COMPUTER MODELS

• CRUCIALLY IMPORTANT FOR DESIGN
• Predict Capacities, Queue and Delays.
• Predict Accidents
• Determine geometry and ROW
• Basis of Evaluation
• Basis of Justification
• FOUNDATIONAL
• RODEL is a UK roundabout model
• Derives queues and delays from traffic & geometry
• Used UK empirical capacity equations
• Peak Hour divided into 1, 5, 10, 15 min slices
• Each slice is modelled
• Peak Hour evolves over time
  – Volumes
  – Capacities
  – VC Ratios
  – Queues
  – Delays
  – Exit volume
• UK has high traffic density

• Old Traffic Circles started grid-locking

• 1966 - **YIELD LINES** - Gridlock eliminated

• Surprising increase in capacity

• But some roundabouts still congested
POST 1966

• The Mini Roundabout was invented (TRL)
  – Stunningly successful

• Higher capacity than some large roundabouts?

• Yield line capacity not understood

• Traffic Circle capacity equations obsolete

• Yield line capacity model was needed
Problems with Capacity Prediction

- Gap Theory developed in UK (Tanner 1950’s)
- Gap Theory used to estimate roundabout capacity
- Many ‘at capacity’ roundabouts needed fixing
- Their capacity could be directly measured
- Gap Capacity and Measured could be compared
GAP Capacity

• Large disagreement with measured capacity
  – Predicted no congestion --------- when observed
  – Predicted congestion -------------- when not observed
  – Sometimes predictions ------------were reasonable
  – No consistency --------------------- very unreliable!

• Also weak Geometry / Capacity relationship
• Design was therefore very uncertain
• Many complaints to Central Government
Development of a Capacity Model

- UK Government commissioned the TRL
- Gave TRL an open check to derive capacity model
- Rod Kimber was Tanners successor at TRL
- Like Tanner he was keen on Gap Models
- He wanted a better Gap Model for roundabouts
- Measured capacity at ‘at capacity’ operation
- Measured the Gaps at ‘at capacity’ operation
- Formally compared Gap and Measured capacities
- Large disagreement
OBSERVED vs GAP CAPACITY (Single entry)
WHAT WAS HAPPENING
• Research started in earnest.
• Vehicles fitted with telescopic masts
• Fish-eye lens cameras on top of masts
• Parked in the middle of Central Island
• ‘At Capacity’ and ‘sub capacity’ operation filmed
• **This was a revelation**
  – At least 3 capacity mechanisms in addition to gap
  – As VC ratio rose these mechanisms grew in strength
  – They have a large effect on capacity
• Gap mechanism only a part of a complex situation
Problems with Capacity Prediction

- At capacity operation is very complex
- Impossible to separate each mechanism
- Impossible to relate each mechanism to geometry
- Concluded Gap Theory inadequate for roundabouts

- **Empirical model developed by TRL**
- **Capacity directly measures**
- **Capacity related to geometric variation**
- **Lab Report LR942**
EMPIRICAL CAPACITY MODEL

- Capacity measured at existing real world roundabouts
- 11,000 minutes of ‘at capacity’ operation
- Over 500,000 at capacity vehicle observed
- Very wide geometric range
- Very wide traffic volume range
- Sustained queues for more than 30 minutes essential
- Queues never less than 5 vehicles
- Test track experiments on geometry and capacity

- Cost 11 Million Dollars
EMPIRICAL CAPACITY MODEL

- Empirical Capacity Model published in 1980
  - TRL Lab Report LR942
- Accurate, stable, unchanged for 25 years
- Checked in 1997 against 35 Roundabouts
- Model confirmed - NO changes needed

- Very strong geometry / capacity relationships
- Revolutionised Roundabout design in UK
Empirical Equations were **revolutionary**

**Capacity is unbelievably sensitive to geometry**

Very counter intuitive - contradicts intuitive theory

Very powerful at achieving high capacity

Smaller - safer - higher capacity roundabouts
**EMPIRICAL MODEL**

- **UK roundabouts**
  - Have high capacity
  - Falsely attributed to UK driver behaviour
  - UK drivers nor supermen or superwomen
  - UK Signal Capacities is the same as elsewhere

