

# **The Environmental Capacity of Streets – 50 Years On**

## **A presentation to Transport Solutions Wales 2013**

**By Robert Spriggs (Callidus Transport Director)**

### **Slide 1 - Title**

Thank you (madame) Chairman and good afternoon to you all.

As transport professionals I am sure you are familiar with hearing the following phrases on a regular basis:

‘There’s already too much traffic on my road’

‘This is an accident waiting to happen’

‘What will the pollution do for my health?’

‘It’s just not safe to cross my road anymore’.....before saying

‘What are you going to do about?’

I don’t know about you, but I find these types of questions very difficult to answer. They are subjective environmental types of questions.

### **Slide 2 – London Road**

This is a busy road into Bath, the London Road, which carries 24k vehicles per day, including many trucks. It was declared an AQMA on 2003. It has residential frontages and run down businesses.

It is not the side of Bath we are used to seeing but is not uncommon of many cities.

The Council have been battling to find a solution to the reducing traffic volumes but to date without success. But what would an appropriate traffic volume be?

### **Slide 3 – Buchanan, Beeching and Dr Who**

Wind back now 50 years to 1963.

It is the year Dr Beeching released his report on the railways (called the Reshaping of British Railways)

It is also the year Dr Who started with Willian Hartnell as the Doctor.

Less well known unless you are in the field of transport is that it was also the year Professor Colin Buchanan published his seminal report, Traffic in Towns.

Other than 1963, what do the two Doctors and Professor have in common?

Well not a lot. But perhaps you could say one was an expert in rail travel, one an expert in road travel and one an expert in time travel. That's of little relevance but it puts the period I am talking about in context.

## Slide 4 – Traffic in Towns

I shall concentrate on the Buchanan Report, Traffic in Towns, which was commissioned by the then Minister of Transport, Ernest Marples

This report represented considerable foresight, as you can see from this graph.

What this shows is Buchanan's prediction of car traffic growth to 2010 (from 1963 don't forget).

He predicted that by 2010, everyone who wanted a car would have a car, a point of saturation. Population forecasts for the UK showed that by 2010, the Country would have 70,000 inhabitants.

This point of saturation would be at 0.55 vehicles per person, equivalent to 40 million cars.

He was not far wrong – the actual figure today is a population of about 63 million and 34 million vehicles (which actually fits in with his middle line) is 0.54 vehicles per person.

He suggested that the arrangement of our streets had been immediately put out of date by the arrival of the car.

As a result there was a clear conflict between 'accessibility' and 'environment' because of the ways our cities are designed.

And he posed the question of society – do we want to accommodate this growth? – if the answer was 'yes', then we have little choice but to build new infrastructure. The infrastructure solutions he came up with would be considered brutal by today's standards.

## Slide 5 – Polarised opinion

In defence of Buchanan, I would put him between the extremes of views at the time on how to deal with traffic.

- On the one hand there was the the New Modernist approach exemplified by French Architect Le Corbusier with his 'Radiant City' concept. He said, and I quote, 'the winding road is the Pack Donkey's Way, the straight road is man's way'. His streets were based on aesthetics and functional design, and seven levels of road hierarchy, one level being solely for pedestrians.
- At the other extreme, we have Jane Jacobs (an American-Canadian Journalist of urban studies) in her writing on Death and Life of Great American Cities. She was very critical of the ordered view of ideal urban structures, cellular patterns of district neighbourhoods and the neat separation of pedestrians and vehicles. She saw cities as growing organically and considered the street as an important aspect of our social interactions.

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Buchanan combined these views with a Le Corbusier style hierarchical highway infrastructure but retro-fitted into a Jane Jacob style streets.

As I said, the results were quite brutal at one level and would have resulted in major rebuilding in our cities.

However, he also recognised the need for what he termed 'environmental areas', shown green here. In these areas there was a right:

- To be safe from traffic
- To enjoy stimulating surroundings
- To be reasonably free from noise
- To be able to walk about in comfort and safety

'Environmental ' then also included social aspects

## **Slide 6 – Buchanan's Theory**

Buchanan took what he described as 'crude capacity' (which today we are familiar with as the DMRB equivalent road capacities), and 'tempered' it with the ease with which pedestrians could cross the road.

This produced new capacity values which he terms the 'Environmental Capacity' of the road.

This slide shows a relationship he derived between road width (and therefore the time taken to cross the road) and the acceptable volume of traffic.

Type A he considered to be streets with a better level of protection – better visibility for drivers, fewer parked cars, fewer entrances and continuity of footways. There were also Types B and C.

Vulnerability referred to the types of pedestrians with the more vulnerable being the elderly or parents with children.

I have rather crudely fitted values from DMRB based on the equivalent road widths for Urban All Purpose (UAP) roads types 3 and 4. We can consider these to be 'crude capacities'.

You can see very clearly that the Environmental Capacity is significantly less than the 'crude capacity'. In fact crude capacity increases with road width whilst environmental capacity decreases.

