LinSig Overview

An Introduction to LinSig

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Safety Moment

• Raise your hand if you check your blind spot when exiting the car.
• Raise your hand if you ride a bike and have had a car door open on you.
• In the UK between 2004 and 2020, serious injuries (adjusted) rose by 26% whilst pedal cycle traffic grew by 96% in this same period.
• The 3 most common contributory factor assigned to both pedal cyclists and other vehicle types was ‘failed to look properly’ followed by a failure ‘to judge other person’s path or speed’ and ‘Driver or rider careless, reckless or in a hurry’.
• A method known as the "Dutch reach" has been introduced to the Highway Code in the UK; The practice is used widely across Europe and encourages people to open vehicle doors with their opposite hand to avoid injuries to passing cyclists.
Who am I?

- My name is Jacob Hughes and I have been using LinSig for 7 years, working for AECOM throughout that time.
- Based in the Manchester office, though been part of Bristol and Exeter Streets teams too.
- Modelled many complex signalised junctions and networks across the UK and Ireland.
- Provides checking/verification of internal modelling deliverables and thorough audit checks of external models.
- Have run the AECOM LinSig training courses alongside Roger since 2018.

- Please place any questions you have in the chat.
Who am I?

• My name is Roger Dickinson and I have been using LinSig for 25 years.
• Worked for AECOM for over 22 years. Based in the Exeter office
• Seconded to Transport for London for 3 years
• Modelled many complex signalised junctions and networks across the UK and Ireland.
• Have run the AECOM LinSig training courses since 2012.

• Please place any questions you have in the chat.
It will introduce the LinSig modelling software programme and cover:

- Basic Modelling Theory
- Data Input
- Model Validation
- Model Results
- Other features

Due to time limitations, we will not cover the process of building a LinSig model in detail.
LinSig Overview

What is LinSig and how it works
What is LinSig?

LinSig is a traffic modelling software tool used to assess the capacity of signalised junctions and small / medium sized networks, including roundabouts. It can also model priority-controlled junctions and roundabouts.

It has been developed by JCT Consultancy, who are based in Lincoln.

It allows the user to assess potential changes to the junctions relatively easily and has the ability to quickly eliminate unfeasible options before design work is undertaken.

It is compatible with how Signal Controllers work.

Also has a SCATS-based controller model and is widely used in Australia and New Zealand.
What is the scope of a LinSig model?
What is the scope of a LinSig model?
LinSig Theory – Flow Profile Graph

Arrive Profile
Accept Profile
Capacity of Stopline
Leave Profile

Queued traffic discharging during the green = red area of graph
Arrivals during the green
Arrivals during the red

0 15 30 45 60 75 90 105
0 300 600 900 1200 1500 1800 2100
Leave (flow) profiles moving through the network

J1: West Junction
- PRC: 48.5%
- Total Traffic Delay: 4.3 pcou/hr
- Controller: 1

J2: East Junction
- PRC: 72.8%
- Total Traffic Delay: 5.6 pcou/hr
- Controller: 2

Cycle Time: 90 secs

KEY
- Green Time
- Modelled Cruise Time

Lane J1.1/1 Flows
- 7 - 72
- 37 - 47

Lane J2.2/1 Flows
- +10 secs

Lane J2.3/1 Flows
- +11 secs

Arm J1.2 - North Street
- +10 secs

Arm J1.4 - Exit
- 5

Arm J1.1 - High Street
- 65

Arm J2.1 - East Street
- 51
LinSig Degree of Saturation & Practical Reserve Capacity

Degree of Saturation (DoS, %) is the proportion of how saturated a lane is compared to its capacity.