- **The difference is due to geometry**
  - A direct consequence of the Empirical Equations

- Countries like US relatively new to Roundabouts
- US Roundabouts at *sub capacity* operation
- Capacity **CANNOT** be measured
- Capacity **CANNOT** be estimated from gaps
EMPIRICAL MODEL

• RODEL and ARCADY use empirical capacity
  – Used for designing new roundabouts
  – Used for modifying existing congested roundabouts

• ACID TEST of CAPACITY MODEL
• Fix existing congested roundabout
• With existing traffic and no ROW
• Model predicts subtle geometric changes
  – Reduce queues from 100 to minimal number
  – Small modification done within 4 weeks
  – Queues of 100 vehicles vanish - volumes increase
  – Excellent feedback - do not have to wait 20 years
US CAPACITY MODEL

- UK Empirical model cost ............. $11.0 M
- FWHA spending less than ............ $ 1.0 M
- US has a small number of roundabouts
- Operating at low VC ratios (not ‘at capacity’)
- Narrow geometric range (mostly are SLR)
- Narrow Volume Range (mostly SLR)

- Sustained queues for 30 minutes essential
- Queues must never less than 5 vehicles
- Sporadic non-capacity queues useless
US ROUNDABOUT MODEL

• US data insufficient for
  – Capacity Measurement
  – For an Empirical Model

• A theoretical gap model is almost certain
• Only gap capacity mechanism
• Other NON gap capacity mechanisms omitted

• FHWA Model will be limited by gap limitations
1. Change geometry
2. Large increase in incapacity
3. Large reduction in VC ratio
4. But no change in delays
5. No change in gap parameters
6. Therefore it is falsely concluded:-
   1. There is no change in Capacity
   2. Capacity insensitive to geometry
CASE STUDY
A
ROUNDABOUT
IN ISRAEL
• Single lane roundabout built in Israel
• Capacity overestimated

• One leg congestion on Day 1
• Sustained queues during peak hour

• Researchers measured capacity directly

• Compared capacity with Capacity Models
ISRAEL - Measured vs Gap Methods

- 1. Tanner
- 2. Troutbeck
- McDonald
- Ashworth
Empirical vs Observed
(Unfamiliar, timid driver behaviour)
ISRAEL - Empirical vs Observed
(Revised for familiar driver behaviour)
RODEL

- A is design tool for generating designs
- Developed by a designer for designers
- Not just for checking designs after drawing
- Rodel used **before** drawing to derive geometry
- Geometry known before drawing starts
- Far better than drawing blind then checking
TWO MODES

• RODEL has two Modes of operation

• **Mode 1**
  
  • Generates ~ 40 geometry options / leg
  • From user specified target delays / leg
  • Alternative selected for each leg
  • That best fits ROW and maximise safety
TWO MODES

• **Mode 2**

• Refines selected geometry
• Fully Interactive with 3 sec ‘What If’ cycle

• Mode 1 = ‘the driver’
• Mode 2 = ‘the putter’
• Many like to ‘put’ from the ‘tee’ to ‘green’
INPUT AND OUTPUT

• **All Input and Output on a single screen**

• All relevant information *always visible*
  – Relationships between geometry
  – Relationships between flows
  – Relationships between geometry and flows
  – Relationship between INPUT and RESULTS

• Fully interactive

• Very educational

• Generates a feel for geometry / capacity / delay
BETTER DESIGNS IN LESS TIME

• Results understood in relation to input
• Rapid understanding of problem
• Rapid solution
• Saves a LOT of time
• **Better designs in a fraction of the time**
• Other models are not fully interactive
• Input on several screens
• Output in separate FILE that needs editing
• ‘what if’ cycle takes several minutes
• When results found – question forgotten
• Miss solutions Rodel finds

• **RODEL finds solutions other models miss**
Current negotiations between Rodel and TRL
Aim for TRL to adopt Rodel
Partnership between Rodel and TRL
To develop new version of RODEL
Full Windows program
Many very powerful enhancements
Designed by a designer, for designers
Animated Graphical output
Finish