Integrated Planning for School and Community

Stokes County Schools
October 24, 2005

Operations Research and Education Lab (OR/Ed. Lab)
Institute for Transportation Research and Education

North Carolina State University
Integrated Planning for Schools and Community (IPSAC)

A mathematical model for forecasting school enrollment and determining the optimal locations for new schools and attendance boundaries.

- Forecasting
- Planning Segment Analysis
- Land Use Studies
- School Enrollment Forecasts
- Location Optimization
- Attendance Boundaries Optimization
- Segment Level Scenario Builder
## OR/Ed. Lab Clients

| Alamance County Schools - 02, 03 |
| Asheboro City Schools - 04 |
| Bladen County Schools - 04 |
| Buncombe County Schools - 98, 99 |
| Brunswick County Schools - 03, 04, 05 |
| Chapel/ Carrboro Schools - 95, 96, 97, 98, 99, 00, 01, 02, 05 |
| Chatham County Schools - 04, 05 |
| Craven County Schools - 96, 97, 98, 99, 00, 01, 02, 04, 05 |
| Iredell-Statesville Schools - 98, 99, 00, 01, 02, 03, 04, 05 |
| Gaston County Schools - 98, 99, 00, 01, 02, 03, 04 |
| Granville County Schools - 02, 03, 04, 05 |
| Guilford County Schools - 94, 95, 96, 97, 98 |
| Harnett County Schools - 98, 99, 00, 01, 02, 03 |
| Haywood County Schools - 99 |
| Hoke County Schools - 99 |
| Johnston County Schools - 95, 96, 97, 98, 99, 00, 01, 02, 03, 04, 05 |
| Lenoir County Schools - 03 |
| Moore County Schools - 04 |
| Mooresville Graded Schools - 99, 00, 01, 04 |
| Nash-Rocky Mount Schools - 04, 05 |
| New Hanover County Schools - 95, 96, 97, 98, 99, 00 |
| Onslow County Schools - 03, 04, 05 |
| Orange County Schools - 95 |
| Randolph County Schools - 05 |
| Richmond County Schools - 00 |
| Rock Hill, SC School District #3 - 02, 03, 04, 05 |
| Pitt County Schools - 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 00, 01, 02, 03, 04 |
| Union County Schools - 99, 00, 01, 02, 03, 04, 05 |
| Wayne County Schools - 95 |
| Wake County Schools - 97, 04, 05 |
Integrated Planning for School and Community
Stokes County Schools

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Historical Data

- Stokes County Births from 1996 to 2003
  (NC Department of Health and Human Services)

- Stokes County Schools First Month School Average Daily Membership from 2000-01 through 2005-06
Stokes County Births History

1996-2003: ~ 3 Additional Live Births per Year

Resident Live Births

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<tr>
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<th>Live Births</th>
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<td>2003-04</td>
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Stokes County Schools Enrollment History

~19 New Students per Year

Average Daily Enrollment

- 2000-01: 7316
- 2001-02: 7404
- 2002-03: 7436
- 2003-04: 7433
- 2004-05: 7316
- 2005-06: 7412
Forecasting

- For known data, the Cohort Survival Ratio (CSR) is the ratio between the number of students in two consecutive years.

- Example: Suppose there were 500 students in grade 1 district-wide for one year. The following year, there were 520 students in grade 2. The CSR for that time period would be $520/500 = 1.04$. 
Forecasting

- For projections, the known CSR values for five previous years are averaged using various weighting schemes. Traditionally, the 1,1,1,1 and 4,3,2,1 weightings are used.

- For Stokes County Schools, optimal weighting provided the most aggressive projections consistent with historical growth patterns.
Optimal Weighting

Enrollment Forecast

- K to 5
- 6 to 8
- 9 to 12

Year:
- 2000-01
- 2001-02
- 2002-03
- 2003-04
- 2004-05
- 2005-06
- 2006-07
- 2007-08
- 2008-09
- 2009-10
- 2010-11
- 2011-12
- 2012-13
- 2013-14
- 2014-15
- 2015-16

Students:
- 2000-01: 2061
- 2001-02: 1723
- 2002-03: 2154
- 2003-04: 1742
- 2004-05: 1688
- 2005-06: 1795
- 2006-07: 2210
- 2007-08: 2315
- 2008-09: 2280
- 2009-10: 2325
- 2010-11: 2455
- 2011-12: 2527
- 2012-13: 2560
- 2013-14: 2626
- 2014-15: 2648
- 2015-16: 2731

Students: 2016-17: 2811
4,3,2,1 Weighting

Enrollment Forecast

K to 5
6 to 8
9 to 12
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Stokes County Schools

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Planning Segments

94 planning segments

Avg. number geocoded 2004-05 students by segment: 75
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Why Land Use Studies?