LinSig considers any lane over 90% DoS to be oversaturated (highlighting it in red) and provides a negative Practical Reserve Capacity (PRC, %) for the junction. PRC results per junction are based on the lane with the worst DoS.
Uniform Queuing (DoS < 80%)
- Queue grows and clears every cycle

Oversaturated Queuing (DoS > 110%)
- A residual queue remains at the end of the cycle and is carried over to the next cycle

Random Queuing (DoS between 80% & 110%)
- Random variations from cycle to cycle whereby a different number of vehicles get through the stopline
Mean Max Queue (MMQ)

- Maximum Back of Queue + Oversaturated & Random Queue
- The average value, over the peak hour, of the maximum queues occurring each cycle
- It is therefore difficult to validate the queue values against observations
- Queues less than $\frac{3}{4}$ of the available storage area are considered to contain the queue every cycle.
- Any MMQ exceeding the lane length will be highlighted red by LinSig.
Limitations of LinSig

- LinSig models an average cycle during the modelled hour, so it doesn’t replicate variations to traffic during the peak hour.
- Traffic entering the network is assumed to arrive with a flat profile across the cycle / peak hour.
- Queues in the LinSig model are assumed to stack “vertically”, so if a downstream link is full, the model will still send traffic through. It is not a microsimulation model. However, the use of Bonus Greens could be used to replicate how much effective green is available to replicate the downstream blockage.
LinSig Overview

What data is required for a LinSig model
What does LinSig look like?
Data Input – Information Needed

Network Information

• Signal Layout Drawing (lane widths, lane lengths, turning radii)
• Saturation Flows (lane capacities)

Signal Information

• For an existing Junction:
  • Controller Specification Document (phases, stages, intergreens, phase delays & prohibited stage movements)
  • Signal Output Data (observed stage lengths, offsets, variable on-site intergreen times and demand dependency)

• For new junctions, these will need to be determined / calculated
Data Input – Information Needed

Site Visit

- Determine lane usage or flare (short lane) usage
- Vehicle behaviors (using the lanes they should)
- Saturation flows surveys (lane capacities)
- Under-utilised green time (exit blocking)
- Confirm or collect signal timings
- Cruise times (uncongested time between stoplines)
Examples of Controller Specification Documents
Calculation of Signal Information

- Chapter 6 of the Traffic Signs Manual (Traffic Control) 2019 is the guide to the modelling of signalised junctions in the UK.
- Transport for London also has some of its own guidance.
- It has a lot of information, including the calculation of intergreen times for vehicle, cycle and pedestrian phases (the safe time gap for one phase to stop and the next to start).
Data Input – Traffic Flows

- There are two methods – Matrix Based or Lane Based flows.
- Zones need to be created for each entry / exit point.
- A powerful matrix estimation tool can be used to create flow matrix from individual junction turning counts.
- The flows between junctions need to be fairly consistent to give an accurate matrix.
- Flows are then assigned to available routes by a delay-based assignment.
- Flows on routes can be fixed (i.e. bus lanes or observed unequal lane usage).
LinSig has a **formula flow function** that allows flow matrices to be factored up and matrices added to other matrices (i.e. base + development traffic)

**Base traffic flows**
- From observed traffic surveys, so DoS values should be <100%
- If junction is operating over capacity, you can add queuing traffic back into the model.

**Future year traffic flows**
- These could be from a strategic highway model
- So you need to be consistent junction capacities between the two models
- Some iterations between the two may be needed
Data Input – Other mode flows

- Buses can be input separately (with their own zones, bus speeds and time at bus stops)
- Cycle lane flows can be input with the traffic or with their own zones, but it is not possible to have separate cycle cruise speeds if they are mixed with traffic
- Pedestrian flows across junctions can be modelled. If not known, default values (i.e. 10 pedestrians per route) can be used to determine average delay per pedestrian
A key part of the model is how long it takes vehicles to get from one stopline to the next

- Measured from site observations (average of 10 readings, but vehicles must not be delayed)

- Calculated from average cruise speeds and travel distances (stopline to stopline distance and average speed for the movement)
LinSig Input

The majority of lane information is input in the Edit Lane box on the Network Layout View screen.

