projections 1978
K	2635	2601	2584	2630
1	2660	2692	2692	2649
2	2789	2822	2806	2786
3	2882	2900	2848	2880
4	2764	2714	2698	2756
5	2609	2641	2641	2614
6	2812	2812	2947	2814
7	3023	3060	3023	3011
8	2900	2900	2882	2908
9	3190	3190	3256	3201
10	3465	3640	3665	3466
11	2627	2575	2557	2632
12	1787	1841	1800	1794
Special Education	1605	1676	1676	1603
Post Graduate	0	0	0	0
Ungraded	102	93	126	103
TOTAL	38015	38262	38262	37847

Step 11. Projections by Individual School

Student enrollment projections for each school were prepared by using a school to sub-district proportional ratio technique. The following describes the technique with actual data for Sub-District 1 (Table 43) to illustrate the process.

The proportional ratios were formed by dividing each school's enrollment by the sub-district total enrollment for the past three years. For example, in Sub-District 1, the 1977-78 proportional ratio for Drew was calculated by dividing Drew's 1977-78 enrollment by the 1977-78 Sub-District 1 total enrollment (390 ÷ 37847 = .010). Two-year and three-year average ratios were also computed. Table 43 displays the 1975-78 enrollments for each school of Sub-District 1, the proportional ratios formed for each year by school (shown in parenthesis), and the two and three-year average ratios.

TABLE 43

1975 To 1978 School Enrollments and Ratios
Used to Project 1978-79 School Enrollments for Sub-District 1

School Name	Grade Organization	Total Enrollment & Proportional Ratio 1975-76	1976-77	1977-78	Two Year Average Ratio	Three Year Average Ratio
Anderson	K-5	907 (.022)	930 (.023)	833 (.021)	.022	.022
Barry	K-6	944 (.023)	952 (.024)	830 (.021)	.023	.023
Belmont	K-6	867 (.021)	815 (.020)	769 (.020)	.020	.020
Brooks	TMR-SPI	139 (.003)	146 (.004)	165 (.004)	.004	.004
Bryant	K-6	1012 (.025)	841 (.021)	826 (.021)	.021	.022
Catharine	K-5	636 (.016)	615 (.015)	604 (.016)	.016	.016
Catto	ED-RO	199 (.005)	195 (.005)	171 (.004)	.004	.005
Comegys	K-6	915 (.022)	967 (.024)	982 (.025)	.024	.024
Daroff	K-6	831 (.020)	794 (.020)	790 (.020)	.020	.020
Drew	K-8	409 (.010)	402 (.010)	390 (.010)	.010	.010
Walnut Center	PK-1	124 (.003)	123 (.003)	111 (.003)	.003	.003
Dunlap	K-6	570 (.014)	534 (.013)	472 (.012)	.012	.013
Hamilton	K-8	977 (.024)	921 (.023)	926 (.024)	.023	.024
Harrington	K-4	1018 (.025)	928 (.023)	900 (.023)	.023	.024
Harrity	PK-5	669 (.016)	646 (.016)	608 (.016)	.016	.016
Holmes	K-6	609 (.015)	583 (.015)	562 (.014)	.014	.015
Huey	K-6	1246 (.030)	1181 (.029)	1050 (.027)	.028	.029
Lea	K-8	1313 (.032)	1302 (.032)	1292 (.033)	.032	.032
Locke	K-6	713 (.017)	730 (.018)	711 (.018)	.018	.018
Longstreth	K-4	1104 (.027)	1052 (.026)	1040 (.027)	.026	.027
McMichael	K-8	1049 (.026)	961 (.024)	898 (.023)	.024	.024
Mitchell	K-5	1108 (.027)	1074 (.027)	1032 (.027)	.027	.027
Morton	PK-5	977 (.024)	972 (.024)	983 (.025)	.024	.024
Patterson	K-5	942 (.023)	871 (.022)	823 (.021)	.022	.022
Powel	K-8	428 (.010)	442 (.011)	424 (.011)	.011	.011
Read	-	51 (.001)	-	-	-	-
Rhoads	K-6	729 (.018)	708 (.018)	650 (.017)	.018	.018
Washington	K-8	909 (.022)	847 (.021)	869 (.022)	.022	.022
Wilson	K-6	537 (.013)	498 (.012)	492 (.013)	.012	.013
Wolf	-	301 (.007)	-	-	-	-
Penrose	PK-5	-	537 (.013)	557 (.014)	.014	-
Pepper Middle	6-8	900 (.022)	993 (.025)	1026 (.026)	.026	.024
Tilden Middle	6-8	1328 (.033)	1259 (.031)	1108 (.029)	.030	.031
Turner Middle	5-8	1641 (.040)	1657 (.041)	1585 (.041)	.041	.041
Sayre Jr. High	7-9	1840 (.045)	1789 (.045)	1704 (.044)	.044	.045
Shaw Jr. High	7-9	1409 (.034)	1402 (.035)	1281 (.033)	.034	.034
Sulzberger Jr. High	7-9	1449 (.035)	1429 (.036)	1476 (.038)	.037	.036
Bartram Sr. High	9-12	4384 (.107)	3999 (.100)	3938 (.101)	.100	.103
University City	9-12	2987 (.073)	3114 (.078)	2756 (.071)	.075	.074
West Philadelphia Senior High	10-12	2678 (.066)	2899 (.072)	3181 (.082)	.077	.073

Table 44 incorporates the 1978-79 enrollment projections calculated for each school of Sub-District 1 using the 1977-78 ratios, the two and three year average ratios, and the adjusted projected enrollments. The projections were established by multiplying each ratio times the projected sub-district enrollment for 1978-79.

The projections were compromised and adjusted to sum to the sub-district projection and to reflect population and residential trends in the sub-district.

Calculation Time and Approval Process

The School District of Philadelphia's enrollment projections are calculated annually during the months of December and January. The actual calculations require approximately one and a half weeks - one week for a statistical clerk to make the straight methodological calculations, and three or four days for the District Demographer to make adjustments to the calculations. The adjustments are made in terms of the "reasonableness" of the projections. Based on his comprehensive knowledge of past district, sub-district, and individual school enrollments, district grade-level enrollment/organization, policy alterations, and residential and population trends, the District Demographer is able to adjust the numbers if the estimates appear to be dramatically different than the information he has for a particular school or grade level.

After the calculations have been adjusted, the resulting projections are reviewed and approved by the Executive Director of the Office of Research and evaluation. The approved projections are then sent directly to the Managing Director in the Budget Office to develop the following year's budget proposal. Sub-district and school administration receive a copy of the projections in late spring and begin planning for fall enrollments at that time.

TABLE 44

1978-79 Student Enrollment Projections
by School for Sub-District 1

PROJECTED ENROLLMENTS

School Name	1977-78 Ratios	Two Year Average Ratios	Three Year Average Ratios	Adjusted 1978-79
Anderson	797	835	835	817
Barry	797	873	873	813
Belmont	759	759	759	[illegible]
Brooks	152	152	152	164
Bryant	797	797	835	809
Catharine	607	607	607	593
Catto	152	152	190	167
Comegys	949	911	911	961
Daroff	759	759	759	775
Drew	380	380	380	380
Walnut Center	114	114	114	110
Dunlap	456	456	494	464
Hamilton	911	873	911	908
Harrington	873	873	911	881
Harrity	607	607	607	596
Holmes	532	532	569	551
Huey	1025	1063	1101	1028
Lea	1253	1215	1215	1264
Locke	683	683	683	695
Longstreth	1025	987	1025	1002
McMichael	873	911	911	877
Mitchell	1025	1025	1025	1009
Morton	949	911	911	961
Patterson	797	835	835	805
Powel	418	418	418	414
Read	-	-	-	-
Rhoads	645	683	683	634
Washington	835	835	835	851
Wilson	494	456	494	483
Wolf	-	-	-	-
Penrose	532	532	-	509
Pepper Middle	987	987	911	1002
Tilden Middle	1101	1139	1177	1031
Turner Middle	1556	1556	1556	1548
Sayre Junior High	1670	1670	1708	1666
Shaw Junior High	1253	1291	1291	1252
Sulzberger Junior High	1443	1405	1367	1442
Bartram Senior High	3834	3796	3910	3871
University City	2696	2847	2809	2706
West Philadelphia Senior High	3113	2923	2771	3124

Summary

The School District of Philadelphia calculates enrollment projections for three levels - district, sub-district and individual school. The district and sub-district projected enrollment totals act as control totals in making the individual school and grade-level projections.

A modified grade progression ratio methodology is used in calculating the district grade-level projections. The grade level projections are adjusted to add to the district projected totals which have been extremely accurate in the past. Kindergarten and first grade enrollment projections utilize a ratio of the actual numbers of kindergartners and first graders in recent years, to number of births in the city five and six years prior. This ratio, averaged over four years of past data, is multiplied by the number of births five and six years prior to the year being projected to arrive at the projected enrollments for the two grade levels.

Sub-district enrollments are projected by grade level using a proportional technique whereby a ratio is calculated that incorporates past grade level enrollment for a sub-district divided by the past grade level enrollment for the district. The ratio is multiplied times the projected district grade level enrollment to arrive at the projected grade level enrollment for each sub-district.

Student enrollments for individual schools are projected using a school to sub-district proportional ratio technique. The proportional ratios are formed by dividing each school's enrollment by the sub-district total enrollment for the past three years. An average ratio for each school is computed and multiplied by the projected sub-district enrollment to achieve the school projections. The individual school projections are adjusted so as to sum to thesub-district total projection and to reflect population and residential trends in the sub-district.

The actual calculations take approximately one week to complete. Up to another week is spent reviewing and adjusting the projections to reflect new developments in the school attendance areas, the sub-districts, and the over-all district.

After being approved by the Executive Director of the Office of Research and Evaluation, the projections are sent to the Budget Office where the following year's budget proposal is developed on the basis of the projections.

Chapter 6

The Austin Independent School District Enrollment Projection Methodology

The Austin Independent School District
Enrollment Projection Methodology

Austin Independent School District

The Austin Independent School District, the sixth largest in Texas, serves over 57,000 students. Like the Austin metropolitan area, the school age population has rapidly expanded geographically, leaving some schools without enough students to justify their continued operation.

The school district serves most of the city of Austin and some outlying areas. Six other districts exist in the area.

The school district employs over 3,000 teachers, more than 31 percent of whom possess graduate degrees. Teacher salaries range from $9,624 to $18,075 per annum. The teaching staff is 11.5 percent Mexican-American and 12.75 percent Black. They serve over 57,919 students, approximately 42 percent of whom are minorities. The average elementary class size is 24. The district's student/teacher ratio is 22 to 1.

School attendance has remained relatively steady at the 92.93 percent level. Although student enrollment has been only slightly decreasing, the distribution of students in the district has shifted dramatically and some schools have been closed.

An area of major focus for the Austin Independent School District is planning for the implementation of a desegregation plan for utilization on January 21, 1980.

The Department of Planning and Programming in the Austin School District provides annual and long-range enrollment projections for use in management planning for demands for facilities, personnel, and educational services and programs.

A description of the enrollment projection methodology presently in use in the Austin Independent School District follows.

Austin Student Enrollment Projection Methodology

Austin Independent School District student enrollments are projected for one to ten years into the future on the basis of a computerized system known as the School Resource Allocation Model. The model was developed and implemented by Dr. Terry Bishop, director of Planning and Programming for Austin Independent School District.

The School Resource Allocation Model (SRAM), programmed in FORTRAN IV, projects and analyzes enrollment, personnel, and facilities for the district and individual school levels, and has the capability to simulate school boundary changes and integration procedures. Figure 4 displays the flowchart of SRAM. Only the enrollment portion of the model, however, will be discussed in this chapter[2], and will follow the outline used in chapters 4, 5 and 7.

Projections of student enrollments for the district, by grade level, are updated annually using the cohort survival ratio methodology. Based on ten years of past enrollments and several environmental and policy variables, projections are made for two time periods of the school year, known as the START (beginning) and PEAK (middle). The input variables used in the projections are listed and appear in Figure 5. Low, high, and average cohort survival ratios for the ten years are analyzed for use in projecting grades 1 through 12. Kindergarten enrollments are estimated by a birth to past kindergarten enrollment ratio, except during the years that policy alterations have been made. In 1977, for instance, the Texas legislature implemented a new policy for Texas schools that provided for the eligibility of all five year olds for kindergarten enrollment. With the new policy just being implemented, and without historical data for kindergarten enrollment within the context of the new policy, 1978-79 kindergarten enrollment was projected to be the same as that projected for first grade for 1978-79.

Individual school student enrollments are projected by grade level for the START time period using the cohort survival ratio methodology and ten years of past enrollment data. For initial grades when school building changes are necessary (i.e., middle school, junior high and senior high), the past proportion of the initial grade enrollment from feeder schools to the school enrollment is used for projecting enrollments. Total school enrollments are estimated for the PEAK time period using past enrollment trends.