- Include stakeholders and communities’ perceptions on growth issues in the county
- Validate perceptions through Geographic Information Systems (GIS) data analysis
- Articulate growth potential in terms of school attendances (Allocation of Gain)
Land Use Study: Interviews

Information gathered:

- Key trend indicators
- Growth
- Infrastructure—transportation, water/sewer
- Anticipated non-residential development
- Anticipated residential development
Key Trend Indicators—Population

- 2000-2003 population increase of 2.1% for Stokes County compared with the state average of 4.65% in the same period
- 2004-2009 Stokes County growth projected at ~415 additional persons per year, through 2009
- Municipal population changes 2000-2003—greatest increases; King 2.3%
- Growth in Yadkin Township / King Area
Stokes County Population Distribution

- 10.42%
- 8.23%
- 14.44%
- 11.46%
- 12.44%
- 13.08%
- 19.36%
- 10.57%
- 11.46%
- 12.44%
Stokes County Population Distribution

- 10.42%
- 8.23%
- 14.44%
- 43.01%
- 11.46%
- 12.44%
Key Trend Indicators—Employment

- Stokes County unemployment rate has consistently been slightly lower than the state average
  - 4.8% (Stokes County) vs. 5.0% (North Carolina) in May of 2005
- Major employers of the county are (1) School System, (2) County Government, and (3) Medical service and General Practitioners
- Big Oaks Industrial Park will be the site of the Forsyth Technical College’s Emergency training center
Factors Encouraging Growth

- Population Growth primarily through new subdivisions
- Popularity as relocation area or alternative to other Triad Area Counties
  - Small-Town Community
  - Family Environment
  - Strong Community Values
  - Lower-Cost family oriented subdivisions / developments
- Availability of municipal water in the King Area
- Availability of municipal sewer service in King
Growth Constraints

- Distance to employment centers in the Triad, i.e. Greensboro and High Point
- Sauratown Mountain Range
- Lack of High-Volume Thoroughfares in the Southeastern Portion of the County
- Soil constraints to onsite waste disposal in the Meadows and Sauratown Townships
Infrastructure—Transportation

- **Current capital improvements:**
  - Northern Beltway around Winston Salem
  - Interstate 74 project (reclassification of Highway 52)
    - Interchange at Main St. in King
    - Interchange in the Pinnacle Community, Pearch Rd.
  - Highway Widening Projects in King
Infrastructure—Water/Sewer

Water:

- King, Walnut Cove, Danbury all have public water systems
  - King currently at 62% of capacity
  - Walnut Cove and Danbury are both at approximately 80% capacity
- King Planning Expansion to Yadkin River Plant
- Water Line Extension North along Highway 66 to Sauratown Fire Department
Infrastructure—Water/Sewer

Sewer:

- King, Walnut Cove, and Danbury have Treatment Plants
  - King is at 49% of capacity
  - Walnut Cove has excess capacity
  - Danbury at capacity
- King Sewer Expansion to Intersection of Highway 66 and Mountain View Rd
Non-Residential Development

- Forsyth Technical College’s Emergency Training Facility at Big Oaks Industrial Park
- Small, Service Businesses Opening in the King Area
Characteristics of residential growth:

- Subdivisions in the King Area / Yadkin Township
- Average of 30 Lots per new development
- 3-5 year build out
- Average Price of $210,000
- Real Estate Market is targeted in this area at young, established families, relocating to the area from other parts of the Triad
Residential Development

- **Current Approved Subdivisions**
  - Chelsea Ridge, Spainhour Road: 52 lots In Construction
  - Moser Farms, Hwy 66 / Mountainview Rd: 82 lots & 83 townhomes
  - Oakmont, Goff Rd: 42 lots In Construction
  - Braywick, White Rd: 62 townhomes In Construction
  - Water’s Edge Apartments: 288 units, Pending Approval
  - Plantation Point, Plantation Dr: In Construction
Residential Development

- **Subdivision / Development Statistics**
  - 706 Residential Lots Approved
  - 220 Currently Available
  - Typical Build out of 3-5 Years

- 392 Apartments and Townhomes Approved
  - 40 In Construction Now
Summary

- Development of Stokes County Currently Concentrated in the King / Yadkin Township Area
- I-74 / Northern Expressway
- Sewer Expansion from Forsyth Utilities
- Continued Commercial Development in the Triad Area
Land Use Studies: Geographic Information Systems (GIS) Data Analysis

