The wisdom of crowds

A survey of forecasting accuracy

Over the past 10 years **Robert Bain** has published extensively on the accuracy of traffic forecasts, comparing predictions with outcomes and examining bias and error. Earlier this year he decided to approach the subject from a different perspective. He surveyed practitioners themselves to hear their take on the performance of state-of-the-practice traffic forecasting. The survey results, summarised here, could have important implications for engineers, planners and policy-makers – and economists involved in project appraisal.

In his book, *The Wisdom of Crowds*, James Surowiecki argues that the aggregate view of a diverse collection of independent individuals is often more accurate than that of an individual group (crowd) member. With this hypothesis in mind, I set out to survey modellers and other transportation practitioners about their views on the predictive capability – or limitations – of traffic forecasting today. Short, punchy email-based market research enables such polls to be conducted quickly and, importantly, international views can be canvassed. I promoted the survey through two popular email lists with strong interests in traffic modelling (and keen participation from traffic modellers): the UK's Universities' Transport Study Group (UTSG) list and the Travel Model Improvement Program (TMIP) list hosted by the Texas Transportation Institute. Survey responses were received from consultants, academics and government representatives – many holding senior positions – based in Australia, Bangladesh, Brazil, Canada, Chile, Hong Kong, Ireland, New Zealand, Sweden, the UK and the US. An interesting crowd!

Survey results

The survey focussed on two simple scenarios: forecasting future traffic volumes for (a) an existing road and (b) a new-build. Respondents were asked to consider predictive capability in the context of four forecasting horizons: the next day, one-year ahead, five-years ahead and 20-years ahead. The aim was for respondents to indicate the likely error range (or notional confidence interval) in each case. The crowd wisdom is summarised in *Table 1*.

Table 1: Survey Results (n = 46)

Forecast Horizon	Likely Error Range	
	Existing Road	New Road
The next day	± 7.5%	n/a
One-year ahead	± 10%	± 15%
Five-years ahead	± 15%	± 25%
20-years ahead	± 32.5%	± 42.5%

Notes: Respondents were not asked about 'next day' forecasts for new builds.
Percentages have been rounded.

The results presented in *Table 1* accord with intuition. The error ranges widen as the forecasting horizons stretch and the intervals associated with existing roads are consistently narrower than those for new roads (which compound the forecasting challenge). A number of survey respondents, however, reported very narrow ranges:

- Five respondents assigned a range of ± 0% to next-day forecasts;
- Eight respondents assigned ±3% (or less) to one-year forecasts;
- Ten respondents assigned ± 8% (or less) to five-year forecasts;
- Six respondents assigned ± 10% (or less) to 20-year forecasts.

Are these realistic responses? Comments provided by other respondents suggested that, as traffic volumes typically vary on a day-to-day basis by between ±5% and ±10%, the likely error range associated with any forecast would exceed these intervals.

Overconfidence

Overconfidence is a much-researched and well-established cognitive bias that reflects the fact that people's subjective confidence in their own judgments is commonly greater than their objective accuracy. In range estimation, for example, practitioners have been shown to systematically estimate narrow intervals when evaluating unknown future quantities and assign high confidence levels to their own predictions. So does the traffic forecasting profession – or sections of it – suffer from overconfidence? To explore the issue further, let's consider transportation model inputs (before turning later to model outputs).

Most traffic forecasting assignments require modellers to consider and incorporate growth. Traffic growth, itself, is commonly formulated as some function of GDP, car ownership, fuel price, population and so forth – or a combination thereof. Consider the uncertainty associated with possibly one of the more predictable of these input variables; population. At a national level, population projection accuracy has generally been shown to be good. However, that accuracy deteriorates (a) as forecast horizons lengthen, and (b) as study areas shrink – towards the zone sizes typically employed in traffic modelling (Shaw, 2007). Smith and Shahidullah (1995) calculate errors for small-area population projections

– over a 20-year horizon – of between 25% and 35%. Yet one-third of respondents to the traffic forecasting survey assigned ranges of ± 20% or less to 20-year traffic forecasts. And census tract analysis by Smith, Tayman and Swanson (2001) suggests average errors of 45% and 54% for 25-year and 30-year population projections respectively. These are wide intervals for a key input variable employed in most traffic forecasting studies.

Turning to model outputs, it is instructive to examine the outturn accuracy of traffic forecasts. *Figure 1* presents data recently released by the Highways Agency. It compares traffic forecasts for 55 major schemes with outturn figures, in terms of percentage error: (forecast–outturn)/outturn.