The following sections summarize Austin's enrollment projection technique and illustrate the process used to project 1978-79 enrollments.

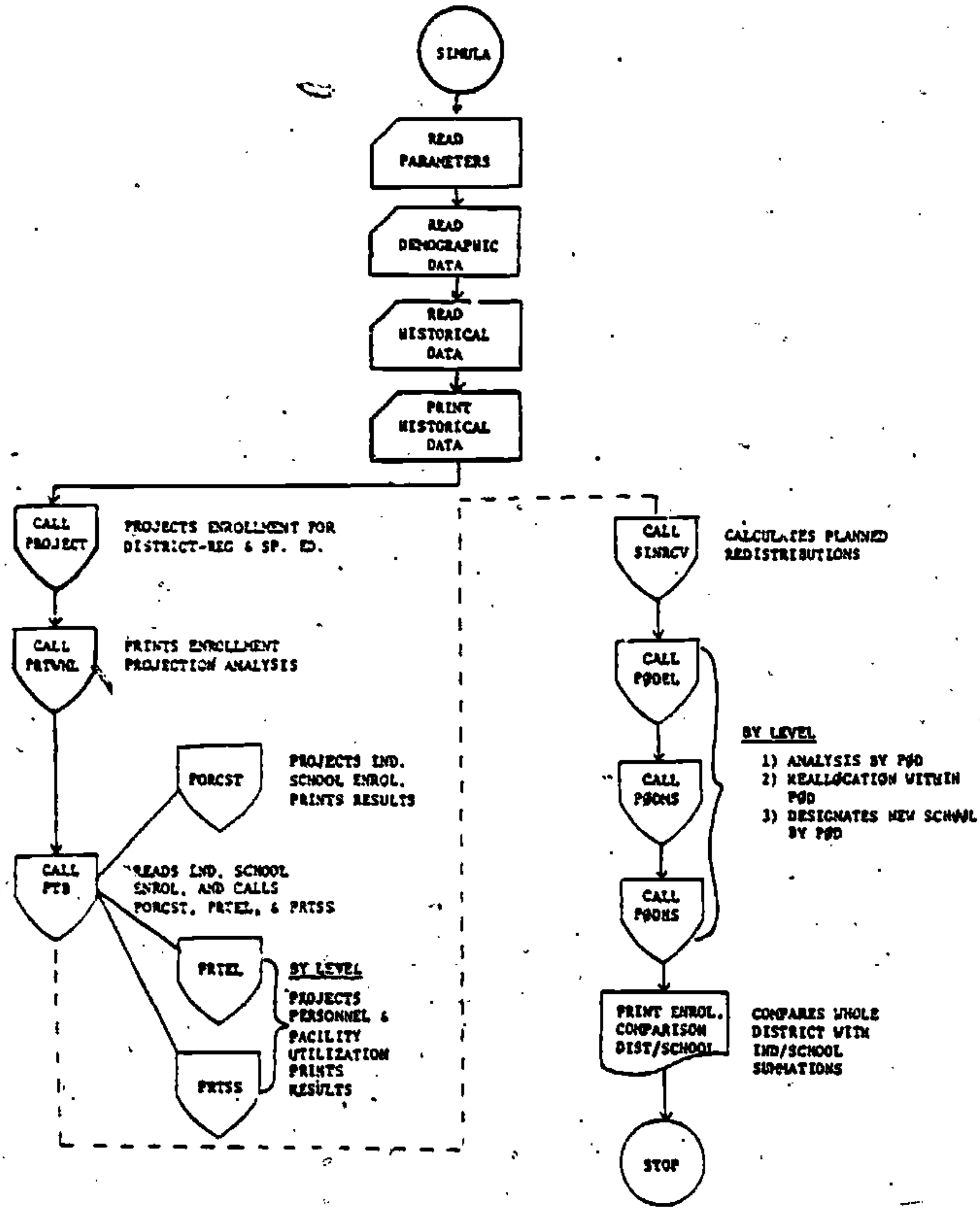
Grade-Level Projections

Austin used a seven step process to project 1978-1988 grade-level enrollments by means of the cohort survival ratio methodology. Projections are calculated for two annual periods of the school year known as the START (beginning) and PEAK (middle). The projection technique has been truncated to show only a one year projection for use in this chapter. An abbreviated description of the process used to project 1978-79 START and PEAK enrollments is presented here.

[2] Specific information on the personnel, facilities and boundary simulation portions of the model, as well as the enrollment portion, can be found in Dr. Bishop's Ph.D dissertation entitled, "Development and Evaluation of a School Simulation Planning Model" (University of Texas at Austin, January 1975).

FIGURE 4

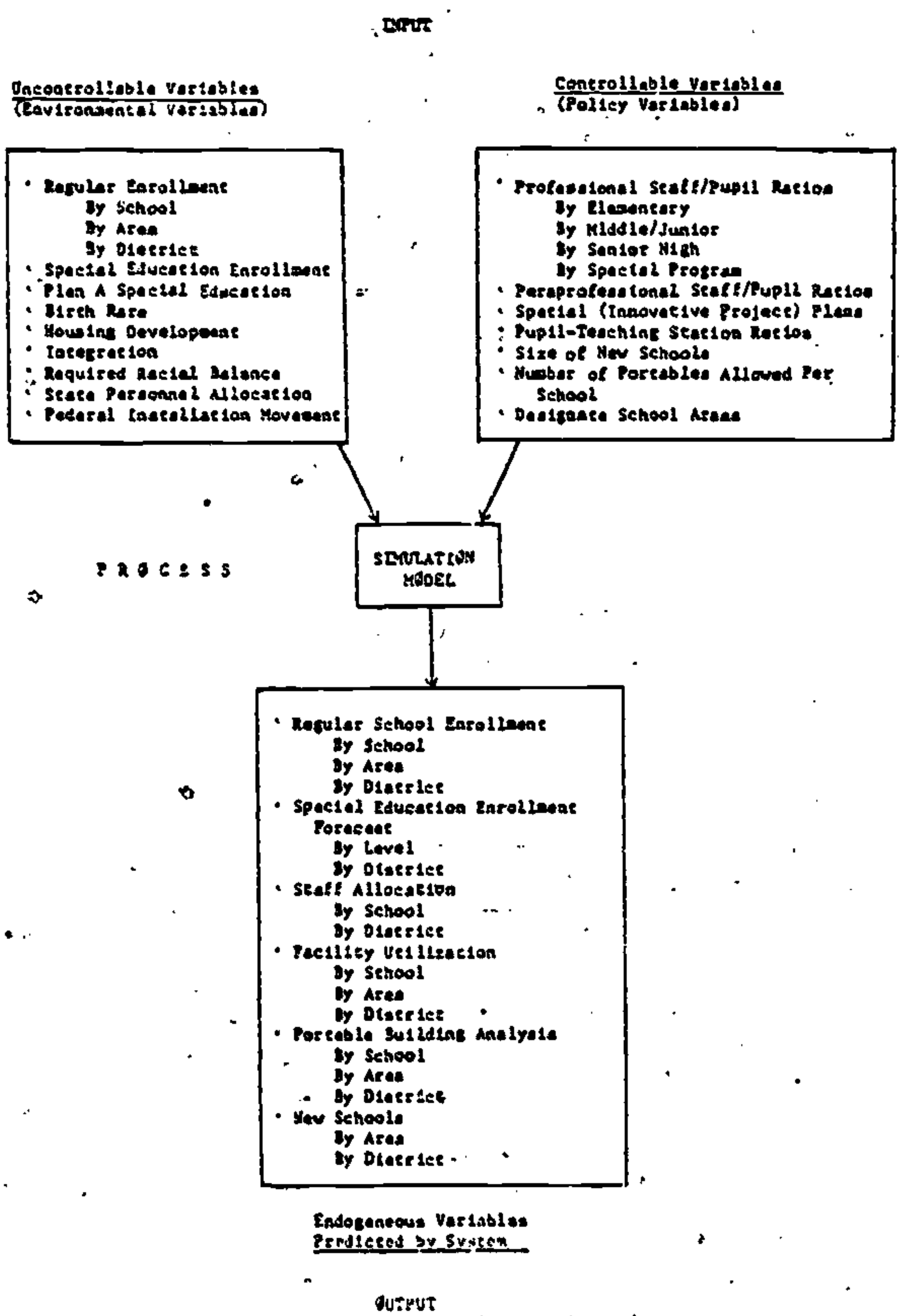
General Flow Chart for the School Resource Allocation Model



10

FIGURE 5

Classification of Variables for Enrollment Allocation Model



110

Step 1. Collection of Past Enrollment

A data base of up to ten years of past enrollments by grade level is used in the ten-year grade-level projections that are updated annually in Austin. Three years of past data for the Start and Peak periods are shown in Table 45to illustrate the 1978-79 enrollment projections.

TABLE 45

September and January Enrollments for 1975 to 1978

Grade	September 1975-76	September 1976-77	September 1977-78	January 1975-76	January 1976-77	January 1977-78
K	3155	3379	3368	3210	3477	3412
1	4429	4743	4972	4463	4753	4986
2	4263	4447	4711	4270	4491	4701
3	4159	4118	4332	4135	4135	4313
4	4291	4140	4011	4291	4170	4053
5	4631	4142	4035	4651	4128	4025
6	4888	4540	4086	4900	4537	4088
7	4892	4900	4657	4914	4859	4622
8	4970	4834	4822	4919	4810	4765
9	5142	5046	5058	4944	4859	4881
10	4573	4845	4936	4395	4592	4672
11	4259	4451	4341	3905	4114	4055
12	3519	3392	3517	3294	3178	3328
TOTAL	57171	56977	56846	56291	56103	55901

Step 2. Formation of Cohort Survival Ratios for Grades One through Twelve

To compute the 1978-79 district enrollment projections, by grade level, the School Resource Allocation Model first calculated the cohort survival ratios and standard deviations for each grade-to-grade category for the START time period. Ratios were computed for each grade-to-grade progression by dividing the enrollment for a specific grade for a specific year by the next lower grade's enrollment of the preceding year. A mean survival ratio[3] for each grade-to-grade category, as well as high and low survival ratios, were developed from standard deviations and were then used to estimate enrollments for 1978-79. A read-in option was also provided. The read-in option allowed for the introduction of a survival ratio that represented outside variances not considered by the high, low, or mean survival ratios, such as school closures or district policy alterations.

[3] The ratios in this section are based on ten years of historical data.

Table 46 displays the high, low and mean survival ratios and standard deviations for each grade progression used for the 1978-79 START enrollment projections.

TABLE 46

Survival Ratios and Standard Deviations for Each Grade Progression for the START Enrollment Projections

Grades	Survival ratios High	Low	Mean	Standard Deviation
1-2	1.022	0.991	1.006	.015
2-3	0.999	0.970	0.985	.014
3-4	1.022	0.978	1.000	.022
4-5	1.003	0.972	0.988	.015
5-6	1.013	0.983	0.998	.015
6-7	1.052	1.015	1.033	.018
7-8	1.003	0.980	0.992	.012
8-9	1.075	1.028	1.052	.023
9-10	1.003	0.937	0.970	.033
10-11	0.984	0.925	0.954	.030
11-12	0.820	0.785	0.803	.017

Step 3. Calculation and Selection of START Enrollments for Grades One through Twelve

After survival ratios were calculated for ten years of past data, and high, low, and mean survival ratios were recognized, six projection variations were calculated. Table 47 displays the high, low, and mean projections for the 1978-79 START period along with projected enrollment figures that reflect the changes occurring at each grade level.

TABLE 47

High, Low and Mean Enrollment Projections by Grade Level for 1978-79 START Time Period

Grade	Estimated Enrollment High	Low	Mean	Projected Enrollment
1	4981	4981	4981	4981
2	5085	4931	5008	5008
3	5073	4781	4926	4926
4	4809	4472	4639	4639
5	4441	4121	4280	4280
6	4074	3832	3952	3952
7	4297	4023	4159	4159
8	4312	4063	4186	4186
9	5025	4693	4858	4858
10	5198	4646	4918	4918
11	4991	4381	4681	4681
12	3983	3583	3781	3781

Step 4. Calculation of Kindergarten Enrollment

In 1977, the Texas legislature made all five year olds eligible for kindergarten enrollment. Without historical data for kindergarten classes, SRAM projected kindergarten enrollment for 1978-79 to be the same as that for first grade for 1978-79. The projected kindergarten enrollment for 1978-79, therefore, was 4,981 for the START of the year and 4,983 for the PEAK of the year.

Step 5. Calculation of Special Education Enrollments

Special Education enrollments were projected on a group basis using the cohort survival methodology described in Step 2. Table 48 displays the past three years of Special Education enrollment and the projected 1978-79 enrollment for START and PEAK times.

