OR/Analytics in UK Policing
Reflections of a practitioner

Sue Merchant
Blue Link Consulting UK
VP International Activities INFORMS
My background

- BSc Physics
- Ministry of Defence – OR analyst; MSc in OR/Stats part time
- Metropolitan Police (Scotland Yard)– from senior OR analyst to Director of Internal Consultancy
- Met Police - Head of Policy Unit; Assistant Commissioner’s ‘right hand’ woman; Head of Business Change Group
- Independent Consultant
- Past President of OR Society, past VP IFORS, INFORMS VP International Activities
Facts about the Met Police circa 1990

- 28000 police officers
- 15000 other staff: forensic scientists, admin, car maintenance, cooks, strategic planners, OR analysts,...etc
- 7 million residents in greater London + visitors
- Area about 1,600 square kilometres
- Local and National functions
- Budget > £ 1 billion p.a.
- Internal consultancy department: around 50 staff (mix of police, work study officers, OR scientists, psychologists, administrators)
Examples of Met project requests

and types of techniques used to help tackle the problems

• Optimal location of police stations? *Location analysis and MCDA*
• Does the Neighbourhood Watch scheme work? *Statistical methods*
• How can we improve the operation of Criminal Record Office (4.5 million hard copy files) & can we move to a microfiche system? *BPR, forecasting, Critical path analysis*
• How should we prioritise building works within limited budget? *MCDA*
• Which are the best performing police units and why? *DEA*
• Which routes should our dispatch vans take to minimise time? *Travelling salesman*
• How can we prepare a business case for replacing our key intelligence system?
• Which computer systems should we develop and in which order over next 10 years? What should be our information systems strategy? *Hierarchical business model + Delphi for objectives.*
• How can we rationalise our inspecting bodies? *Soft OR methods*
• How can we distribute our manpower fairly? *Balancing Workload and other factors*
• How effective is CCTV in convicting rail station criminals? *Sampling and persistence!*
• How can we show that London is the safest city in the world? (!) *Hmmm...!!*
Typical problems faced when doing projects

- Data incompatibility between computer systems;
- Much data held manually;
- Senior officers not involving analysts early enough in a trial, and not prepared to let a new system of working bed down before seeking an evaluation;
- Fast changeover of senior officers – the need to keep building credibility of analysts;
- Victims of our own success – analysts ‘stolen’ from our dept.
Examples of other force/university projects

• Optimising the location of National police air support bases
• Measuring the impact of police patrols
• Predicting crime locations
• Predicting the spread of disorder during riots
• Assessing the relative harm caused by drug types to inform policy
• Taking staff welfare into account in choosing rosters
• How to make the Notting Hill Carnival safer
Using simulation to achieve cost reductions in the UK’s National Police Air Service
The problem

• In 2012 the UK National Police Air service was formed to replace the air support services of many of the 43 forces, giving borderless tasking, to deliver cost effectiveness;
• Savings of 23% were achieved but more were required;
• West Yorkshire Police volunteered to act as the lead force for further studies;
• After much preliminary work they were commissioned to provide an evidence-based view of the likely performance/viability of alternative bases (focusing on numbers of helicopters and their locations).
The Model included:

• All 23 bases and 24 helicopters in England and Wales and the concept of fixed wing aircraft (*the resource*)
• 300 different operating areas for 43 forces (*the activities*)
• Different types of support (eg searching for suspects, pursuit of vehicles) (*the entities*)
• Characteristics of those calls for support where the priority and duration changes for each type of support
The process

The model was built to show a visual representation of the service, including a map of the bases, tasks and aircraft responding.

Known distributions of demand by hour/day/week and level (Force area), task type, duration, priority

* Takes into account whether the aircraft is already responding, when free to assist, time left for operating, likely time to respond and return to base to refuel
Other features included in the model

• Chance of operation being abandoned through bad weather
• Number of hours a pilot can fly in a shift
• Maintenance schedules

Assumptions/simplifications (examples)

• Aircraft only land at their own base and refuel each time
• Only a single aircraft responds to a task
• No overtime
• Fixed wing aircraft were new so little data available
Outcome

• Board agreed on a new 15 base operating model: 19 helicopters and 4 fixed wing aircraft
• Bases operating 24/7
• Additional saving of 14%

Chief Operating Officer of NPAS said: “As a direct result of this work we were able to develop the new operating model and base locations and latterly a completely new funding model”

Project success factors thought to include:
• Engagement with diverse stakeholders and buy in through visual simulation
• Avoiding local emotional bias in decision-making by removing the details of which bases were selected
• Providing an evidence-based process
• Roadshows round the country to get buy-in at the end of the project
The Crimestoppers Project

- Call centre was expecting huge increase in volume
- Management had a hunch that changing the shift pattern would help improve performance but couldn’t test this or agree amongst themselves
- Decision needed: **which shift pattern will cope best with increased demand**
- One month to get answers
- No documentation of call centre process
- Very patchy data available
- Location awkward for us
- No simulation software
## Main Performance Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Target</th>
<th>Actual 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>% calls answered in 20 secs</td>
<td>90%</td>
<td>86%</td>
</tr>
<tr>
<td>Abandoned calls per week</td>
<td>&lt; 200</td>
<td>355 (of 5800) 6.12%</td>
</tr>
<tr>
<td>Staff utilisation</td>
<td>Better balance of busy/not busy</td>
<td>Not measured</td>
</tr>
</tbody>
</table>

Also: staff costs not to be greatly increased above current levels and staff to be content with changes
Business processes

• **Main categories of staff**
  • call handlers
  • online form handlers
  • Shift leaders

