Rock of Gibraltar Airport

Thomas Power
Roberto Vasquez
Jonathan Farland
Sebastian Priest
Gibraltar

- British territory on the Mediterranean Coast
- Ceded from Spain in 1713
- Used as a fortress by the British military in World War II
- 28,000 civilian population
- 12,690 labor force
About Gibraltar Airport

- Located in the British territory of Gibraltar
- Originally built in WWII for strategic advantage
- Harbors both military and commercial aircraft
Tourist Attractions
The Rock of Gibraltar

- 1,400 ft. tall limestone mountain
- Protected wildlife reserve
- Moorish Castle & World War II Tunnel System
- Attracts 4 million visitors every year
Tourism impact on the Economy

- Around 5 million tourists travel to the Gibraltar Peninsula annually
- Amount of tourist expenditure is around 230 million pounds
- Tourism accounts for 30% of Gibraltar’s GDP
- Tourist and civilian population account for high levels of congestion
Airport Operations

The Airport of Gibraltar carries 4 airlines

- EasyJet Airlines
- Monarch Airlines
- British Airways
- Anadus Lineas Airlines

There are 42-46 weekly commercial flights
Airport Layout

- Harbors only one runway for both departures and arrivals
- Modes of transportation:
  - Car
  - Taxi
  - Bus
  - Motorcycle/Bicycles
- Winston Churchill Ave. crosses the runway through which traffic runs through
The Problem
Transportation Facts

- There are around 14 arrivals and departures daily.
- The average time Winston Churchill Ave. is closed during an arrival or departure is 10 minutes.
- On any given day, the road can be closed for a total of 2 hours.
- Alternatives: implement a ferry system around the runway.
The Model

Network Topography

Physical Topography
The Issues with Modeling

- Determining...
  - Daily Demand
    - 5 million annual visitors divided by 365 days a year.
  - Associative costs with using Winston Churchill Ave.
    - Bureau of Public Roads Methodology for Road Cost
  - “Practical Capacity” of Utilizing Links ‘a’ and ‘b’
    - Winston Churchill estimated to have a practical capacity of 14,000 cars/day
Bureau of Public Roads (BPR) method of estimating associate road costs:

\[ Ca = Ca^0 \left[ 1 + \alpha \left( \frac{fa}{ta'} \right)^\beta \right] \]

**Ca**: Travel time on link a

**Fa**: link flow on link a

**Ca^0**: free flow travel time

**ta prime**: "practical capacity" of link a

**\( \alpha, \beta \)**: Model Parameters (typically \( \alpha = .15, \beta = 4 \))

Non-Linearity!
The Model
<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Data</th>
<th>Data Type</th>
<th>Dw</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Demand</td>
<td>5,000,000</td>
<td>Visitors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visitation Days/year</td>
<td>365</td>
<td>Days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily Demand</td>
<td>13698.63</td>
<td>Visitors/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period of Time (t)</td>
<td>1</td>
<td>Day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flights per year</td>
<td>2,288</td>
<td>Flights</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flights per day (avg)</td>
<td>6</td>
<td>Flights/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Ferry Distance</td>
<td>2.607</td>
<td>Nautical Miles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mediterranean Ferry Speed</td>
<td>17.38</td>
<td>Nmiles/hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel Time</td>
<td>0.15</td>
<td>Hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily Operational Hours</td>
<td>8</td>
<td>hours/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to Load/Unload</td>
<td>0.05</td>
<td>minutes/car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O/D Pair (1,3)</td>
<td>(1,3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Path 1 (P1)</td>
<td>(a, b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Path 2 (P2)</td>
<td>(e)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>8.69702</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cb (fb, fc)</td>
<td>74.1327</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (e)</td>
<td>82.8297</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (p1)</td>
<td>82.8297</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (p2)</td>
<td>82.8297</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fa</td>
<td>12222</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fb</td>
<td>12222</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fc'</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fd'</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>1476.59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bureau of Public Roads (BPR) method of estimating associate road costs:

\[ Ca = C_a^0 \left[1 + \alpha \left(\frac{f_a}{t_a^0}\right)^{\beta}\right] \]

Ca: Travel time on link a  
Fa: link flow on link a  
Ca^0: free flow travel time  
\( t_a \): prime: "practical capacity" of link a

<table>
<thead>
<tr>
<th>Practical Capacity of &quot;a&quot;</th>
<th>14000</th>
<th>Cars/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical Capacity of &quot;b&quot;</td>
<td>14000</td>
<td>Cars/day</td>
</tr>
<tr>
<td>Practical Capacity of &quot;e&quot;</td>
<td>14000</td>
<td>Cars/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>0.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta )</td>
<td>4</td>
</tr>
</tbody>
</table>
Iberian Government's integrated Traffic, Parking and Transport Plan

- Car Parking facilities and schemes
- Policing and Enforcement of Parking schemes
- Public Transport & Car use reduction measures
- New Roads
Car Parking facilities and schemes

- Local residents in the area where they live
  - Multi storey car parks in residential areas
  - Permit holders only parking schemes in all residential areas

- Local residents when paying short visits to other parts of Gibraltar
  - More short term paying car parks around the city
  - More metered parking spaces in the city centre and in each of the residential areas

- Visitors to Gibraltar
  - Unavailability of street parking will force visitors to park their cars in the large multi storey car park
Policing and Enforcement of Parking schemes

- The appointment of Parking and Traffic Enforcement Officers
- The introduction of `on the spot' parking fines for non locally registered vehicles.
- The raising of the levels of parking fines, including fixed penalty notices
- Increased use of 'tow away' in cases of obstruction or serious unlawful parking
- Clamping of persistent offenders
Public Transport & Car use reduction measures

- Improvements to the availability and reliability of the taxi service

- Improvement and expansion of the bus service, including:
  - Free bus service on most routes
  - Increased frequency of services
  - Late night bus service

- ‘Take, ride and leave' facility
New Roads

- **Winston Churchill Avenue Scheme**
  - Dual carriageway Tunnel under the runway at Eastern Beach
New Layout