TABLE 48

Past Enrollment and 1978-79 Projected Enrollment for Special Education Programs

START Enrollment				PEAK Enrollment			
1975-76	1976-77	1977-78	Projected 1978-79	1975-76	1976-77	1977-78	Projected 1978-79
1399	1526	1709	1880	1392	1521	1732	2004

Step 6. Incorporation of Projected Group Enrollment

In addition to grade level projections, the School Resource Allocation Model (SRAM) provided high, low, and mean enrollment projections for groups of grades (grades 1-12, 1-6, 7-8 and 9-12) to ensure the selection of the best projection estimate. (The larger the number to be estimated, the more accurate the projection. The projected smaller numbers (i.e., individual schools) are chosen to sum to the larger group totals for the most accurate results). The elementary, junior high, senior high and special education enrollment projection totals are shown in Table 49.

TABLE 49

1978-79 Enrollment Projections for Elementary School, Junior High School, Senior High School and Special Education

	Projected Enrollment 1978-79
Elementary School	31,893
Junior High School	8,840
Senior High School	18,163
Regular Total	58,896
Special Education	1,880
District Total	60,776

Step 7. Projections by Individual School

Projected student enrollments for the START time period for each school in the Austin Independent School Disrict were calculated by the cohort survival ratio method utilizing ten years of past enrollment data. For each grade-to-grade progression within each school, survival ratios were calculated for each year. Low, high, and mean ratios were then identified and new ratios introduced when outside variances were not considered in the basic survival ratios.

These introduced ratios were established by looking at the past year's projected enrollment and the survival ratio used in the projection for each school by grade level. A comparison was then made with the actual past year's enrollment and survival ratio for each school by grade level. The past year's survival ratio was adjusted to reflect any new growth or school closures in attendance areas. Projections were then calculated for each grade level utilizing one of the four survival ratios. Initial grades at each school were projected on a proportional basis, whereby the past proportion of feeder school enrollment to each school was used as the survival ratio.

The following sections describe the steps used to project elementary, junior high and senior high school enrollments, using the past three years of actual enrollments.

Elementary School Enrollment Projections

During the 1978-79 school year, there were 61 elementary schools in the Austin Independent School District. Table 50 displays, by grade level for two elementary schools - Allison and Andrews - the past three years of enrollment and the survival ratio used to project the START period non-initial grade enrollments. Projected enrollments in initial grades of the elementary schools (kindergarten) were calculated by multiplying a proportion of the number of births five years prior to the kindergarten year to the kindergarten enrollment, by the number of births five years prior to 1978-79. Enrollment projections for the START time period were calculated by grade level, and school enrollment totals were calculated for the PEAK time period.

On Table 50, the 1977-78 enrollment for each grade level was multiplied by the survival ratio appearing next to it in parentheses, to project the next grade enrollment. For example, the 1977-78 first grade enrollment (121) was multiplied by .930 to acquire the projected 1978-79 second grade enrollment (113).

TABLE 50

1974-78 Enrollments, Survival Ratios and 1978 Projections
for Elementary Schools by Grade Level for the START Time Period
and the Projected School Total for the PEAK Time Period

Past Enrollment

	START					PEAK			
Allison	1975-76	1976-77	1977-78	(Survival Ratio)	Projected START 1978-79	1974-75	1975-76	1976-77	Projected PEAK 1978-79
K	103	113	108		111	90	111	106	
1	102	118	121	(.930)	121	128	103	111	
2	111	101	128	(1.000)	113	131	113	105	
3	123	103	104	(1.000)	128	146	126	103	
4	131	131	96	(1.000)	104	138	130	129	
5	131	108	113		96	151	130	116	
Total	701	674	670		673	781	713	670	674
Andrews									
K	65	58	61		97	60	59	59	
1	81	90	105	(1.000)	105	77	84	90	
2	84	83	85	(1.000)	105	69	84	86	
3	78	86	78	(1.000)	85	98	82	84	
4	96	74	86	(1.000)	78	96	97	80	
5	93	90	79		86	116	90	96	
Total	497	481	494		556	516	496	495	560

Junior High School Enrollment Projections

Eleven junior high schools served the Austin Independent School District during the 1978-79 school year. Table 51 illustrates three years of past junior high school enrollment, non-initial grade survival ratios, the projections used for each school by grade level for the START time period, and the projected school total enrollment for the PEAK time period for two schools - Allen and Bedichek. The initial grade enrollments were projected by multiplying the past proportion of elementary feeder school attendance to each junior high school, by the projected enrollment at the feeder elementary schools.

TABLE 51

1974-1978 Enrollments, Survival Ratios and 1978 Projections for Junior High Schools by Grade Level for the START Time Period and the Projected School Total for the PEAK Time Period

	Past Enrollment								
	START					PEAK			
Allan	1975-76	1976-77	1977-78	(Survival Ratio)	Projected START 1978-79	1974-75	1975-76	1976-77	Projected PEAK 1978-79
6	235	199	176	(1.050)	163	216	244	199	
7	242	246	277	(.900)	185	380	241	251	
8	359	233	232		204	407	343	255	
Total	836	678	635		552	1003	828	675	520
Bedichek									
7	591	629	607	(1.054)	549	554	597	628	
8	563	608	605		640	541	562	616	
Total	1154	1236	1212		1189	1095	1159	1244	1199

Senior High School Enrollment Projections

Table 52 displays, for two senior high schools - Reagan and Travis - three years of past enrollment data, non-initial grade survival ratios, 1978-79 enrollment projections for grades 9, 10, 11, and 12 for the START time period, and senior high school total projections for the PEAK time period. Similar to the junior high school enrollment projection process, initial grades were calculated by multiplying a proportion of junior high feeder school enrollment to senior high school enrollment, by the projected enrollments for the junior high feeder schools.

TABLE 52

1974-1978 Enrollments, Survival Ratios and 1978 Projections for Senior High Schools by Grade Level for the START Time Period and the Projected School Total for the PEAK Time Period

Past Enrollment

	START				Projected START	PEAK			Projected PEAK
Reagan	1975-76	1976-77	1977-78	(Survival Ratio)	1978-79	1974-75	1975-76	1976-77	1978-79
9	486	499	574	(.950)	546	502	485	489	
10	467	445	456	(.900)	360	463	429	429	
11	395	517	355	(.700)	410	374	372	473	
12	309	299	340		248	301	303	284	
Total	1657	1750	1725		1749	1537	1623	1675	1659
Travis									
9	560	528	573	(.950)	578	496	509	515	
10	501	498	518	(1.100)	544	441	461	476	
11	495	530	560	(.750)	570	437	447	488	
12	330	340	361		420	233	311	293	
Total	1886	1896	2012		2112	1607	1728	1772	2048

Calculation Time and Approval Process

The annual calculation process for projecting enrollments in the Austin Independent School District commences in November and is completed in early March. The actual calculations begin in November with the updating of the School Resources Allocation Model incorporating enrollment information from the previous year. The updating which utilizes the same parameters as used in the previous year takes approximately two weeks. These projections are sent to the district demographer who takes two to three days to review the projections on a school by school basis against the last year's actual enrollment. The demographer researches each school attendance area to identify changing trends and circumstances. He then decides if a significant alteration in the previous year's enrollment was due to a new trend that will continue (such as a closing of a private school in the area), or if the enrollment alteration was just happenstance for the given year. The demographer makes recommendations for a new cohort survival ratio to reflect his decision for each school. Changes to the updated program are usually made in a half day's time and another half day is used for the Director of Planning and Programming and the demographer to review the new results. If changes are necessary, the program is rerun.

Around the middle of January the projections are sent to the Finance Office for staffing allocations. The projections and staff allocations are sent to the individual schools. The principals are allowed approximately one month to express concern over the projected enrollment and staffing numbers. They must present their concerns along with a justification in writing. The revised projections are usually distributed in early March and any individual school disagreement beyond that time is made on an individual school basis.

Presently no adoption by the Executive Cabinet is necessary since enrollment projections are merely considered to be an administrative process that needs to be done. After the implementation of the new desegregation mandate, however, the enrollment projections which will for the first time project declining enrollment, will be considered a political process and cabinet approval will become necessary.

Summary

Austin Independent School District enrollments are projected one to ten years into the future utilizing the cohort survival methodology in an automated system known as the School Resource Allocation Model (SRAM). Projections are made by grade level for the district and for the beginning of the school year for individual schools. School totals are projected for the middle of the year.

The SRAM provides high, low, and mean survival ratios developed from standard deviations to estimate grade level enrollments. A read-in option is also provided to allow for the introduction of survival ratios that are considered to better reflect outside variances not considered by the other three ratios.

Kindergarten projections are normally calculated on a basis of a ratio of kindergarten to number of births in the city five years prior to the year being projected. A 1977 Texas legislative mandate, however, altered the eligibility requirement for kindergarteners. With no historical data on which to base new projections, 1978-79 kindergarten enrollments were projected to be identical to the first grade projections.

The calculation and approval process requires about four and a half months. Individual school principals are given an opportunity to agree or disagree with the projections and when adequately justified, adjustments are made to the projections. The approval process is predicted to change slightly in future years due to the new desegregation mandate. With the projection of enrollment decline, the enrollment projection process will be considered political and cabinet approval will be necessary.

Chapter 7

The Seattle Public School District
Enrollment Projection Methodology

The Seattle Public School
District Enrollment Projection Methodology

Seattle School District

The Seattle School District, contiguous with the city boundaries, covers an area of 81.72 square miles. In December 1978, 53,885 students were enrolled in the district. As of the same date, the district employed approximately 3,000 professional personnel. Over the past ten years, the student/teacher ratio has decreased; in 1967, there were 21.1 pupils per teacher and in 1977 only 16.2 pupils per teacher. Teachers earn an average yearly salary of $18,948.

In recent years, Seattle has faced a decline in the public school enrollment. By October 1979 Seattle Public Schools had dropped to almost 50,000 students, the lowest number of enrollees since 1924. In the past five years (1974-79) enrollment has declined 27 percent; since 1969 district enrollment has declined 44 percent. The Seattle district also has implemented recently a desegregation busing plan to reduce the racial imbalance among the attendance areas within the district. This new plan makes it difficult to predict future enrollment by previous methods.

Seattle Desegregation Plan

Seattle is a city with a large and diverse population. As in most big cities, ethnic groups tend to live in neighborhoods with others of their race and nationality, creating segregated schools when students simply attend their neighborhood schools. In 1977, the Seattle District School Board first determined the need for busing as a means to achieve racial balance in the schools. The Seattle Plan, as the desegregation plan was called, was fully implemented into the Seattle School system during the fall of 1978.

The Seattle Plan has four basic components. They are listed below:

1) Zone Organization: For administrative purposes, the District is divided into three zones. These zones were designed to assist in student movement and to structure program development.

2) Paired or Triad Elementary Schools: Desegregation is accomplished by the pairing or triading of schools within each of the three zones. A school is considered racially imbalanced if the enrollment exceeds the total minority enrollment of the district by 20%. Predominantly minority schools are paired or triaded with predominantly white schools. Pairing is done by a re-configuration of grade levels of affected schools. One leg of the pair has kindergarten and grades 1 through 3; the other leg of the pair has kindergarten and grades 4 through 6. There are paired schools with a kindergarten through grade 5, schools which have K, 1 through 3 and K, 4 and 5 grade levels.

3) Assignment Patterns for Secondary Schools: Racial imbalance is reduced through the use of school assignment patterns. Students residing in elementary school attendance areas are assigned to middle and junior high schools and high schools within the zone according to patterns which would best achieve a racial balance.

4) Educational Options: This is an important feature of the Seattle Plan. It provides the students with the option of transferring to different schools within their zone, but only if that transfer does not upset the racial balance of the receiving school. Four types of transfers are available for educational options. They are:

   a. The option program transfer
   b. The alternative program transfer
   c. The individual program opportunity transfer
   c. The voluntary racial transfer program

The board refused to disrupt the high school students' school years by forcing juniors and seniors to complete their education in a different school. Thus, mandatory busing takes place only in the entering grades of the secondary school years. The Office of Student Placement holds the authority and the responsibility for the assignment or transfer of students in compliance with the Seattle Desegregation Plan.

The Seattle School District provided transportation for the students in those areas included in the desegregation program. Students who choose options must arrange their own transportation. A student is eligible for transportation, however, if he/she lives beyond two miles of his/her school attendance area.

The Seattle School District's Department of Planning, Research and Evaluation monitors the population patterns of the district's individual attendance areas. As the trend toward lower school enrollments increases, the school district relies on accurate predictions, both on a long and short-term projection range. The Department of Planning, Research, and Evaluation is responsible for these projections. As the city continues to change, the Department of Planning, Research and Evaluation also updates its information and expands its program as the city expands.