Referring to the fitted distribution, *Figure 1* suggests that 90% of actual traffic volumes fall between -33% and +30% of their respective forecasts. These forecasts were made for the opening-year of each of the 55 schemes and, on average, the forecasts were made five years in advance. In contrast, respondents to the traffic forecasting survey assigned ranges of ±20% or less to five-year forecasts. Other studies of traffic forecasting accuracy have revealed ranges of ± 43% for early-period traffic forecasts (Bain, 2009); almost identical to the range assigned by survey respondents to 20-year forecasts.

Conclusions

There appears to be some evidence of overconfidence from within the traffic forecasting profession. Error range estimates tend to be narrower than those suggested by empirical evidence. If the very (unrealistically) narrow range estimates are removed from the sample of responses, the resulting 'crowd wisdom' is as summarised in *Table 2*.

Table 2: Survey Results (omitting unrealistically narrow ranges)

Forecast Horizon	Likely Error Range	
	Existing Road	New Road
The next day	± 7.5%	n/a
One-year ahead	± 12.5%	± 17.5%
Five-years ahead	± 20%	± 27.5%
20-years ahead	± 42.5%	± 47.5%

Notes: Percentages have been rounded.

The observed Highways Agency forecasting performance data described earlier would appear to be in-line with the revised ranges presented in *Table 2*.

To illustrate the impact of these ranges, *Figure 2* presents a simple forecast of a link volume of 20,000 vehicles/day (in 2010) growing by 3% per annum over a 20-year horizon. Based on the survey results, the forecasting 'uncertainty envelopes' for an existing and a new road are shown in green and red respectively.

The uncertainty surrounding traffic forecasts is commonly understated and, to date, the topic has attracted surprisingly little attention in the literature. This should be addressed. Traffic forecasters need to reflect on the accuracy of their forecasts and the findings need to be communicated to the profession. In so doing, intelligent, empirically-derived confidence intervals could be properly assigned to traffic forecasts and lessons could be learned to guide future forecasting practice.

References:

Shaw, C (2007), *Fifty Years of United Kingdom National Population Projections: How Accurate Have They Been?, Population Trends*, Summer 2007.

Smith, K and Shahidullah, M (1995), *An Evaluation of Population Projection Errors for Census Tracts, Journal of the American Statistical Association, March 1995, Vol. 90, No. 429, Applications and Case Studies*.

Smith, K et al (2001), *State and Local Population Projections: Methodology and Analysis, European Journal of Population, Volume 18, Number 3, 303-305*, Springerlink.

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Figure1: **Traffic forecasting performance (*Highways Agency*, 2010)**

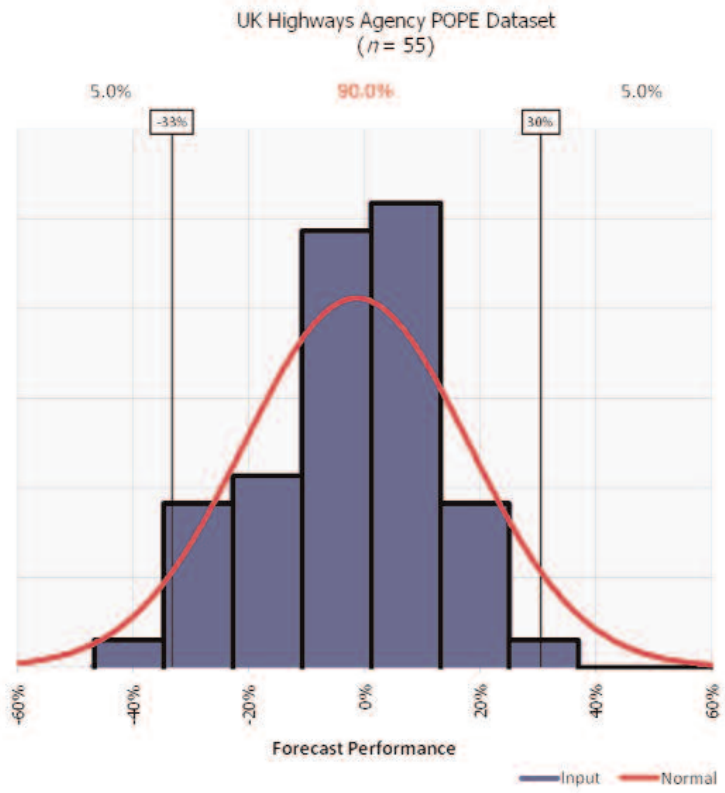

Figure 2: **Traffic forecast showing uncertainty envelopes**