• **Original process**
  • Shift leaders take calls if all call handlers busy

• **Possible alternative process**
  • calls diverted to shift leaders then online staff
# Modelling *original* process

<table>
<thead>
<tr>
<th>2 types of customer contact</th>
<th>3 categories of staff</th>
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<tr>
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<tr>
<td>Online</td>
<td>Online staff</td>
</tr>
<tr>
<td></td>
<td>Shift leaders</td>
</tr>
</tbody>
</table>

Arrival profile

- Call type
  - Phone calls
  - Online

- Queue
  - Q
  - SL Q
  - Online Q

- Staff
  - Call handlers
  - Shift leaders
  - Online Staff

allocate to roles

- Staff available over time distribution
- Rosters
  - Shifts
  - Staff teams

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Modelling *proposed* process

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Arrival profile

Call type
- Phone calls
- Online

Queue
- Q
- SL Q
- Late call Q

Staff
- Call handlers
- Shift leaders
- Online Staff

Allocate to roles

Staff available over time distribution

Rosters

Shifts

Staff teams
### Illustration of original roster patterns

#### 6 days on, 4 days off

| JANUARY | SUN | MON | TUES | WED | THUR | FRI | SAT | SUN | MON | TUES | WED | THUR | FRI | SAT | MON | TUES | WED | THUR | FRI | SAT |
|---------|-----|-----|------|-----|------|-----|-----|-----|-----|------|-----|------|-----|-----|-----|------|-----|------|-----|-----|-----|-----|
| Agent 1 | BH/RD | R   | E    | E   | L    | L    | N    | N    | N   | R    | R    | R    | R   | S    | S    | L    | L    | A/L  | TOIL | R   | R   | R   |
| Agent 2 | BH/RD | R   | E    | E   | L    | L    | N    | N    | R    | R    | R    | R    | E   | E    | L    | L    | L    | N    | N    | R    | R    | R    |
| Agent 3 | BH/RD | R   | E    | E   | L    | S    | S    | N    | R    | R    | R    | R    | E   | E    | L    | L    | L    | N    | N    | R    | R    | R    |
| Agent 4 | BH/RD | R   | A/L  | A/L | L    | L    | N    | N    | R    | R    | R    | R    | R    | E   | E    | L    | L    | L    | N    | N    | R    | R    | R    |
| Agent 5 | BH/RD | R   | R    | R    | E    | E    | TOIL | L    | N    | N    | R    | R    | R    | R    | E    | TOIL | L    | L    | N    | N    | R    |
| Agent 6 | BH/RD | R   | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | E    | L    | L    | A/L  | A/L  | R    |
| Agent 7 | BH/RD | R   | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | E    | L    | L    | N    | N    | R    |
| Agent 8 | BH/RD | R   | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | A/L  | A/L  | L    | L    | N    | N    | R    |
| Agent 9 | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    |
| Agent 10 | N   | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | S    | L    | L    | N    |
| Agent 11 | N   | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | TOIL | TOIL |
| Agent 12 | B/H  | TOIL | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    |
| Agent 13 | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | E    | E    | L    |
| Agent 14 | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | TOIL | R    | R    | R    | R    | S    | S    | L    |
| Agent 15 | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    |
| Agent 16 | B/H  | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | TOIL |
| Agent 17 | E    | E    | L    | L    | N    | A/L  | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    |
| Agent 18 | E    | E    | L    | L    | N    | R    | R    | R    | E    | E    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | S    |
| Agent 19 | E    | E    | S    | S    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    |
| Agent 20 | B/H  | E    | L    | L    | N    | N    | R    | R    | R    | R    | E    | E    | L    | L    | N    | N    | R    | R    | R    | E    | E    |

**Key:**
- E=07:00-16:00
- M=09:00-18:00
- L=16:00-01:00
- N=22:00-07:00
- R=rest day
Data needed for model

• Incoming call volumes – distribution by hour of day, day of week ?
• Time to answer calls and do follow up tasks- distribution ?
• Number of staff on duty across the day and week ✅
• Break times and durations ✅
• Targets to be met ✅
Analysis of 2011 calls data

Call volumes similar Monday - Friday

Tricky to assess volumes to use in the simulation because:
• Additional business was being taken on during year.
• Peak in summer 2011 was thought to be a result of the riots.
Screenshot of 1 week’s run using current shifts

Target: 90% of calls to be answered in 20 seconds
Model outputs: current shifts
phone calls offered and answered

Problem with Saturday
Model outputs: original shifts call handling staff utilisation on Saturday

Inefficient use of staff over 24 hour period
Iterative improvements

Results for an average week

% calls answered in 20 seconds

Alternatives modelled

1. Client initial proposal - longer shifts
2. as 1 with some part time weekend shifts added
3. as 2 with amendments to weekend shifts
4. as 3 but extending one shift
5. as 4 but changing start times for early shifts
And then…….

• Modelling work complete, shifts agreed June
• Phone call from Crimestoppers in August:
  • staff don’t like proposed shifts
  • they have a proposal of their own
  • can you check this out?
• Took opportunity to get some actual data
  • for April – August
  • phone call patterns close to estimated
  • some concern with online form data
• Staff proposal more expensive but
  • no better service
Validation

Lost calls: actual v modelled

lost calls in 3rd week April

Actual
Modelled

Monday Tuesday Wednesday Thursday Friday Saturday Sunday
And what happened?

• New rosters introduced Jan 2013
• Early Feb we were told that results were great! The staff were able to deliver a reduction in lost calls and better performance against target.
• **Success factor**: good visual simulation tool enabled working *with* the client
Thanks for listening!
Questions?

May all your clients be contented ones!