A description of the student enrollment projection methodology presently used by Seattle Public Schools follows.

Seattle Student Enrollment Projection Methodology

Seattle School district utilizes the cohort survival enrollment projection methodology in arriving at district level and individual school level enrollment projections for the future year.

Enrollment projections on the district-level are calculated by grade level using an average of three years' cohort survival ratios, weighted to allow the year closest to the projected year to have the most explanatory power. When tested with past data, the three year average cohort survival ratio provided more accurate projections for Seattle than using the previous year's cohort survival ratio, or an average of the past two or four years. This technique utilizes the same principle of average ratios as that used in Austin. Austin, however, bases its unweighted average cohort survival ratios on ten years of past enrollment data.

Because the Seattle desegregation plan's first year of operation was the 1978-79 school year, no trends reflecting the impact of the plan were available, so the average district grade-level cohort survival ratios were used to project individual school enrollments by grade level, as had been done in the past.

Grade-Level Projections

Seattle school district grade level enrollments are projected on a yearly basis at two intervals--January and October--using the cohort survival methodology for grades one through twelve and for October kindergarten, while the January kindergarten projection utilizes a number of live births to kindergarten ratio.

The nine steps used to project district student enrollments for October 1978 and January 1979, with actual data illustrations, are described below.

Step 1. Collection of Past Enrollment

Total enrollment by grade level for the four previous Octobers and Januarys were used for projecting October 1978 and January 1979 enrollments. Table 53 displays the past enrollments used for projecting those two enrollment figures.

Table 53 also illustrates the enrollment patterns in Seattle over the past years and the enrollment trends within the school year. Between 1974 and 1977, October total district enrollment dropped by 10,395 students, an average of 3465 per year. October to January enrollments have decreased at an average yearly rate of 1762. The rate of decline within a given school year and between school years slowed down in 1977-78 even though enrollments continued to decline.

Step 2. Formation of Survival Ratios for Grades One through Twelve

Step 2 entails computing survival ratios on the basis of the past enrollment data found in Table 53. Table 54 shows the survival ratios for each year of data for the two projected time periods, as well as an average ratio computed in the next step.

Differing methodologies were used to compute ratios for projecting October 1978 and January 1979 enrollments. For October 1978 projections, survival ratios were formed for each grade level by dividing October 1974-77 enrollments for grades 1-12 by January 1974-77 enrollments for the preceeding grade level. For example, the second to third grade survival ratio for 1977 was formed by dividing October 1977 third grade enrollment by January 1977 second grade enrollment [e.g., $\frac{\text{October (77) (third grade)}}{\text{January (77) (second grade)}} =$

$\frac{4170}{4499}$ = .9269] to obtain a second to third grade survival ratio of .9269. Similar calculations were done for each year.

January 1979 survival ratios were calculated in a slightly different manner. The January ratio does not represent a grade-to-grade survival as does the October ratio. Instead, the January ratio represents the survival within each grade from October to January. The ratios were formed by dividing January enrollments for a given year and grade level (K through 12) by October's enrollments for the same school year for the same grade level. For instance, the 1977 second grade survival ratio used for January projections was calculated by dividing January 1977 second grade enrollment by October 1976 second grade enrollment to obtain a ratio of .9910 [e.g., $\frac{\text{January (77) (second grade)}}{\text{October (76) (second grade)}}$ = 4259 = .9910]. Similar calculations were done for each year and grade.

TABLE 53

Enrollment Data by Grade Level Used in Projecting October 1978 and January 1979 Grade Level Enrollments

Grade	October 1974	January 1975	October 1975	January 1976	October 1976	January 1977	October 1977	January 1978
K	5095	5120	5041	5005	4296	4311	3623	3610
1	4906	4846	4890	4861	4822	4807	4292	4255
2	4637	4638	4599	4532	4540	4499	4557	4493
3	4422	4410	4418	4398	4254	4259	4170	4128
4	4594	4542	4313	4299	4167	4135	3995	3945
5	4881	4832	4422	4376	4044	3970	3938	3865
6	4906	4868	4654	4642	4083	4042	3784	3710
7	5258	5160	4937	4869	4468	4375	3959	3926
8	5383	5311	5057	4974	4674	4476	4276	4237
9	5331	5156	5326	5054	5102	4809	4487	4457
10	5498	5191	5280	4940	5120	4855	4826	4483
11	5426	5149	5211	4810	4969	4656	4795	4435
12	5295	5004	5028	4716	4810	4491	4535	5216
TOTALS	65632	64227	63176	61476	59349	57685	55237	53760

TABLE 54

Survival Ratios for Each Year by Grade Level for
October Projections and January Projections

Survival Ratios Used In October Projections					Survival Ratios Used In January Projections				
	January to October					October to January			
Grade	1975	1976	1977	Average Ratio	Grade	1975-76	1976-77	1977-78	Average Ratio
K-1	.9551	.9635	.9956	.9782	K	.9929	1.0035	.9965	.9983
1-2	.9491	.9340	.9480	.9436	1	.9941	.9969	.9914	.9937
2-3	.9526	.9387	.9269	.9352	2	.9855	.9910	.9860	.9876
3-4	.9780	.9475	.9381	.9479	3	.9955	1.0012	.9900	.9947
4-5	.9736	.9407	.9524	.9521	4	.9968	.9924	.9875	.9907
5-6	.9632	.9331	.9532	.9482	5	.9896	.9817	.9815	.9830
6-7	1.0142	.9626	.9795	.9797	6	.9975	.9900	.9805	.9865
7-8	.9801	.9600	.9774	.9721	7	.9863	.9792	.9917	.9867
9-10	1.0241	1.0131	1.0036	1.0102	9	.9490	.9426	.9934	.9691
10-11	1.0039	1.0059	.9877	.9965	10	.9356	.9483	.9290	.9366
11-12	.9765	1.0000	.9741	.9832	11	.9231	.9370	.9250	.9287
					12	.9380	.9337	.9297	.9325

Step 3. Calculation of Average Survival Ratios

As Table 54 shows, the survival ratios used in the October projections fluctuated for each grade progression between 1975 and 1977, as did the survival ratios for each grade level, used in the January projections. To capitalize on past trends to explain future enrollment, an average survival ratio was computed. The average was weighted to allow the year closest to the year being projected to have the most explanatory power. The weights 3, 2, and 1, were assigned to each year's October survival ratios according to their proximity to the data being projected. For instance, the ratio of .9436 used for second grade October projections was found by 1) multiplying the 1-2 survival ratios for 1975, 1976 and 1977 by 1, 2, and 3, respectively and 2) adding the weighted ratios, and 3) dividing by 6. (E.g., [(1975 1-2 grade survival ratio) + 2 (1976 1-2 grade survival ratio) + 3 (1977 1-2 grade survival ratio)] ÷ 6 = [1 (.9491) + 2 (.9340) + 3 (.9480)] ÷ 6 = (.9491 + 1.8680 + 2.8440) ÷ 6 = .9436.)

For the January 1979 projections, the 1975-76, 1976-77, and 1977-78 ratios were multiplied by 1, 2, and 3, respectively, added, and divided by 6. [E.g., January 1979 second grade ratios = [1 (1975-76 second grade ratio) + 2 (1976-77 second grade ratio) + 3 (1977-78 second grade ratio)] ÷ 6 =

[1 (.9855) + 2 (.9910) + 3 (.9860) ÷ 6 = 9876].

TABLE 55

Enrollments and Ratios for Projecting October 1978 and January 1979 Enrollments

Grade	January 1978 Enrollments	Average January to October Ratio	October 1978 Projections	Average October to January Ratio	January 1979 Projections
K	3610	.9782		.9982	
1	4255	.9436	3531	.9937	3509
2	4493 →	.9352 ↘	4015	.9876	3965
3	4128	.9479	4202 →	.9947 →	4180
4	3945	.9521	3913	.9907	3877
5	3865	.9482	3756	.9830	3692
6	3710	.9797	3665	.9865	3616
7	3926	.9721	3635	.9867	3587
8	4237	1.0043	3816	.9787	3735
9	4457	1.0102	4255	.9691	4124
10	4483	.9965	4502	.9366	4217
11	4435	.9832	4467	.9287	4149
12	4216		4360	.9325	4066
TOTALS	53760		51584		50178

Step 4. Calculation and Selection of 1978-79 Enrollments

First through twelfth grade enrollments for October 1978 were estimated by multiplying the average weighted survival ratios obtained in Step 2 for each grade by the actual 1978 January enrollment for the previous grades. The calculations are shown in Table 55 [e.g., October 1978 fourth grade enrollment was projected by multiplying January 1978 third grade enrollment by the 3 to 4 ratio - 4128 (.9479) = 3913]. January 1979 projections were obtained by multiplying the average ratios by the projected October 1978 enrollments for each grade (e.g., January 1979 third grade enrollment was projected by multiplying the October 1978 third grade projection by the third grade ratio - 4202 (.9947) = 4180). The multiplication of January enrollments by the January-to-October survival ratio is done diagonally, not horizontally as the table may imply. The multiplication of the October to January ratio and the October projections is linear, however.

Table 55 displays the information needed to make the two projections; the average ratios and the January 1978 enrollment, as well as the projections for October 1978 and January 1979, excluding kindergarten.

Step 5. Formation and Calculation of Kindergarten Enrollments

Three kindergarten ratios that incorporated birth data and past kindergarten enrollment data were established and averaged to obtain a ratio for projecting October 1978 kindergarten enrollment.

Four steps were used to project October 1978 kindergarten enrollment. Those steps and calculations follow:

1) Three ratios were established using October 1975, 1976, 1977 kindergarten enrollments and dividing by the number of births in Seattle five years prior to each year. (E.g., $\frac{\text{\#Kindergartners in 1975}}{\text{\#Births in 1970}} = \frac{5041}{8482} = .5943$; $\frac{\text{\#Kindergarthers in 1976}}{\text{\#Births in 1971}} = \frac{4296}{6854} = .6268$; $\frac{\text{\#Kindergartners in 1977}}{\text{\#Births in 1972}} = \frac{3623}{5522} = .6561$).

2) The ratios were then assigned weights of 3, 2, or 1 according to their proximity to October 1978. (E.g., $\frac{\text{\#Kindergartners in 1975}}{\text{\#Births in 1970}}$ was multiplied by 1 = .5943 x 1 = .5943; and $\frac{\text{\#Kindergartners in 1976}}{\text{\#Births in 1971}}$ was multiplied by 2 = .6268 x 2 = 1.2536; and $\frac{\text{\#Kindergartners in 1977}}{\text{\#Births in 1972}}$ was multiplied by 3 = .6561 x 3 = 1.9683).

3) An average was established by adding the weighted ratios and dividing by 6.00 to obtain the ratio used in the October 1978 kindergarten projections (.5943 + 1.2536 + 1.9683) ÷ 6.00 = .6360).

4) Finally the above ratio was multiplied by the number of births in Seattle five years prior to October 1978 (.6360 x 5420 = 3467).

January 1979 kindergarten enrollments were estimated by multiplying the October 1978 kindergarten enrollment projection by the kindergarten October-to-January survival ratio established in Step 2. [January 1979 projected kindergarten enrollment = October-to-January survival ratio for kindergarten x October 1978 projected kindergarten enrollment = .9983 x 3467 = 3461].

Step 6. Estimation of Special Education Program Enrollment

Special Education program enrollments for October 1978 and January 1979 were projected using the same methodology as regular grade level projections, although enrollments were not projected by grade level since special education programs do not incorporate a grade progression.

Table 56 shows the actual enrollments in special education programs from January 1975 to January 1978 that are used for calculating the ratios used in the October 1978 and January 1979 projections. The second line of Table 56, the October to January cohort survival ratios, was established by dividing January enrollments by the previous October enrollments. The third line of the table, the January to October cohort survival ratios, was computed by dividing October enrollments by the previous January enrollments.

For both the October to January and the January to October ratios, a weighted average ratio was established. The weights 3, 2, and 1, were assigned to each ratio on the basis of the ratio's proximity to the date being projected. The average-weighted ratios of .8308 and 1.1547 were then multiplied by the actual January 1978 enrollment and the October 1978 projected enrollment, respectively, to arrive at the projections of 2022 and 2335 for the two dates.