Roughly, we are looking at acceptable flows of between 200 and 400 vehicles per hour for a standard single carriageway.

You will find a graph very similar to this in DMRB Volume 11 Section 3 Part 8.

## **Slide 7 – Buchanan Theory**

In fact the Traffic in Towns team developed the method further to include a measure of accessibility and a measure of environment.

The accessibility represented the ease with which a car could travel into and out of an area, somewhat different from the term 'accessibility' we use today. It is a bit like an inverted version of the *Ratio of Flow to Capacity* [RFC]) that we use today. It is presented as an index.

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The environmental capacity is an adjustment to the crude capacity and presented as an absolute traffic number.

There are similarities here in the multi-criteria approaches we use today, with the different criteria weighted according to their adjudged importance.

A higher [A] value means a more accessibility network and results in a higher accessibility index.

The higher the [E] value, the better the provision for pedestrians. Increasing either the E value or the crude capacity, increases the environmental capacity.

I actually think this is somewhat counter-intuitive.

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By way of example

- We can consider a transport network to support 1600 vehicles, adjusted by a factor to represent Safety, Convenience etc. I have shown a score of A of 54 out of 100. This would represent the transport supply.
- If the traffic demand is 1250 vehicles, then the Accessibility Index equals 69. Fewer vehicles and the accessibility index increases.
- The environmentally adjusted transport network supply = 608 vehicles. This can be increased with a higher value of E.

## Slide 8 – Supply and Demand

Buchanan's approach can be considered alongside our understanding of supply and demand.

On this graph, the x-axis represents the quantity of trips made and the y-axis the price or cost of those trips.

The demand curve shows that less trips are made the higher the cost of making a trip (or according to the laws of diminishing returns), the more trips we make the less benefits we get from them.

The supply curve shows that the more trips we make, the higher the cost to ourselves (the private cost) in terms of out of pocket expenses and our time.

We will continue to make trips so long as the marginal benefits we derive from making a trip outweigh our marginal costs – a point of convergence between supply and demand is the assumed result.

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This of course ignores the external social costs of our journey making, which if it were to be reflected, would be at a higher cost and lower trips – this is precisely the Environmental Capacity to which Buchanan was attempting to address.

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As planners of transport, it is our role to balance the demands and supply. However, we have to make a judgement about how much of the external cost we design for.

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Arguably adding additional capacity simply releases more of the demand as more trips can be made at a lower price.

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Oh, and we have future demand to consider, which sees a demand for more trips but at a higher price.

Buchanan very much recognised these factors in his work.

## Slide 9 – Evidence

I would have liked to have shown you a slide with lots of evidence on it but unfortunately lots of useful evidence is very hard to come by. Instead we have to look to mostly historic work.

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Buchanan still remains a bench mark – as we have seen, he suggested that in the order of 200 to 400 vph (or 2,000 to 3,000 per day) would represent a threshold.

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Donald Applyard's classic work in 'Liveable Streets' 1981 surveyed households in San Francisco on streets with different traffic flows. For each household, he wanted to see how many neighbours they were friends with or were acquainted with and this was affected by traffic flow (as shown in an extract from his work here).

His work concluded similar flows to Buchanan at about 2,000 per day.

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Traffic's Human Toll carried out by Transportation Alternative in 2006 repeated the Applyard study in New York but looked at lots of different social and environmental factors.

The study found significantly greater negativity of attitudes between medium traffic and heavy traffic flows than between light traffic and medium traffic flows – suggesting that 2 – 3,000 vehicles per day is about right – again consistent with Buchanan.

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The only concrete recent information I have found is a short statement in MfS which states that for shared space, traffic flows should be less than 100 vehicles per hour – this though is not really to do with environmental reasons and is much less than Buchanan.

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Design Manual for Roads and Bridges Volume 11 on Environmental Assessment assumes that relief from severance on existing roads is only significant for flows above 8,000 vpd – a figure somewhat higher than those above.

People who have written on this subject have tended to point to the fact that even more recent attempts to define environmental capacity have their roots in either Buchanan's or Applyard's work.

### **Slide 10 – Link flow diagrams**

Somewhat crudely, I have tried to represent on these diagrams what different flows might look like at a point in time.

This is based on a 200m length of free flowing road with a speed limit of 30mph and traffic arriving at a uniform rate. The road is about 7 metres wide and a pedestrian crosses the road at 4.8kph.

This first picture shows a flow 400 vehicles per hour (200 in each direction) – similar to Buchanan's upper limit of environmental capacity. You can see that the car traffic is not too imposing on the street and there are reasonable gaps between cars to cross.

<Click> The second picture shows a flow of 1500 vehicles per hour (750 each way). The cars are passing much more regularly and there are limited gaps to cross.

<Click> The third picture show flows of 3000 vehicles per hour (1500 each way) and is probably at or beyond the capacity of the link. It also assumes 8% HGVs. There would be very limited opportunity to cross in this case.

