RoadBlock

**Alliance against road building**

**Briefing on Cost Benefit Analysis (COBA)**

Where do they get their figures from? What is COBA? How can I use it?

# Economic Appraisal of Roads – COBA

COBA is the cost-benefit analysis package used by the DfT to justify its 'investment' in a road scheme. It is important to realise that COBA is not science, but has enough of science in it to sound plausible. It is worthwhile, on occasion, to focus on some specific aspects of the COBA print-out, because these can reveal interesting issues to which an inspector may be persuaded to listen.

**The Mechanism of COBA**

The road network comprises links and nodes. The traffic engineer must define the network before (Do-Nothing – DN) and after (Do-Something – DS) the scheme and compute the transport distribution on the two networks. This computation starts with the '*traffic model'*.

**Traffic Model:** The traffic model attempts to establish a table of origins and destinations of trip desires - the *Trip Matrix* (TM). Origins and destinations are geographical zones, usually of a size such that the number of trip ends in them that relate to journeys, in the vicinity of the road scheme, are of the same order – an engineer usually builds a TM from cordon survey data.

**Assignment:** The TM is assigned to the network – an individual trip in the matrix finds its way through the network by the route of least cost to the user – this cost including the congestion cost imposed by all other trips on the network. There is a simple iterative algorithmic process to do this. The result is the traffic flow on every link – a selection of these modelled flows are compared with surveyed data – a process called '*Validation'*. ***It is usually worthwhile checking this validation*** – do the observed and modelled flows match well in the most important places? If the model is not good the Inspector may be persuadable that COBA is not likely to be good.

Once validated, the model can be used to assign the TM to the DS network. ***This assignment is the second useful thing to examine.*** If the scheme is a simple bypass to a small town it is unlikely that the assignment will deliver unexpected results, but if it is a more complicated scheme then there may well be links within the network which appear to have their traffic significantly increased. Objectors can often use this information politically.

**Traffic Forecasts**

Traffic forecasting is based on the assumption of an S-shaped curve of vehicle ownership, reflecting the growth of wealth with time. The process would make more sense if the DfT were to consider the possibility of underlying determinants of economic growth that could embrace the possibility of it failing – e.g. due to the passing of peak oil production. ***But inspectors rarely listen to arguments about forecasts – saying these are 'government policy'.***

The forecasts are applied to the TMs for given classes of vehicle, to produce matrices for the so-called Design Year (usually 15 years from first scheme year). These TMs are then assigned to both the DN and the DS networks to give predicted traffic distributions for the design year. ***This predicted traffic map is also worth examining.*** Very often links for which a benefit is claimed at the opening year will have increased their traffic to more than the present level, thus allowing one to comment on the uselessness of the whole investment.

**COBA Costs and Benefits**

The costs and benefits of a road scheme are calculated over the Design Life (usually 30 years). The direct costs are construction and maintenance. ***If the COBA value (see below) is positive but not high it is worth pointing out that Highways Agency construction cost estimates are on average exceeded in outturn costs by about 30%.*** The benefits of the scheme are computed as the difference in costs deemed to be experienced by society arising out of vehicles driving on the DN and DS networks. Only two elements of these costs are computed: 1) accident costs and 2) motorist time and vehicle operating costs (usually the dominant factor)

**Fixed Trip Matrix:**

COBA only works on the assumption of what it calls a Fixed Trip Matrix. This is a confusing term but means that at any time in the design life the network differences between DS and DN do not change the motorised trips that are taken, they will merely alter the way those trips assign themselves to the network. Thus COBA ignores any *rescheduling* (the possible change of time of day when the trip is made), *redistribution* (the change of origin or destination), *modal shift* (change to different vehicles or even to a non-road transport form) or *generation* (new trips).

**Accident Costs:**

COBA models the accident cost of a network by assigning accident rates to links and junctions of known type and modelled traffic levels. Usually the engineer confines the process to defining the types of links and junctions and COBA works out its values on the basis of accident figures for roads of the specified type, but the engineer has some powers to modify this use local accident data to overrule the COBA averages, but has to make a case for doing this- ***the objector should seek to check that this is being done reasonably*** – for example if, in the print-out of COBA, a significantly large accident cost is computed at a given junction in the system, it is well to ask where the input data for that junction came from. A single large historic freak accident at one junction, for example, ought not to be given statistical validity over the average accident rate for such a junction type unless there is good reason given that this particular junction has this inherent danger in it.