TABLE 56

Actual Special Education Enrollments, Survival Ratios, and Projected Enrollments for October 1978 and January 1979

	ACTUAL							AVERAGE-WEIGHTED RATIOS		PROJECTED	
	January 1975	October 1975	January 1976	October 1976	January 1977	October 1977	January 1978	January to October	October to January	October 1978	January 1979
Special Education Program Enrollment	2714	2260	2513	2332	2782	2129	2434	.8308	1.1547	2022	2335
October to January Cohort Survival Ratios	--		1.1119		1.1930		1.1433				
January to October Cohort Survival Ratios		.8327		.9280		.7653	--				

Step 7. Estimation of Alternative Program Enrollments

Table 57 was designed to display the numbers used to project alternative program enrollments for October 1978 and January 1979. The ratios that appear below the actual enrollments represent October-to-January and January-to-October survival ratios, found by dividing January enrollments by the previous October enrollments and by dividing October enrollments by the previous January enrollments. The average weighted ratio for January to October was found by multiplying the January 1977/October 1977 ratio by 3, the January 1976/October 1976 ratio by 2, and adding both to the January 1975/October 1975 ratio, and dividing by 6. Enrollment for October 1978 was projected by multiplying the average January to October ratio by the January 1977 actual enrollment. January 1979 enrollment was estimated by multiplying the average October to January ratio by the October 1978 projected enrollment. The resulting projections were 1,608 for October 1978 and 2,080 for January 1979.

Step 8. Collation of Projections and District Totals

Table 58 shows the October 1978 and January 1979 projections for regular programs, special education, and alternative programs calculated in Steps 4 through 7.

TABLE 57

Actual Alternative Program Enrollments, Survival Ratios, and Projected Enrollments for October 1978 and January 1979

	ACTUAL							AVERAGE-WEIGHTED RATIOS		PROJECTED	
	January 1975	October 1975	January 1976	October 1976	January 1977	October 1977	January 1978	January to October	October to January	October 1978	January 1979
Special Education Program Enrollment	1090	985	1333	1093	1457	1559	1945	.8269	1.2938	1608	2080
October to January Cohort Survival Ratios	--	1.3533		1.3330		1.2476					
January to October Cohort Survival Ratios	.9036		.8200		1.0700		--				

TABLE 58

District Level Projections by Grade Level for October 1978 and January 1979

Grade	October 1978	January 1979
K	3,467	3,461
1	3,531	3,509
2	4,015	3,965
3	4,202	4,180
4	3,913	3,877
5	3,756	3,692
6	3,665	3,616
7	3,635	3,587
8	3,816	3,735
9	4,255	4,124
10	4,502	4,217
11	4,467	4,149
12	4,360	4,066
Subtotal	51,584	50,178
Special Education	2,022	2,335
Alternative Program	1,608	2,080
GRAND TOTAL	55,214	54,593

Step 9. Projections By Individual School

Individual school enrollments in Seattle are projected twice a year, in October and January, using a mixed model design. The mixed model allows for special treatment of paired and triaded schools in the Seattle desegregation plan.

Desegregation added considerably to the difficulty and complexity of projecting enrollments on the individual school level in Seattle. Because the 1978-79 school year represented the first year of desegregation implementation in Seattle, historical trends were unavailable to assist with the prediction of the impact of desegregation on individual school enrollment. Answers to the many questions that center around desegregation could not be predicted without the base of past trends. Examples of questions include: Will there be a race difference for retention rates at each school? How much "white flight" will occur? How many parents will not want their children involved with busing and will decide to transfer them to alternative programs or private schools? Because the questions above, and so many more, could not be addressed in projecting the first year of desegregation, the past methodology for projecting individual school enrollment was utilized.

Below is a description of Seattle's individual school enrollment projection methodology. This methodology, which utilizes the same concept as grade-level projections, is illustrated by actual data used to project October 1978 and January 1979 enrollments. The projections are divided into elementary, middle, junior high, and senior high school categories. The elementary tables include two sub-categories, "regular" schools and paired or triaded schools.

Elementary School Projections

Elementary school projections are complicated by the desegregation busing plan that pairs 16 schools and involves 18 schools in triads. Projections for the 49 "regular" elementary schools, however, are explained and illustrated below.

Regular Elementary Schools

Forty-nine regular elementary schools were in operation in Seattle during the 1978-79 school year. A regular elementary school is defined as one which students attend in their respective neighborhood between grades kindergarten through 5 or 6.

The steps used to project regular school enrollments for October 1978 and January 1979 were identical to those used to project district-wide enrollments by grade level. For each school, separate projections by grade level were totaled to produce a school enrollment total. Grade-level enrollments for October 1978 were estimated by multiplying January 1978 enrollments for each grade level by the January-to-October cohort survival ratio obtained in Step 2. Grade-level enrollment estimates for January 1979 were computed by multiplying the projected October 1978 enrollment by the October-to-January cohort survival ratios also obtained in Step 2. Table 59 displays, for two schools - Adams and Alki, the information used to make individual school projections.

TABLE 59

January 1978 Enrollments, Survival Ratios
and October 1978 and January 1979 projected student Enrollments
for Adams and Alki Elementary Schools

School	Grade	Actual January 1978		January to October Ratio	Projected Oct. 1978	January to October Ratio	Projected January 1979
Adams	K	45			48	.9982	48
	1	38	K-1	.9782	42	.9937	42
	2	57	1-2	.9432	32	.9876	32
	3	44	2-3	.9352	52	.9947	52
	4	60	3-4	.9479	40	.9907	40
	5	50	4-5	.9521	58	.9830	57
	6	46	5-6	.9482	38	.9865	38
Total		340			310		309
Alki	K	17			28	.9982	28
	1	20	K-1	.9782	29	.9937	29
	2	23	1-2	.9432	22	.9876	22
	3	22	2-3	.9352	22	.9947	22
	4	22	3-4	.9479	23	.9907	23
	5	22	4-5	.9521	25	.9830	25
	6	34	5-6	.9482	22	.9865	22
Total		160			171		171

Paired and Triaded Elementary Schools

During the 1978-79 school year, the Seattle school district attempted to increase the number of non-minority students attending predominantly minority schools and vice versa. To accomplish this most effectively and efficiently, eight predominantly non-minority schools and eight predominantly minority schools were paired to create racially-balanced schools of grades 1 through 6. In a similar fashion, 18 schools of predominantly one racial composition were aligned to form six triads. Within these pairs and triads, a system was established so that all students in a pair or triad would attend one school for two or three grades, then another school in the triad or pair for two or three grades. Kindergartners, however, attended their neighborhood schools. This system eliminated the burden of busing the same students throughout elementary school.

October 1978 and January 1979 pair/triad projections were computed using the district cohort survival ratios established earlier for grade-level projections. Table 60 displays the information used to project October 1978 and January 1979 enrollment for two of the eight paired schools: Graham Hill and Northgate. Table 61 shows identical information and projections for three of the 16 triaded schools.

To project October 1978 enrollments for paired schools, as Table 60 indicates, January 1978 enrollments for grades 1 through 6 were summed before being multiplied by the previously established January cohort survival ratios. The projected October grade enrollments for each school were multiplied by the October-to-January cohort survival ratios, to obtain projected grade totals for January 1979.

Unfortunately, triad enrollments for October 1978 were not quite as easy to project because a proportion of each school's population was assigned to each of the other two schools. In some cases, students from all three schools attended one school for one or more grades. Table 61 contains the actual January 1978 enrollments used to obtain the projected October 1978 triad school enrollments for Brighton, Hay and West Queen Anne. The table also contains the October 1978 projections used to obtain the projected enrollments for January 1979 for the three schools.

TABLE 60

January 1978 Student Enrollment, Survival Ratios, and October 1978 and January 1979 rojected Enrollment by Grade Level for Graham Hill and Northgate Elementary Schools

Grade	January 1978 Enrollment Graham Hill	Northgate	Total	Jan. to Oct. Survival Ratio		Proj. Oct. 1978 GH	N	Oct. to Jan. Survival Ratio	Proj. Jan. 1979 GH	N
K	33	23	56			49	23	.9982	49	23
1	32	24	56	k-1	.9782	54		.9937	54	
2	36	28	64	1-2	.9432	55		.9876	54	
3	51	32	83	2-3	.9352	57		.9947	57	
4	30	28	58	3-4	.9479		79	.9907		78
5	34	34	68	4-5	.9521		55	.9830		54
6	29	24	53	5-6	.9482		66	.9865		65
Total	245	193				215	223		214	220
Spec.	45		45							

TABLE 61

January 1978 Student Enrollment, Survival Ratios, and October 1978 and January 1979 Projected Enrollment for Brighton, Hay and West Queen Anne Elementary Schools

Grade	January 1978 Enrollments: Brighton	Hay	West Queen Anne	Total	Jan. to Oct. Survival Ratio	Projected October 1978: B	H	WQA	Oct. to Jan. Survival Ratio	Projected January 1979: B	H	WQA
K	31	35	22	88		33	35	21	.9982	33	35	21
1	59	32	31	122	k-1 .9782		53	36	.9937		53	36
2	57	39	26	122	1-2 .9432		51	58	.9876		50	57
3	52	31	19	102	2-3 .9352		63	55	.9947		63	55
4	52	21	28	101	3-4 .9479	98			.9907	97		
5	55	38	20	122	4-5 .9521	97			.9830	95		
6	48	45	25	118	5-6 .9482	107			.9865	105		
Total	354	241	180			355	202	170		330	201	169
Spec.	24	32		56								

Middle School Projections

Six middle schools served grades five, six, seven and eight in the Seattle Public School District during the 1978-79 school year. Student enrollment projections for these schools were calculated in the same manner as the regular elementary school projections. Table 62 shows the breakdown by grade level for January 1978 actual and October 1978 and January 1979 projected student enrollments for Boren and Eckstein Middle Schools. Once again, the January to October cohort survival ratios calculated in Step 3 were multiplied by the actual January 1978 enrollments for each grade within each middle school to obtain the October 1978 projected enrollments. The projected October 1978 values, in turn, were multiplied by the October to January cohort survival ratios to obtain the January 1979 projected enrollments.

TABLE 62

January 1978 Student Enrollment, Survival Ratios, and, October 1978 and January 1979 Projected Enrollment By Grade Level for Boren and Eckstein Middle Schools

School	Grade	January 1978 Enrollment	Jan. to Oct. Survival Ratios	Projected October 1978		Projected January 1979
Boren	6		(5-6) .9482	176	.9865	174
	7	196	(6-7) .9797	187	.9857	185
	8	223	(7-8) .9721	200	.9787	196
	9	188	(8-9) 1.0043		.9691	
Total		607		563		555
Eckstein	6	250	(5-6) .9482	223	.9865	220
	7	256	(6-7) .9797	321	.9867	317
	8	352	(7-8) .9721	258	.9787	253
Total		858		802		790

Junior High School Projections

During the 1978-79 school year, nine junior high schools served students in grades seven, eight, and nine and one junior high school served grades five through nine.

Student enrollments were projected by grade level using the cohort survival ratios computed in Step 2, in the same manner as the middle schools, as described in the preceding section.

Student enrollments for January 1978 and projected student enrollments for October 1978 and January 1979 for two of Seattle's ten junior high schools appear in Table 63.

TABLE 63

January 1978 Student Enrollment, Survival Ratios and October 1978 and January 1979 Projected Enrollment by Grade Level for Adams and Madison Junior High Schools

School	Grade	January 1978 Enrollment	Jan. to Oct. Survival Ratios	Projected October 1978	Oct. to Jan Survival Ratios	Projected January 1979
Adams	7	298	(6-7) .9797	285	.9867	280
	8	359	(7-8) .9721	313	.9787	306
	9	408	(8-9) 1.0043	485	.9691	470
Total		1065		1083		1056
Madison	7	300	(6-7) .9797	214	.9867	211
	8	318	(7-8) .9721	285	.9787	278
	9	341	(8-9) 1.0043	366	.9691	354
Total		959		865		843

Senior High School Projections

Twelve senior high schools were in operation during the 1978-79 school year in the Seattle Public School District. Five senior high schools served grades 10 through 12 while seven senior high schools served grades 9 through 12.

Student senior high enrollments for October 1978 were projected by grade level by multiplying the appropriate grade progression ratios obtained in Step 2 by the January 1978 enrollments. January 1979 enrollments were projected by multiplying the appropriate October to January ratios obtained in Step 2 by the projected October 1978 enrollments. Table 64 incorporates senior high student enrollments for January 1978 and the projected enrollments for October 1978 and January 1979 for two of Seattle's twelve senior high schools, Ballard and Cleveland.

TABLE 64

January 1978 Student Enrollment, Survival Ratio and October 1978 and January 1979 Projected Enrollment by Grade Level for Ballard and Cleveland Senior High Schools

School	Grade	Jan. 1978 Enrollment	Jan. to Oct. Survival Ratios	Projected Oct. 1978	Oct. to Jan. Survival Ratios	Projected Jan. 1979
Ballard	10	423(9-10)	1.0102	349	.9366	327
	11	397(10-11)	.9965	387	.9287	360
	12	389(11-12)	.9832	384	.9325	358
Total		1209		1120		1045
Cleveland	10	250(9-10)	1.0102	245	.9366	230
	11	268(10-11)	.9965	246	.9287	229
	12	222(11-12)	.9832	265	.9325	247
Total						

Calculation Time and Approval Process

Grade-level student enrollment projections for the Seattle School district are calculated in January of every year for two time periods - October and January. The actual calculations take approximately two days of the district projectionist's time. After review and approval by the Director of the Budgeting, Research and Evaluation Department, the projections are sent directly to the Budget office where the total number of staff to hire for the next year is calculated based on a staffing formula applied to the January projections. Projected January enrollments represent the average number of students enrolled in the district during the school year, so are used for calculating the number of staff to hire. October projections are used for planning for the opening of school.