### **Slide 11 – Link flow diagrams with car travel distance**

This slides shows the same as the previous slide but also includes the distance cars would travel in the time it takes an able pedestrian to cross the road.

You can clearly see that only in the 400 vehicles per hour scenario would there be sufficient gaps between cars to cross.

Again, this fits in well with the assumptions of both Appleyard and Buchanan.

### **Slide 12 – Swindon**

My observation previously about comparing the DMRB link capacities with Buchanan's environmental capacities is perhaps a little misleading. It is really the capacities of junctions in our urban environments that determine capacity and this is very much lower than link capacity. Therefore street pattern is important to consider.

Take this slice out of Swindon. The town centre is on the left and the city has expanded out to its extremity in the east.

I have made reference underneath to an excellent book by Stephen Marshall on Street Patterns in which he identifies how layouts have changed over time

1. Gridiron (turn of the 20 century)
2. Fragmented parallel (1950s)
3. Warped parallel (1960s)
4. Loops and lollipops (1970s)
5. Lollipops on sticks (1980s)

Buchanan's influence of the 1960's is clear with a hierarchy of roads and environmental cells in the 3<sup>rd</sup> segment from the left.

Beyond this, the layouts of the 70s and 80's are lower density and have been very much designed with the car in mind.

Current thinking on layout, as we see in Manual for Streets for example, moves us back I would say to the pre-1960s era. Arguably this takes us full circle to the problem Buchanan recognised of trying to address the conflicts between 'environment' and 'capacity'.

## Slide 13 – Today's approach

So what is today's approach?

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Perhaps unlike in the 1960's, today we fully recognise the problems associated with traffic.

Manual for Streets published in 2007 steers us toward a greater balance between streets for movement and streets as places.

MfS recommends the use of Quality Audits, which can be broken down in to audits of just about anything that might be affected e.g. walking, cycling, visual, safety etc.

However, nowhere does MfS have any specific traffic values, other than for shared space which I previously mentioned.

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The approach of the Government's Traffic Analysis Guidance (TAG) has a comprehensive set of objectives all of which could be considered to be relevant to environmental capacity.

I highlight two in particular that are of interest:

- Environmental capital – applies mostly to the natural environment but also to townscape. Used in transport schemes, it appraises environmental features by determining how important they are and to whom. It could be possible to monetarise these features and therefore to make quantitative assessment of trade-

offs, perhaps with driver journey time savings. Ultimately though the measure is on a qualitative scale.

- Social and Distributional Impacts (SDIs) – measures the impacts of transport interventions on different groups of people - this includes impacts from noise, pollution, severance, road safety etc. Ultimately though, the measure is on a qualitative scale.

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Our approach today is both one of balance and also of thoroughness. However, it remains on the whole, qualitative.

I venture to suggest that absolute traffic flow figures, along the lines of those identified by Buchanan, or Applyard, would be helpful.

## **Slide 14 – Control measures**

It might be said that controlling traffic to reflect environmental capacity is not straight forward. Indeed traffic capacity can be considered quite ‘lumpy’ i.e. you can have 1 lane or 2 lanes, you cannot have 1.5 lanes.

However, I think that through just the conventional measures we use to manage traffic, we can actually control the flow of traffic to quite a fine degree.

I show here the types of measures that we typically use and how they might relate to traffic capacity.

They range from clearway type roads, where pedestrians are prohibited, to pedestrian only streets where vehicles are prohibited.

There are various types measures in between that have a varying degree of impact on traffic capacity.

Our reasons for implementing these measures aren’t normally based on some environmental capacity measure – but they could be.

For example, I don’t think it would be unreasonable to introduce a pelican crossing on the basis that it reduces the flow of traffic on a road that is more in line with the environmental capacity of that road.

## **Slide 14 – Conclusion**

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It is difficult to do justice to this subject in such a short presentation. Having looked into it more deeply as part of this presentation I have realised that it is an extremely complex subject and far from an exact science.



That said, I think Buchanan's approach has validity. He himself said it was underdeveloped in his report and needed much more research.

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What is interesting about Environmental Capacity is that it sets an absolute value.

We tend to use proportional changes and target percentage reductions which often mean very little.

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The methods we use today are very much more sophisticated than Buchanan's and take into account many more criteria, for example climate change, social impacts etc.

However, we have only been able to combine these criteria using qualitative measures.

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We are subconsciously applying environmental capacities in much of the work we do on a day-to-day basis.

We know we want more walking and cycling, safer roads and less noise and air pollution. And we know we want less traffic. But do we know how much traffic this represents.

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I think we could refine our methods, which are after all far more sophisticated than Buchanan's, to reflect some real traffic flow values. I believe this would help us to focus much of the other work we do.

## **Slide 15 – Dr Who**

Surprisingly, neither Buchanan nor Beeching knew of each other work in 1963.

I doubt they also knew of the Doctor.

Perhaps only he can tell us what will happen in the next 50 years.

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