Connectors are where the stopline to stopline journey times are calculated.
LinSig Overview

Signal Timings
Signal Timings
The use of Bonus Greens can allow the effective green (the amount of green time observed over the modelled hour) to be replicated. It is used in the following scenarios:

- Demand Dependent Stages that don’t get called every cycle (reallocating green time)
- Under-utilised Green Time (exit blocking leads to traffic being unable to move through the stopline)
- A cycle advanced stop line delaying when the vehicles behind can start

The values are only applied to traffic lanes.
Modelling the Effective Green
LinSig Overview

Model Validation

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Base Model Validation

- Ensure models have the right capacity (saturation flow surveys if possible)
- Signal timings should be collected at the same time as the traffic surveys
- Junctions which operate under MOVA or VA control can be difficult to model as the green times and cycle time can vary throughout the modelled hour
Base Model Validation

Degree of Saturation
• Modelled values can be compared against observations for each stopline

Queue Length
• Observations can be compared, but you need to make sure they have been collected correctly
• The Mean-Max Queue is the average of all the maximum queues across the peak hour
• Comparing observed queues to queue graphs per lane

Journey times
• Can be done from zone to zone
• They can also be determined from stopline to stopline
• Can include buses and cycles (if modelled separately)
LinSig Overview

Signal Optimisation

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• Optimise signal timings for both Delay and PRC (Practical Reserve Capacity). PRC is linked to the DoS values.
• Optimise for Green Splits and Offsets (all timings) or just offsets (keeps the stage lengths the same) for networks
• You can fix specific stage lengths before optimising. You can also lock the offset of when Stage 1 starts.
• Optimiser weightings can ensure key movements are prioritised when the signals are optimised.
• There is a Cycletime Optimisation View that runs the models with a variety of cycle times.
LinSig Overview

Understanding LinSig Results
LinSig Results

Network (or individual junction) Parameters
- Practical Reserve Capacity (positive value means all DoS values are under 90%)
- Total Delay

Lane Parameters
- Degree of Saturation (aim to get under 90%)
- Mean Max Queue (aim to get them under 75% of the available storage area)
- Delays

DoS values may be under 90%, but the queues can be more than the storage!
LinSig Results

- Report Generator
- Network Layout View. Create your own text formats. Red Text (over capacity)
- Print Layout Mode
<table>
<thead>
<tr>
<th>Ref</th>
<th>Lane</th>
<th>Flow (pcu)</th>
<th>Degree of Saturation</th>
<th>Delay (s/pcu)</th>
<th>Mean Max Queue (pcu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>Albany Road (E/B) Ahead</td>
<td>338</td>
<td>24.4%</td>
<td>6.3</td>
<td>3.4</td>
</tr>
<tr>
<td>1/2</td>
<td>Albany Road (E/B) Ahead</td>
<td>391</td>
<td>26.3%</td>
<td>6.3</td>
<td>3.9</td>
</tr>
<tr>
<td>1/3</td>
<td>Albany Road (E/B) Right</td>
<td>289</td>
<td>51.2%</td>
<td>21.0</td>
<td>5.1</td>
</tr>
<tr>
<td>2/1</td>
<td>Albany Road (W/B) Left</td>
<td>329</td>
<td>22.0%</td>
<td>3.9</td>
<td>2.3</td>
</tr>
<tr>
<td>2/2</td>
<td>Albany Road (W/B) Ahead</td>
<td>426</td>
<td>36.0%</td>
<td>13.2</td>
<td>6.6</td>
</tr>
<tr>
<td>3/1</td>
<td>Wells Way Left</td>
<td>176</td>
<td>32.0%</td>
<td>33.1</td>
<td>4.1</td>
</tr>
<tr>
<td>3/2</td>
<td>Wells Way Right</td>
<td>217</td>
<td>72.8%</td>
<td>62.8</td>
<td>7.2</td>
</tr>
<tr>
<td>3/3</td>
<td>Wells Way Right</td>
<td>218</td>
<td>72.8%</td>
<td>62.7</td>
<td>7.2</td>
</tr>
</tbody>
</table>

**Cycle Time**: 104 secs

**Practical Reserve Capacity**: +23.6%

**Total Delay**: 14.08 pcuHr
LinSig Results

Flow Graphs

- Used to see when different platoons of vehicles arrive at downstream stoplines

Queue Graphs

- Used to see when during the cycle the maximum queue length is likely to occur
- If queues reach an upstream junction the graph will indicate when in the cycle it occurs
LinSig Results – Delays and Journey Times

- Zone to Zone Route Delays and Journey times (total and average per pcu)
- Journey times for discrete sections of a wider route can be determined manually by adding stopline delays to the cruise times for the section in question.
- Time Distance Diagrams to see how well the vehicle movements co-ordinate through the network
# LinSig Results – Pedestrian Journey Times