Individual school enrollments are projected by grade level and are presented annually to the District Budget Office before April 1. The individual school projection calculations require a minimum of one week and a maximum of two weeks to complete. Personnel in the Budget office apply the state staffing formula to the projections and send to each of the schools in the district, the number of students to expect by grade level, and the number of staff assigned to the school for the projected year. The schools are allowed approximately one month to respond to the Budget office if they disagree with the student enrollment projections and/or the number of staff they will be allowed.

Enrollment projections usually undergo approximately two or three revisions before the beginning of the school year. Each revision requires approximately the same amount of time as the actual calculations. Revisions are made when knowledge of new district operations is gained (e.g., school closures, new busing routes) and around the beginning of August when students requesting optional programs have been assigned to a school.

Summary

Student enrollment projections in the Seattle Public School District are calculated annually for two time periods - October and January. 1978-79 grade level enrollments were projected for the district and for each of the 83 elementary schools, 6 middle schools, 9 junior high schools, and 12 senior high schools.

An eight step process was used to calculate the 1978-79 grade-level enrollments for the district using the cohort survival methodology. An average of three years, January to October cohort survival ratios, (weighted to allow the year closest to the projected year to have the most explanatory power) was used to project October enrollments, while a three year weighted average October-to-January survival ratio was used in projecting January enrollments. Actual calculations require approximately two days of the district projectionist's time.

The 1978-79 school year represented the first operational year for the new district desegregation mandate. Without his orical trends for which to project enrollments based on the effects of busing, the district cohort survival ratios were used to project individual school enrollments by grade level. These projections took approximately two weeks to calculate and were revised when knowledge of school closures and the number of student transfers were gained.

The process for the district acceptance of the projected enrollments is straight forward. After review and approval by the Director of Budgeting, Research, and Evaluation, the projections are sent directly to the Budget Office where the number of staff to hire for the ensuing year is calculated. The number of students expected to enroll along with the number of staff to be received is sent to each school for approval.

Chapter 8

Proposed Modification for the Seattle Public School District Enrollment Projection Methodology

Proposed Modification for the Seattle Public School District Enrollment Projection Methodology

During the 1978-79 school year, Seattle Public School District implemented a desegregation plan to achieve racial balance in its schools, (as explained in detail in the previous chapter). Desegregation is accomplished by the pairing or triading of elementary schools. Predominantly minority schools are paired or triaded with predominantly non-minority schools. Pairing and triading is done by a re-configuration of grade levels of the involved schools. One school of a pair houses kindergarten and grades 1-3; the other school houses kindergarten and grades 4-5 or 6. Triaded schools present a more complicated grade configuration. Each attendance area houses its own kindergarten students. Each school of a trio, in addition to kindergarten, houses either grades 1-2, 1-3, 3-5, or 4-5. Beyond the elementary school grades, students are assigned to the middle school, junior high school and high school within their elementary school attendance area according to patterns which would best achieve a racial balance.

In addition to the grade re-configuration and student assignments, the Seattle Desegregation Plan allows for option/alternative program transfers, provided the transfer does not upset the racial balance of the receiving school. The Office of Student Placement holds the authority and the responsibility for the assignment or transfer of students in compliance with the Desegregation Plan.

With the implementation of a new desegregation plan, which will undergo annual revisions, it is obvious that an enrollment projection methodology based on past enrollment trends can no longer be effectively utilized in the Seattle School District. Seattle School District planners need to be able to rely on an extremely accurate enrollment projection methodology for annual revisions based on desegregation impact assessments. The methodology must be one that not only projects grade level enrollment for each school, but in addition provides for the simulation of possible grade level re-configurations, pairing and triading of schools, busing routes, and student transfers.

The Seattle Public School District Research Department worked with researchers from the Center for Studies in Demography and Ecology at the University of Washington to devise a modification to their present enrollment projection methodology. A design has been developed and is presently ready for field-testing and validation. The proposed design is described below.

Because past enrollment trends were considered to be of less importance in projecting individual school enrollments within the context of the desegregation plan, a new methodology was adopted that projects enrollments on the basis of present enrollment and demographic trends, and incorporates variations of the present methodology based on past trends. It utilizes Markov chain theory which is described in Table A-4 of Appendix A.

The new enrollment projection methodology which will be a totally automated system, will enable Seattle School District (SSD) planners to perform routinely the following tasks:

1) To forecast future public school enrollment using all available individual and areal characteristics and a wide range of assumptions about future demographic changes;

2) To estimate future school enrollments if schools are closed, new schools are built, or the boundaries of attendance areas are modified;

3) To estimate future school enrollments under alternative desegregation strategies.

This innovative procedure is possible in Seattle because it has maintained unique and complete geo-coded student files for several years. The SSD also possesses software that can aggregate all students living in abritrarily specifiable sub-areas of the city. The proposed procedure capitalizes upon these excellent resources.

The key ingredients of the procedure are the following:

1) The available geo-coded student files;

2) The existing software associated with the geo-coding system;

3) Variations of the cohort survival procedure which the SSD staff currently employs;

4) The notion of forecasting for micro-level residential areas, and then aggregating these into attendance areas, rather than forecasting for the attendance areas themselves;

5) New software to implement (3) and (4).

The Final Product

When this procedure is completely programmed, it will be implemented in two steps. First, a small area forecast file (SAFF), based on explicit assumptions about the future, will be prepared. The input data for a forecast will comprise a past small area file (PSAF), which summarizes the characteristics of SSD students for the past several (e.g. five) years, and the (estimated) characteristics of pre-school children and births. The assumptions will be applied to the PSAF through control cards or job instructions. The instructions for a forecast will include specification of the number of years to be forecast, and the following:

1) For each individual-level variable (e.g. race),

   a) the number of preceding years of experience to be used (if zero, the variable is to be ignored);

b) the weights to be attached to each of these years;

c) the degree of the Polynomial to be fitted through these years (e.g. 0 for a mean, 1 for a straight line, 2 for a parabola, etc.);

d) the level of aggregation to be used (e.g. 0 for all of Seattle, 1 for major areas, 2 for minor areas; 3 for census tract).

2) For each areal-level variable (e.g. land use; at present no such variables are coded), (a-d) as 1 (a-d) above.

Specifications of types (1) and (2) would apply to all grade levels and all pre-school levels.

3) For future births (only required if the number of years to be forecast exceeds five), the number to be forecast will automatically follow the specifications in (1) and (2) for available variables. An additional option, however, would impose a set of year-to-year inflation/deflation factors representing hypothesized trends in the birth rate.

Once a SAFF has been prepared, it can be used repeatedly to generate future school enrollment predictions for a virtually limitless range of modified attendance areas and assignment patterns. An allocation run (which identifies residential areas with specific schools) produces a large table and/or a graph. A table displays the forecasted enrollment in each school for each future year and for all combinations of grade and race (additional breakdowns would also be possible). A graph would include a map of Seattle showing school attendance area boundaries and two or three-dimensional representations of enrollments. (The output could be limited, if desired, to provide data for a specific school or set of schools.)

For each allocation run, the user must supply instructions specifying the grade structure and the attendance areas for each school in the entire system. A precise format of these instructions has yet to be developed, but it is anticipated that after a basic allocation deck has been prepared, corresponding, for example, to the current assignment pattern, a typical modification to that deck (e.g., closing a school and re-allocating its former attendance area) would take about five minutes. Reference to a city map or atlas will identify the current assignment pattern and the reference numbers of all sub-areas. Alternatives could be compared easily, quickly, and cheaply.

Allocation runs could incorporate variation in either facilities utilization or busing assignments.

The Logic of the Procedure

This procedure's high efficiency presumes that indivisible micro-level areas can be agreed upon. These areas will consist of five to six city blocks, each including about 30 to 50 students (about three or four students at each grade level). They would be indivisible in the sense that micro-level areas will be allocated to schools as units. School attendance boundaries will always coincide with the boundaries of these micro-level areas.

When necessary these micro-level areas can also be aggregated into larger areas, for which data may be available on land use, in-migration, out-migration, etc. Using these indivisible sub-areas, the city can be divided into about 10 relatively homogeneous areas called "major areas", into smaller "minor areas", or census tracts. These areas would be nested in one another. The major and minor areas would correspond as nearly as possible to planning areas already defined by the District and the City of Seattle to make maximum use of available data. (The first tested version of the system may be able to use areal data, but areal data must first be collected and coded onto the PSAF.)

The PSAF (past small area file) will be a summary of the geo-coded student files for the past several years (no more than 5 years' information is needed). There will be one record or set of records in the file for each of the (approximately) 1200 micro-level sub-areas of the city. Each file will include summary data on the marginal and joint frequency distributions of the following variables for each year: grade, race/ethnic group, some information on age (e.g., the numbers of students at, above, and below the modal age for their grade, some SES data (e.g., number of students in the free lunch program), and other data from the geo-coded files considered relevant for forecasting. Each sub-area file will also include summary measures of turnover/persistence levels of individual students, and also areal characteristics of larger areas of the city in which the sub-area is nested. Some data would describe changes over the (five-year) period and other data would simply characterize the sub-area for the whole period.

The content and structure of this major summary file are still tentatively outlined. Although the file requires a great deal of data collection and will be expensive to construct, it will have to be updated only once each year to make future forecasts.

For each forecast file (SAFF) desired, the PSAF will be processed by the forecasting module. This will seldom be done more than five to ten times each year after a routine has been developed, although initially a wide range of forecasts will presumably be tried. The forecasting options, indicated earlier, will be implemented by a modification of the usual cohort survival procedure. Although forecasts are to be made for small areas, the data from the PSAF will never be limited to these small areas or even to census tracts. Obviously, too much random error would occur if the forecasts were derived only from small-area data. Minor adjustments may be based on small area data, but the most valuable projections will come from aggregation at the city-wide or major area levels. Future, forecasted frequencies could be made at the micro-level using fractions of persons. When aggregated into attendance areas, these frequencies would be statistically stable.

Residential areas will be allocated to specific schools (by grade level) by the same two methods used for both facilities utilization planning and desegregation planning. For the former, attendance areas will usually be close to the school while for the latter, they may be substantially distant. For either method, however, the researcher would simply have to instruct the allocation module to add up the forecasted student populations of all micro-level areas assigned to each school. Alternative allocations could easily be compared.

A more technical description of the proposed system follows.

System Design

The small area forecasting system is designed to quickly measure the effects of changing school attendance areas. Once the small area file is set up, the system can produce forecasts for a completely new districting strategy in one to two days, while minor changes in an existing strategy can be measured in a few minutes.

The small area forecasting system is divided into four modules, shown in Figure 6. The first three lay the groundwork for the final projections, and are designed to be run only infrequently, perhaps once a year. The fourth, the allocation module, produces the projections by school for each redistricting scheme, and may be run as often as needed to produce the desired simulations.

In the geo-coding module, shown first in the figure, a series of polygons will be designed to subdivide the city into about 1200 Small Areas of 30 to 50 students each. A suggested procedure would begin with the census block group polygons. A map will be drawn showing the location density of students in the Seattle City Schools. The Census Block Group boundaries will be marked on the map, and the student densities noted to divide the census block group into polygons containing 30 to 50 children. Because census block groups contain varying numbers of children, the block groups must be examined individually. However, 614 polygons enclosing relatively homogeneous areas have been already drawn for the block group approach, making it quite suitable for trending and forecasting populations. A minimum number of additional subdivisions of the city will minimize costs. Boundaries of census block groups may not correspond to current attendance areas, so some modifications may be needed.

The computer file containing the complete set of small area polygons will assign small area codes to each student on the geo-coded student history file for the last five years. The geo-coding module will produce a set of five history tapes, with each student coded with his/her Small Area number. There will also be a file containing identification information for each small area, including census tract, block group, major and minor area, and perhaps distance to nearest elementary, middle and high schools.

The history data then will be fed into the analysis module, which would first prepare a Past Small Area File, describing the student population in each Small Area over the last five years. This file will be used to analyze the local trends in student population by small area, major area, minor area, census tract, etc. Other sources of data, such as estimated birth and migration rates, land use patterns, etc., could be used to refine the model analytically.

The analysis module's resulting Past Small Area File of historical data, and the forecasting coefficients, will be input to the Forecasting

Module, which could prepare a complete three-year forecast for each Small Area. Each student from the historical file will be assigned a weight based on the estimated probability of returning from that area, and weights could exceed 1.0 if trends indicate an increase in students of that type in the area.