- Data Preparation
- Student Generation Rate
- Allocation of Gain
GIS Analysis: Data Preparation

GIS county parcel data

- Geocode 2004-05 students to parcels or streets (>92%)
- Identify residential subdivision parcels
  - Developed parcels
  - Available parcels
Parcel level GIS analyses

Calculation of Student Generation Rates

- Total Students: 47
- Total Developed Parcels: 176
- SGR: 0.267

Subdivision Parcel Analysis

Undeveloped Subdivision Parcel
GIS Analysis: SGR

- Student Generating Rate (SGR) is the ratio of students per developed parcel.
- Baseline SGR for Stokes County Schools: For every 100 developed subdivision parcels, approximately 38 students are generated.
Allocation of Gain computations

- **Student Generation Rate (SGR)** =
  \[
  \frac{\text{# of Students}}{\text{# developed parcels in subdivisions}}
  \]

- **# available parcels** = (# parcels in subdivision - # developed parcels in subdivisions)

- **Gain** = SGR*(# available parcels)

- **Allocation of Gains (AOG):** apportioning gains among school districts.
# AOG for Elementary Schools

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<th>SGR</th>
<th>AOG</th>
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<td>Francisco Elem</td>
<td>0.02</td>
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<td>Lawsonville Elem</td>
<td>0.13</td>
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<td>Sandy Ridge Elem</td>
<td>0.48</td>
<td>-1.9%</td>
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<tr>
<td>Nancy Reynolds Elem</td>
<td>0.40</td>
<td>-4.6%</td>
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<td>Germanton Elem</td>
<td>0.46</td>
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<td>London Elem</td>
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<td>Pine Hall Elem</td>
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<td>Walnut Cove Elem</td>
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<td>King Elem</td>
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<td>Pinnacle Elem</td>
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Total: 100.0%
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- **School Enrollment Forecasts**
- Location Optimization
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# Stokes County School System Out-of-Capacity Worksheet

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- **Adequate Capacity**
- **Two-year Warning**
- **Out of Capacity**
2005-2006 School Building Occupancy

- Francisco: 82%
- Nancy Reynolds: 99%
- Piney Grove: 97.5%
- North Stokes: 64%
- Lawsonville: 154%
- Southeastern: 98%
- Sandy Ridge: 92%
- South Stokes: 76%
- Chestnut Grove: 100%
- West Stokes: 102%
- Pine Hall: 72%
- Germanton: 74%
- King: 109%
- Mt. Olive: 179%
- Pinnacle: 145%
- Walnut Cove: 99%
Integrated Planning for Schools and Community
Stokes County Schools

- Forecasting
- Planning Segment Analysis
- Land Use Studies
- School Enrollment Forecasts
- Location Optimization
- Attendance Boundaries Optimization
- Segment Level Scenario Builder
Location/Attendance Boundary Optimization

- Optimization algorithm produces optimal solution minimizing system-wide transportation costs while satisfying constraints
  - Minimization of the transportation costs
    - Contiguous attendance regions
  - Constraints
    - Existing and new school capacities
    - Demographic balance
    - Socio-economic balance
Optimization algorithm generates numerous scenarios until an optimal solution is produced while satisfying given constraints.
High School Scenario Setup

Strategies

- Optimal high school attendances minimizing distance traveled, systemwide
- Optimal high school attendances minimizing distance traveled while equalize school occupancies
- Optimal attendances between South and West high schools
Stokes County School System 2006-07, High School Scenario 1, Optimization of Boundaries for High School Minimizing Distance Traveled. No Occupancy Restrictions. Systemwide

Legend
- roads
- hydro_layer
- North Stokes High - Piney Grove Middle
- South Stokes High - Southeaster Stokes Middle
- West Stokes High - Chestnut Grove Middle
- North Stokes High
- South Stokes High
- West Stokes High
Stokes County School System 2006-07, High School Scenario 2, Optimization of Boundaries for High School Minimizing Distance Traveled. Balancing Occupancy 83%
Stokes County School System 2006-07, High School Scenario 3, Optimization of Boundaries for High School Minimizing Distance Traveled. Current Boundaries North Stokes High School

Legend
- roads
- hydro_layer
- North Stokes High - Piney Grove Middle
- South Stokes High - Southeaster Stokes Middle
- West Stokes High - Chestnut Grove Middle
- North Stokes High
- South Stokes High
- West Stokes High
## High School Scenarios Results