**Time & Vehicle Operating Costs:**

COBA groups traffic according to vehicle types and purpose (working, commuting and other) and assumes average proportions of such vehicles and purposes and the vehicle occupancies. For the occupants of the vehicles it then assigns a value of time ranging from about £22 per hour for a working driver to about £3.70 per hour for a non-working, non-commuting trip. COBA also contains formulaic representations of the costs per km of running a vehicle as a function of speed.

COBA divides the day up into five flow group levels to allow for daily variations. There are also a whole set of seasonality factors used. At a given time (flow group) the modelled traffic level is used to compute the speed of traffic on a link and the mean delay at a junction of a particular type, using simple empirical formulae. Such formulae are also used to compute speed as a function of geometrical road factors like hilliness or bendiness, which the engineer must specify.

A flow group for a given link will thus have a distribution of vehicle types with a distribution of purposes and a distribution of vehicle occupancy travelling at a computed speed over a known distance. The vehicle operating costs and the people's total time traversing the link are thus computed – the 'Link Transit Costs'. Similarly operating costs and time delays are computed for junction negotiation – the 'Junction Delay Costs'. For every link, for every junction for every flow group, for every day of the year all these costs are summed up.

***Perhaps the most important thing to do in examining COBA print-out is to look for transit costs on particular links or delay costs at particular junctions that indicate the onset of gridlock.*** The formulae for speed-flow and junction capacity are naturally such that close to congestion the costs will rise substantially. When a junction or link goes beyond its capacity, COBA has the quaint little property of assuming a fixed maximum cost for a vehicle on that link or at that junction – effectively assuming that all the trips still take place (so incurring costs elsewhere on the network). The build up to congestion is easily detected in a COBA print-out by observing the costs rapidly accelerating in the few years before reaching capacity, followed by a constant high level. Identification of these points on the network is important because these are the places that are generating the benefits. ***One can sometimes discover that all the benefits of a scheme come from some small part of it that could be tackled by simpler, less damaging works than the full scheme.***

**Design Life Summation - Discounting**

For the DN and DS networks COBA will compute the user costs and the accident costs for each year of the 30-year scheme life. It will also compute the additional maintenance costs of the DS network for each year of the scheme life and the construction costs in each year of construction. The user costs and accident costs are dependent on traffic forecasts. In order to sum up the costs over the scheme lifetime it is necessary to introduce the standard discounting process the Treasury demands of any investment. The discounting principle is straightforward. In the following we assume we are talking about real money, corrected for inflation.

If the Treasury wishes to invest £1, it could do so risk-free by putting the money in a bank with an interest rate of $f$. In $N$ years the value of that investment would be £$(1+f)^N$. That value is the benefit of today's investment in N year's time.

Logically a benefit £B in $N$ years time will have an equivalent cash value today of £B/$(1+f)^N$, because the Treasury could put this money into the bank now and have £B in $N$ years time – this equivalent value today is called the *'Discounted Value'*. Similarly a cost £C expected to be incurred in $N$ years time can be covered now by an investment in the bank of £C/$(1+f)^N$. This money we have to provide for now to cover a cost incurred or to secure a benefit in $N$ years time is called the *'Present Value'* of that cost or benefit. The cost-benefit analysis is then logically carried out on the present values of all the costs and benefits over the scheme lifetime.

The *'Net Present Value' (NPV*) of a scheme is the difference between the sum of present value Treasury costs (i.e. for construction and maintenance) and the sum of present value benefits. To measure its investment worth (i.e. the return) this net benefit must be compared with the investment (i.e. the present value costs). The key COBA measure is thus:

$$\frac{\text{Net Present Value}}{\text{Present Value Costs}}$$

This measure is usually expected to be positive, but can be negative if the Government decides that there are other non-economic benefits to outweigh the poor value for money (as for example it would argue for Stonehenge). Of course, if the value is very small, an objector can argue that the non-quantified environmental disbenefits of the scheme easily outweigh it – obviously that's what objectors are usually trying to do, but the *NPV* can be a good figure to hang an argument on – 'You mean to say that the DfT thinks this landscape is worth less than £NPV?'.

**Further Reading:** The COBA process is explained quite clearly in a DfT publication available at: http://www.dft.gov.uk/stellent/groups/dft_econappr/documents/sectionhomepage/dft_econappr_page.hcsp

COBA does not investigate the economic factors relating to changes of TM. In particular it does not look at modal shift. TUBA is a more recent appraisal process that is supposed to cover such issues and is discussed in a separate paper. The issue of traffic generation resulting from a scheme was raised by SACTRA and the HA has attempted to compute aspects of this at a very few inquiries. This process is controversial and we hope to write a paper on this in due course.

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