The Small Area Forecast File will form the primary input for the allocation module. This module would combine the small area forecasts in various ways to produce forecasts at the school level. The different facilities management strategies will be developed and coded into Area Definition Files by drawing lines representing the proposed school attendance area boundaries on a map of the small areas. The map will be used as an input document to code up the Area Definition File.

Working from the Area Definition File, and a School Master File containing feeder patterns, pairing and triading patterns, etc., the allocation module will prepare a School Forecast File, computing a three-year forecast for school populations. The School Forecast File will be built for each major redistricting strategy that the SSD is considering. Once the forecast files have been built, they can be easily modified or "fine-tuned" by the addition and deletion of small areas.

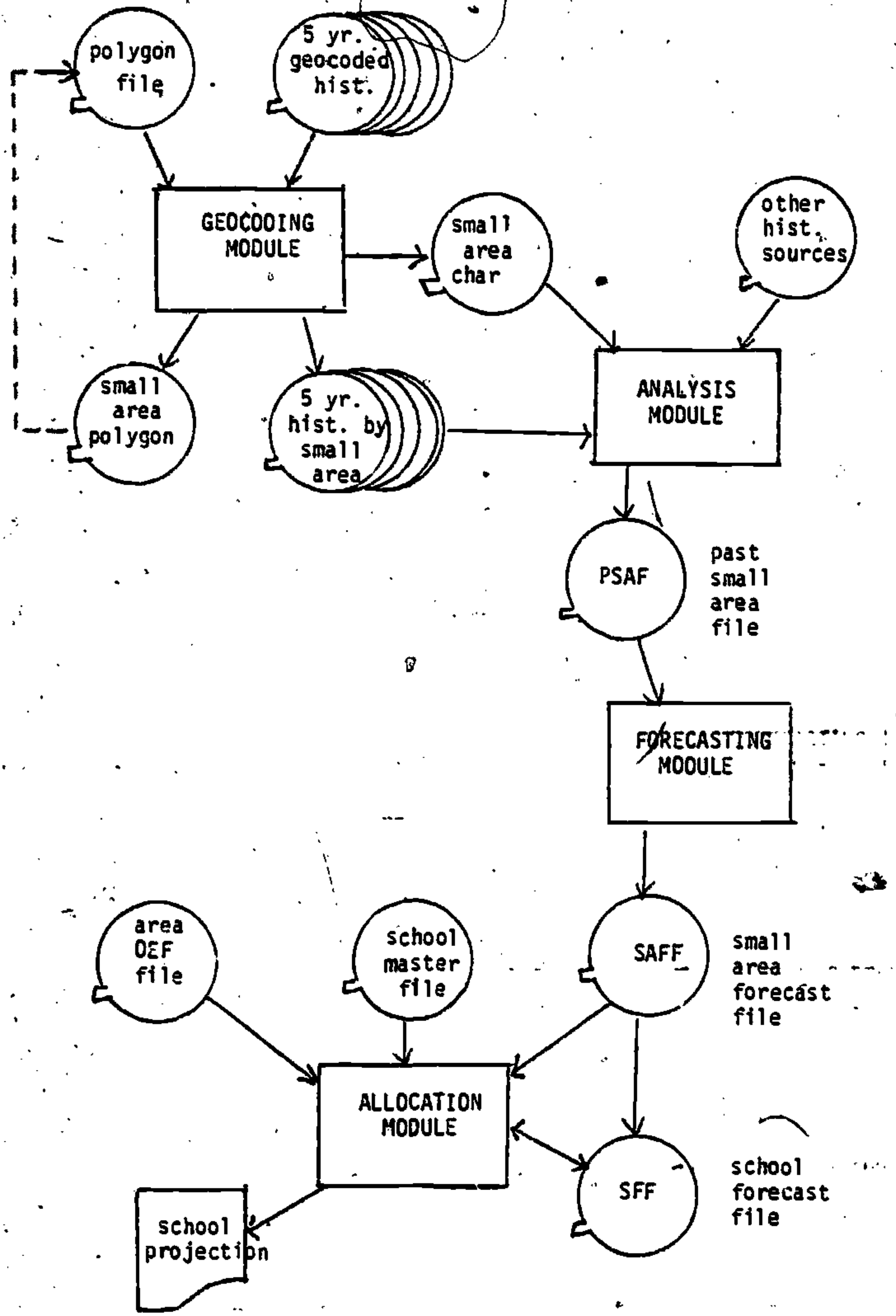
When a final well-clarified Area Definition File is selected, a complete set of forecasts for all schools in the system will be produced. The Area Definition Files could also produce maps showing the final boundaries of the proposed attendance areas. Alternative strategies can be developed and compared quickly using this system.

Once the system has been completed and tested, the yearly production cycle will be straightforward and require relatively little maintenance. On a yearly basis, production would begin as soon as a reliable geo-coded student file is available for the year. If new small areas need to be drawn, this could be done at that time. The new geo-coded student master file would be assigned its small area numbers and passed on to the analysis module, where a new PSAF will be created to show the five-year school enrollment history of each small area. The forecasting module will prepare new forecasts by small area.

At the same time, strategies are to be developed to reflect changes in facilities management requirements. A series of Area Definition Files will be generated. When the analysis and forecasting are completed, a series of School Forecast Files will be prepared, and modified by the realignment of small areas. At that time the computer could produce a clear-cut set of alternative strategies for consideration by District management staff.

FIGURE 6

Small Area Forecasting-System Flow Chart



Summary

With the recent implementation of the Seattle Desegreation Plan, a new enrollment projection methodology was deemed necessary for the Seattle Public School District. A new methodology has been designed and is presently ready for testing and validation.

The new methodology will utilize Markov chain theory to assign a ratio value to the smallest indivisible unit (3 or 4 students per grade level) that represents the probability that each student will stay in his/her attendance area. The ratio will be based on residential, land-use, and birth rate variables representing changes in the city, student grade, race/ethnic group, age, SES data, measures of student turnover/persistence, and student assignment data. Projections for the individual schools, upon incorporation of relevant past enrollment trends, will be accomplished when the methodology simulation subprogram aggregates students into an attendance area.

The new methodology represents the needed tool, with its simulation capabilities, for comprehensive school district planning for declining enrollment and desegregation. The simulation model enables Seattle School District staff to project school enrollments under alternative desegregation strategies, alternative school closures, and alternative boundary changes. Decisions on policy and district structure can be made on this basis with a good idea of the impact of the changes.

The technique which capitalizes on a complete geo-coded-student-file represents a new approach to individual school level enrollment projection methodologies.

Appendix A

TABLE A-1
COHORT SURVIVAL METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
The cohort survival methodology assumes that a consistent number of students pass from one grade to the next from year to year and that a percentage of of such occurrences can be calculated. On the basis of a combination of "percentage of survival" and an enrollment baseline, enrollments for upcoming years can be projected.	The "percentage of survival" - most often the average of three to five years of past enrollment, and sometimes weighted to give the year closest to the projected year more explanatory power - is multiplied by the previous year's enrollment for the previous grade to project future enrollment for a particular grade level. A variation is used to project the first grade or kindergarten: For kindergarten, the survival ratio is calculated by dividing the number of kindergarteners for one year by the number of births in the area five years prior. (continued)	The formula[1] to describe the cohort survival methodology for a particular grade level appears below: $P_{ij} = \frac{E_{i-1,j-2}}{E_{i,j-1}} \times E_{i-1,j-1}$, Where: P_{ij} = Projected enrollment for grade i and year j; E=Enrollment for grade i and year j. [1] Illustrated based on survival ratios built on two years of past enrollment data.	Two to five years of past enrollment in the district by grade level. Annual resident births in the area.	The technique usually provides very accurate projections for the district. It allows for a system-wide view of student flow. (Brown, 1975) The technique is very easy to calculate. It is inexpensive. The data required is usually readily available. Most of the time cohort survival is considered superior to the ratio and time-series analysis techniques. (Watson, 1975) Cohort survival analysis has considerable statistical validity. (Lyell & Toole, 1974)	Most useful under stable system conditions (Webster 1971). the cohort survival methodology requires flow data for proper utilization (i.e., need information on the movement of each pupil each year which is usually unattainable). (Brown, 1975) The methodology cannot provide an explanation as to why a pattern of enrollment exists. Changes other than those as a function of time cannot be accounted for. Two methods are actually used to make projections (i.e., (continued)

TABLE A-1 (contd.)
COHORT SURVIVAL METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
	The ratio (averaged) over a particular number of years) is then multiplied by the number of live births five years prior to the kindergarten year being projected. First grade uses the identical principle, utilizing births in the area six years prior to the first grade enrollment being projected. First grade-to-kindergarten ratios are then established to project kindergarten.				birth ratios and past enrollment ratios). The methodology ignores current trends, therefore requires subjective adjustments. Since the predictor (enrollment for the previous grade) is time-lagged by one year, and is applied to estimates for the next year, and so on for the number of years being projected, any serious errors in the predictors will be compounded. (Charters, 1971)

TABLE A-2
REGRESSION ANALYSIS METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
Regression analysis as an enrollment projection methodology is a specification of a functional relationship between exogenous external variables and enrollment variables. The methodology seeks out factors to explain changes in the district, grade and/or school enrollments. The methodology transfers the problem of enrollment forecasting to that of forecasting the exogenous variables.	Degree of association between the exogenous external variables and enrollment variables are calculated via coefficients of correlation and multiple correlation to locate significant relationships. The parameters of the functional relationship are estimated on the basis of historical data for the values of the enrollment and exogenous independent variables. A statistical trend is identified by the independent variables and extrapolated to arrive at the projections for the coming years.	The regression analysis enrollment forecasting model is identical to that of the traditional regression model. $Y = a + b_i X_i$, where: in the enrollment forecasting case, Y represents the predicted grade, school or district enrollment (criterion a is the historical enrollment base of the criterion.) b_i = the relationship ratio between predictor and criterion. X_i = predictor variable where i can represent 1 to an infinite number of predictors.	Just about any type of data can be used dependent upon the relationship to enrollment trends. examples are: Births by city. Past district enrollment by grade. City occupied housing units. Number of school age children by type of dwelling.	Relatively easy to apply. (Webseter, 1971) Can bring in many variables and many possible combinations of variables to predict future enrollment. (e.g., tuition rates, unemployment rates. land use variables, resident births and deaths. migration, ethnic grouping). Once the key exogenous variables and time lags have been determined, enrollment changes can be easily explained. (Brown. 1973) Can be used equally (continued)	Because of its easy applicability to a given district. the estimation problem may be over-simplified, (a few variables should be included when fewer numbers could provide more adequate projections). (Webster, 1971) Cannot theoretically take a number of predictor variables and select from them the "best" regression equation due to small degrees of freedom associated with projecting local school enrollment (no elimination). (Webster. 1971) (continued)

TABLE A-2 (contd.)
REGRESSION ANALYSIS METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
				well with stable and unstable patterns. (Folk, 1975) Correlation coefficient in the model can provide direct test for the amount of variance explained by the variables. (Charter, 1971)	May be difficult to determine appropriate exogenous variables. The acquisition of the appropriate data may be quite costly. (Brown, 1973) Extreme caution must be taken in interpreting the results. (Lyell & Toole, 1974) Extreme care must be taken in the design of the model. Correlation between the enrollment and a variable may result in the absence of a functional relationship. (continued)

TABLE A-2 (contd.)
REGRESSION ANALYSIS METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
					Assumptions about the extrapolation of a trend are almost always made a priori. (Folk, 1975) Variables must be empirically tested for a given population before they can be confidently placed in an enrollment prediction equation.

TABLE A-3
RATIO METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
The ratio method is essentially a class of enrollment forecasting methodologies which employs the ratio of a predictor to a criterion in the past, to project for a future time. Ratio methods make the assumption that a continuing functional relationship exists between the predictor and criterion. Cohort survival is a grade level-to-grade level ratio method for projecting grade level enrollment.	One of the easiest techniques to employ, the ratio methodology, produces a projected enrollment by multiplying a predictor to criterion ratio representing an estimated enrollment rate, by a predictor (e.g., a school enrollment to district enrollment ratio based on past years' values can produce a future enrollment for the school once multiplied by a base enrollment figure for the district.)	The model varies dependent on the variables utilized, but can be illustrated in the following manner: $Y_j = bX_j + cX_{j+1}$ where Y is the enrollment being projected. $X_j \ldots X_{j+n}$ is a predictor of the enrollment. Variables b, c, etc., represent the ratio of predictor to criterion.	City school age population. Past enrollment, either grade school or district level. Births by city. Land use variables.	Relatively easy to apply. (Webster, 1971) Easy to explain to policy makers. (Lyell & Toole, 1974) Requires a minimum of data. Data requirements can be adjusted to what is available. Ratios can be different for each subgroup of the total group being projected - based on sub-group individual differences. Usually results in accurate projections on the sub-group basis. (Hesse & Bernhardt, 1979) Most direct way to project enrollments.	Because of its easy applicability to a given district, the estimation problem may be oversimplified. (a few variables should be included when fewer numbers could provide more adequate projections). (Webster, 1971) Factors causing a ratio to vary may be overlooked resulting in inaccurate forecasts. (Lyell & Toole, 1974) Variables need to be empirically tested before being used for projections. Research must be done to discover the predictor variables to provide the best estimates of enrollment.