<table>
<thead>
<tr>
<th>Movement</th>
<th>Base (sec)</th>
<th>Proposed (sec)</th>
<th>Difference (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A to B</td>
<td>84.12</td>
<td>84.91</td>
<td>+0.79</td>
</tr>
<tr>
<td>A to C</td>
<td>81.78</td>
<td>82.13</td>
<td>+0.35</td>
</tr>
<tr>
<td>B to A</td>
<td>72.11</td>
<td>71.91</td>
<td>-0.20</td>
</tr>
<tr>
<td>B to C</td>
<td>157.23</td>
<td>149.34</td>
<td>-7.89</td>
</tr>
<tr>
<td>C to A</td>
<td>81.85</td>
<td>81.14</td>
<td>-0.71</td>
</tr>
<tr>
<td>C to B</td>
<td>160.30</td>
<td>152.35</td>
<td>-7.95</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>106.23</strong></td>
<td><strong>103.63</strong></td>
<td><strong>-2.60</strong></td>
</tr>
</tbody>
</table>

Pedestrian journey time is the delay time for pedestrians plus crossing time.
LinSig Results – Animation Mode

Queue Length as a proportion of the link length

Active Stage

Lanes on Green or Red

Animation Control Panel

Animation Mode

Time during the cycle
LinSig Overview

Other Features
LinSig Model Auditing – Model Audit View
# LinSig Model Auditing Checksheets

<table>
<thead>
<tr>
<th>Date</th>
<th>Date Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checker</td>
<td></td>
</tr>
<tr>
<td>Audit</td>
<td></td>
</tr>
<tr>
<td>Vendor</td>
<td></td>
</tr>
<tr>
<td>Approve</td>
<td></td>
</tr>
</tbody>
</table>

## Model Name

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Model Version</th>
<th>Lane Structure (Length, structure, short/long, Treat as Giveway &amp; Storage in front of structure)</th>
<th>Vehicle Flows</th>
<th>Pedestrian Flows</th>
<th>Route List</th>
<th>Phases (Streetcontroller, Phase Reference, phase durations, phase type)</th>
<th>Stage (Referencing, streams, stage sequence, stage group times)</th>
<th>Cycle Times</th>
<th>Inter-vehicle Timing</th>
<th>Phase Delays</th>
<th>Bonus Greed</th>
<th>Saturation Flows</th>
<th>Optimisation</th>
<th>Results (FRC, Entry, MMG)</th>
<th>Looking at model run</th>
<th>Error File</th>
<th>Calibration/Validation</th>
<th>Comparison with PM model</th>
</tr>
</thead>
</table>

- Green: Free
- Yellow: Consider, not essential
- Red: Needs addressing
- Note to auditor
- Yellow: Requires checking at a later date
- No checked, check not required
- Light Grey: No action / response required
- Dark Grey: Action taken
- Light Grey: No action taken
- Dark Grey: Still needs addressing
- Light Grey: Note to auditor

## Auditor Confirmation
LinSig Overview

The future of LinSig
LinSig has developed into the industry leading package for modelling small and medium sized signalised networks.

The current version of LinSig (version 3) was released back in 2009, but it has been updated over the years.

JCT Consultancy are looking to release version 4 in 2022, but the release has been delayed.

Version 4 is supposed to have some microscopic simulation function to model complex blocking back issues at standalone junctions, so Version 3 will still be used in the short term for simple LinSig modelling.
LinSig Overview

AECOM’s LinSig capability
AECOM has approximately 150 users of the software in 26 offices around the UK and Ireland.

Training has also been undertaken with AECOM staff from the GDC in Bangalore, India.
AECOM’s LinSig Training Capability

- “Introduction to LinSig” one-day training course has been run 32 times since 2012, training about 260 people, including people from outside AECOM.

- “Advanced LinSig Features” one-day training course has been recently been added to training offering.

- A two-part “Introduction to LinSig” bitesize course was run on Teams during the Covid Pandemic.
Thank you.

Please feel to get in touch to discuss any modelling issues

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