### Student Statistics (Middle and High Schools) for Stokes County Schools under High School Scenario 1

<table>
<thead>
<tr>
<th>Level</th>
<th>School</th>
<th>Capacity 2005-06</th>
<th># Students 2006-07</th>
<th>% occupancy</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Chestnut Grove</td>
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<tr>
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<td>94.25</td>
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</table>

### Student Statistics (Middle and High Schools) for Stokes County Schools under High School Scenario 2

<table>
<thead>
<tr>
<th>Level</th>
<th>School</th>
<th>Capacity 2005-06</th>
<th># Students 2006-07</th>
<th>% occupancy</th>
<th>Distance</th>
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<td>High</td>
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### Student Statistics (Middle and High Schools) for Stokes County Schools under High School Scenario 3

<table>
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<tr>
<th>Level</th>
<th>School</th>
<th>Capacity 2005-06</th>
<th># Students 2006-07</th>
<th>% occupancy</th>
<th>Distance</th>
</tr>
</thead>
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<td></td>
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</tr>
<tr>
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<td>1130</td>
<td>1028</td>
<td>90.97</td>
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</tr>
</tbody>
</table>
Observations:

- Reduction in distance traveled by high School students at the expense of increased middle school student travel distance
- Systemwide high school redistricting will have the most impacts to South and West high schools
- High school redistricting to equalize occupancy will negatively impact middle school occupancy balance
- Not possible to redistrict to benefit high and middle while maintaining clean feeder pattern
Can clean feeder pattern be maintained by redistricting middle and elementary schools?

Strategy

- Minimizing distance traveled by Middle School Students keeping clean feeder pattern for all levels.
- Since this scenario reduced distance traveled by high school students simultaneously, these boundaries were used as “template” for redistricting Elementary Schools.
Stokes County School System 2006-07, Middle School Scenario, Optimization of Boundaries for Middle and Elementary Schools Minimizing Distance Traveled. No Occupancy Restrictions. Systemwide

Legend

- Chestnut Grove
- Francisco
- Germanton
- King
- Lawsonville
- London
- Mount Olive
- Nancy Reynolds
- Pine Hall
- Pinney Grove
- Pinnacle
- Sandy Ridge
- Southeastern Stokes
- Walnut Cove

roads
hydro_layer

- Chesnut Grove Midd
- Pinney Grove Midd
- Southeastern Stokes Midd
## Middle School Scenario Result

<table>
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<tr>
<th>Level</th>
<th>School</th>
<th>Capacity</th>
<th># Students</th>
<th>% occupancy</th>
<th>Distance</th>
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<td>168</td>
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<tr>
<td></td>
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<td>146</td>
<td>148</td>
<td>101.37</td>
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<td></td>
<td>Lawsonville Elementary</td>
<td>157</td>
<td>186</td>
<td>118.47</td>
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<tr>
<td></td>
<td>Sandy Ridge Elementary</td>
<td>220</td>
<td>203</td>
<td>92.27</td>
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<tr>
<td></td>
<td>Germanton Elementary</td>
<td>335</td>
<td>246</td>
<td>73.43</td>
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<tr>
<td></td>
<td>London Elementary</td>
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<td>336</td>
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<tr>
<td></td>
<td>Walnut Cove Elementary</td>
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<td>99.00</td>
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<tr>
<td></td>
<td>Pine Hall Elementary</td>
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<td>178</td>
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<tr>
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<td>Pinnacle Elementary</td>
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<td>244</td>
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<td><strong>High</strong></td>
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<td>1131</td>
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</tbody>
</table>
Observations

Middle School Scenario 2

- Reduced Distance for all levels
- Maintained Clean Feeder Patterns
- Improved out of capacity and under utilization for Elementary and Middle School Levels
- Balanced occupancy among Elementary Schools at West district but does not solve out of capacity problem for these schools.
- Requires only slight changes in current boundaries.
- Short term solution, need a new elementary school.
Stokes County School System 2006-07, Elementary School Scenario, Optimization of Boundaries for Elementary Schools in West Stokes and South Stokes Districts. Occupancy 89%

Legend
- King
- Queen
- Mount Olive
- New Elementary ES_4
- Pinnacle
- roads
- hydro_layer
- ES_4_moved_segments
- King Elem
- Mt Olive Elem
- Pinnacle Elem
## Elementary School Scenario Result

<table>
<thead>
<tr>
<th>Level</th>
<th>School</th>
<th>Capacity 2005-06</th>
<th># Students 2006-07</th>
<th>% occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nancy Reynolds Elementary</td>
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<td>177</td>
<td>99.43</td>
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<tr>
<td></td>
<td>Francisco Elementary</td>
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<td></td>
<td>Lawsonville Elementary</td>
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