TABLE A-4
MARKOV METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
The Markov Methodology, also called a linear flow model, (Lyell & Toole, 1974) is a multi-stage stochastic process that expresses future enrollment in terms of present enrollment within the system. The process utilizes Markov chain theory to estimate the probability of students advancing to a grade in a successive year, independent of the present year's development. The probability ratios, called transition ratios, are calculated for each grade level and can describe the proportion of students who drop out or in, skip grades, etc. (Folk, 1975; Grace, 1975). The following assumptions are implied within the model: (continued)	At a given time students are classified in a particular grade. Fractional flow rates between grades are estimated and then multiplied by enrollment figures for a base year. New admissions are added to the resulting numbers to arrive at the next year's projections. The process is repeated for the number of years to be projected. The output of any year serves as the input for the next year. (Lyell & Toole, 1974; Grace, Hansen, & Trommeleau, 1975; Folk, 1975)	The basic equation, supplied by Grade (1975) displays the expected grade distribution at a year (t) as the transformed grade total for the previous year (t-1), plus the new entrants: $E[S_j(t)] = \sum_{i,j=1}^{12} P_{ij} \times E[S_i(t-1)] + N(t) \times P_{o,j}$ Where: $S_j(o), j=1,2 \ldots 12$, is the initial grade size. $S_j(t), j=1,2 \ldots 12$, is the grade size at (continued)	Number of births Entering rates for the base year enrollment. Amount of migration to and from each grade	Provides a system wide view of student flow. Conceptually simple (Lyell & Toole, 1974) Flow parameters are easily estimated from current data (Lyell & Toole, 1974) Number of grades can be expanded to give the model the disaggregate form required for some cost procedures.	Requires flow data which is not always available. Most useful under stable conditions. Assumes that changes occur only at one year intervals. Has not been proven to be very accurate. (Lyell & Toole, 1974) Assumptions may be too rigid (i.e., ignores trends and assumes the next step is a function of present state of affairs). Ignores all extraneous variables. Cannot incorporate the estimated number of students (continued)

TABLE A-4 (contd.)
MARKOV METHODOLOGY

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
1) Changes in the educational system and the progress of students occur only at a specified time, once a year. 2) All new entrants enter grade one. 3) A student never re-enters once he/she drops out of school. 4) No student advances more than one grade at a time or is demoted. 5) The nth step transition probabilities are invariant with time and do not depend on the number of steps (n) taken to attain state (j). (e.g., the probability of a student repeating a grade does not change no matter how many times the student has repeated a grade.) (Grace, 1975)		time t to t+1, expressed in vector notation as S(t). N(t) is the expected number of new entrants to the system at time t. $P_{i,j}$ is the probability that a student advances from grade i to grade j. $P_i = 1 - \sum_{j=1}^{12} P_{ij}$ is the probability of loss from grade i. $P_{o,j}$ is the probability of a new entrant entering grade j.			entering at times other than the beginning of the year. The method's iterative technique compounds errors (Lyell & Toole, 1974. Individual rather than aggregated in data input; expensive in terms of data collection and computer time. Depends only on the present and not on the past. Assumes transition probabilities are the same from year to year. (Denham, 1971). Births and migration are logically difficult to express as percentages. (Denham, 1971) The nature of the Markov assumptions mask important trends or characteristics of the historical data base. (Lyell & Toole, 1974)

TABLE A-5
COMBINATION OF METHODOLOGIES

DESCRIPTION	TECHNIQUE	MODEL	DATA REQUIREMENTS	ADVANTAGES	DISADVANTAGES
Methodology which utilizes a combination of appropriate enrollment forecasting methodologies to expedite accuracy.	Technique is to find the most accurate means of predicting sub-groups (e.g., individual grade levels or schools) and combine methodologies to predict the overall school district enrollment.	Additive of a variety of models.	Variable	Based on the individual needs of a school district. Very accurate means of projecting individual school enrollment. Enables individual differences in grade levels and attendance areas to be acknowledged. Enables a methodology change if data for a sub-group is unavailable. Can be inexpensive to implement. Excellent technique for projecting districts with different demographic characteristics. (Hesse & Bernhardt, 1979) Most likely method to enable quantification of the subjective in terms of school attendance area.	Requires much research to discover the most accurate methodology for each sub-group. Deal with very small n's at times.

References

References

Bailey, Jerry D. Declining Enrollments and School Closings. Lawrence, Kansas; Kansas University, 1977. (ERIC Document Reproduction Service No. ED 143 099)

Berman, Paul, and McLaughlin, Milbrey W. The Management of Decline: Problems, Opportunities, and Research Questions. The Rand Paper Series P-5984. Washington, D.C.: National Institute of Education (DHEW), Finance and Productivity Group, August 1977. (ERIC Document Reproduction Service No. ED 147 953)

Bowman, James; Hyde, Keith; Pritchard, Joseph and Wetter, Donald School Enrollment Projections, A Report. Des Moines, Iowa; Des Moines Public Schools, December 1975. (ERIC Document Reproduction Service No. ED 144 259)

Box, George E.T., and Jenkins, Gwilyn M. Time Series Analysis Forecasting and Control. San Francisco; Holden-Day, 1970.

Braden, Barbara and Others. Enrollment Forecasting Handbook Introducing Confidence Limit Computations for a Cohort-Survival Technique. Newton, Massachusetts; New England School Development Council, 1972. (ERIC Document Reproduction Service No. ED 066 781)

Britney, Robert R. Forecasting Educational Enrollments; Comparison of a Markov Chain and Circuitless Flow Network Model. Socio-Economic Planning Sciences, April 1975, 9 (2), 53-90.

Brown, Daniel J. A Smoothing Solution to the School District Enrollment Projection Problem. Educational Planning, May 1975, 2 (1), 13-26.

Brown, R.G. Smoothing Forecasting and Prediction of Discrete Time Series. Englewood Cliffs, N.J.; Prentice Hall, 1973.

Chang, Martha J. Demographic Trends Affecting State Educational Planning; A Florida Example. Educational Planning, October 1977, 4 (2), 48-63.

Charters, W.W., Jr. The Logic Behind Enrollment Forecasting. Administrator's Notebook, April 1971, 19 (8), 1-4.

Davis, Russell G., and Lewis, Gary M. Coping With Declining Enrollments. NASSP Bulletin, March 1977, 61 (407), 1-7.

Davis, Russell G., and Lewis, Gary M. The Demographic Background to Changing Enrollments and School Needs. Cambridge, Massachusetts; Center for the Study of Public Policy, 1976. (ERIC Document Reproduction Service No. ED 122 415)

Denham, Carolyn H. Probabilistic School Enrollment Predictions Using Monte Carlo Computer Simulation, Final Report. Chestnut Hill, Massachusetts; Boston College, 1971. (ERIC Document Reproduction Service No. ED 062 729)

Eisenberger, Katherine E., and Keough, William F. Declining Enrollment: What To Do. A Guide for School Administrators to Meet th Challenge of Declining Enrollment and School Closings. AASA Executive Handbook Series, Arlington, Virginia: American Association of School Administrators, 1974. (ERIC Document Reproduction Service No. ED 1:1 094)

Fascione, Daniel R., and Herron, William P. Projecting School Enrollments: A Research or Political Process? American Educational Research Association annual meeting. New York, February 1971. (ERIC Document Reproduction Service No. ED 047 369)

Finch, Harold L., and Tatham, Elaine L. Declining Enrollment: Why? What are the Trends and Implications?: and Enrollment Forecasting Techniques. Meeting on Coping with Declining Enrollments. Hyannis, Massachusetts, September 1975. (ERIC Document Reproduction Service No. ED 116 728)

Florio, David H. Declining Enrollment. A National School Board Association Conference Report. (Colorado Springs, Colorado) Washington, D.C.; National School Boards Association, August 1976. (ERIC Document Reproduction Service No. ED 149 481)

Folk, Michael. A Critique of Some Futures Prediction Techniques and their Implications for Educational Planners. Educational Planning, 1975, 2 (3), 35-52.

16:

Gilmore, William; Bay, Duane; Woollett, Morgan; and Cornish, Richard. ENSIM. A Users Manual for a Land Use Analysis-Based Enrollment Simulation. Research Report No. 11 of Project SimuSchool: Santa Clara County Component. San Jose, California: Santa Clara County Office of Education, September 1974. (ERIC Document Reproduction Service No. ED 096 751)

Grace, Michael; and Bay, Kyung S. A Random Walk Simulation Model for Enrollment Projections. Journal of Educational Data Processing, 1975, 12 (2), 10-12.

Grace, Michael; Hanson, John; and Trommeleu, Peter. Markov Chain Model for Enrollment Projections. Journal of Educational Data Processing, 1975. 12 (2), 1-9.

Hesse, Rose M., and Bernhardt, Victoria L. Handbook for Population Analysis for School Districts With Declining Enrollment. Eugene, Oregon; Planning Department/Research, Development and Evaluation, Eugene Public School District. February 1979.

Hunt, Lester B. Project SimuSchool: A Path Toward Better Planning. A Report on the Santa Clara County Component. Educational Planning, January 1976, 2 (3), 80-83.

Jaffe, A.J. Handbook of Statistical Procedures for Long-Range Projections of Public School Enrollment. Technical Monograph. Washington, D.C.: Office of Education (DHEW), 1969. (ERIC Document Reproduction Service No. ED 058 668)

Linebarger, Dean; Minana, Floyd; Cornish, Richard; and Hunt, Lester. ENSIM II; A Second Generation, Land Use-Based Enrollment Simulation Model User's Manual. Research Report of Project SimuSchool: Santa Clara County Component. San Jose, California: Santa Clara County Office of Education. (ERIC Document Reproduction Service No. ED 128 928)

Lyell, Edward H.: and Toole, Patrick. Student Flow Modeling and Enrollment Forecasting. Planning for Higher Education, December 1974, 3 (6), 7-10.

Mangelson, Wayne L.; Norris, Donald L.; Poulton, Nick L.; and Seeley, John A. National Enrollment Projection Studies. Planning for Higher Education, December 1974, 3 (6), 1-6.

Minnesota Association of School Administrators; Minnesota State Department of Education; and Minnesota State Planning Agency. Planning for Declining Enrollments. Planning Assistance Manual and Case Studies, St. Paul, Minnesota. July 1976. (ERIC Document Reproduction Service No. ED 128 919)

National Center for Education Statistics, Digest of Educational Statistics. Washington, D.C.; United States Government Printing Office, 1975.

National School Public Relations Association. Declining Enrollment: Current Trends in School Policies and Programs. Arlington, Virginia, 1976. (ERIC Document Reproduction Service No. ED 130 450)

Piele, Philip; and Wright, Darrell. Enrollment Forecasting. Educational Facilities Digest I. Columbus, Ohio; and Eugene, Oregon: Council of Educational Facility Planners, International; and ERIC Clearinghouse on Educational Management, University of Oregon, 1976 (ERIC Document Reproduction Service No. ED 117 782)

Sieradski, Karen. Implications of Declining Enrollments for Schools. NAESP School Leadership Digest Second Series, Number 4. ERIC/DEM Research Analysis Series, Number 19, Arlington, Virginia: National Association of Elementary School Principals, 1975. (ERIC Document Reproduction Service No. ED 114 906)

South Carolina State Department of Education. Declining Enrollment: Implications for South Carolina School Districts. Columbus, South Carolina: Office of Research, October 1977. (ERIC Document Reproduction Service No. ED 144 254)

United States Bureau of the Census. Current Population Reports, Series P-25 No. 601, Projections of the Population of the United States, 1975 to 2050. Washington, D.C.: United States Government Printing Office, 1975.

Wasik, John D. A Review and Critical Analysis of Mathematical Models Used for Estimating Enrollment in Educational Systems. Raleigh, North Carolina: Center for Occupational Education. North Carolina State University 1971. (ERIC Document Reproduction Service No. ED 059 545)

Watson, Cicely. Projection Notes I. Educational Planning, May 1975, 2(1), 35-56.

Watson, Cicely. Projection Notes II. Educational Planning, 1976, 3(1), 22-37.

Webster, William J. An Empirical Comparison of Selected Enrollment Projection Formulas. The Journal of Educational Research, April 1971, 64 (8), 375-381.