
THE QUADRO 2021 MANUAL

PART 0

THE APPLICATION OF THE QUADRO MANUAL

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2. INTRODUCTION

General

- 2.1 This manual describes the computer program QUADRO (QUEues And DELays at ROADworks). The purpose of the program is to provide a method for assessing the total cost of major road maintenance works. An obvious element is the direct works cost of, for example, resurfacing or reconstruction. However, there is another element of cost which can be just as important as the works cost, namely the cost imposed on road users while the roadworks are being carried out. There are three elements of this user cost; delay (value of time), vehicle operating costs, and accident costs. When assessing maintenance works, the total of the works and road user costs should be taken into account. QUADRO will calculate this total. It can be used to compare the full costs of alternative maintenance options and to assess the maintenance implications of different options for road improvements.

Background

- 2.2 The first version of QUADRO provided estimates of traffic delay and resultant costs over a single 24-hour period for one maintenance job. Further development led to QUADRO2 (Ref 0.1) which represented a considerable advance since it would either, for example, evaluate full maintenance costs over a 30 year period, or provide costs for a single job and so assist decisions on current maintenance when traffic delays may be significant. QUADRO2 was compatible with COBA9 (Ref 0.2). QUADRO3 (Ref 0.3) superseded QUADRO2. It incorporated the results of research carried out by the Transport Research Laboratory and consultants who further observed the behaviour of traffic at roadworks situations. It also included revised information on traffic behaviour without roadworks to be compatible with COBA10 (Ref 0.4).
- 2.3 QUADRO4 (Ref 0.5) was developed to be compatible with COBA11 (Ref 0.6). In order to appraise road projects consistently with other modes, it was necessary to move COBA and QUADRO from a 'social cost calculus' to one based on 'willingness-to-pay'. These concepts are fully explained in the "Transport Economics Note – 2001" (Ref 0.7), now superseded by TAG Unit A1.1. There were also other modifications to the COBA economic values and the layout and context of the results tables that had to be included in QUADRO. The QUADRO user will find it helpful to refer to the COBA Manual when a more detailed explanation of some of the economic concepts is needed.
- 2.4 Deleted.
- 2.5 Deleted.
- 2.6 Deleted.
- 2.7 Deleted.

Who Should Use QUADRO?

- 2.8 QUADRO has been designed primarily for use by the Highways England and its suppliers, although it may also be of value to local authorities for non-trunk roads. The main use of the program is likely to be for the motorway network and those parts of the all-purpose network which carry high flows, particularly of heavy vehicles. There are two distinct groups of users of QUADRO. The first group comprises maintenance engineers who are assessing major maintenance works which are likely to create traffic delays. QUADRO will enable such users to estimate the full cost of different types of maintenance works (in broad terms) and different timing of works.
- 2.9 The second group of QUADRO users comprises engineers assessing new road schemes. Their interest is in

evaluating future maintenance implications of proposals for road widening or new road construction. In a few cases these maintenance implications might affect the decision whether to go ahead with a scheme, or the choice between different routes. More frequently they will influence the choice of carriageway provision (number of lanes) and the pavement design. This group of QUADRO users may also use the program to estimate the user costs incurred during the construction stages of schemes.

How QUADRO Works

- 2.10 QUADRO calculates the total works and user costs of maintenance tasks, either specified individually or a part of a life-cycle profile of maintenance activity over the life of the road. For each task the cost and timing of the works are specified by the user, along with information on traffic flows, the traffic arrangements at the site, and a representative diversion route around the site. The program contains an iterative assignment model for allocating traffic to the diversion route if the site becomes overloaded. The effect of the works is evaluated by calculating the time and vehicle operating costs incurred by all traffic on the network, both with and without the works. An additional model assesses the time costs associated with breakdowns and accidents which occur on the site. The costs associated with the accidents themselves, throughout the network, are also calculated. Output available from the model includes information on the speed, queuing, and diversionary behaviour of traffic on an hourly basis, plus cost summaries by type and vehicle category.
- 2.11 The total works and user costs, for a particular maintenance task or profile of tasks over the road's lifetime, are then discounted to a base year. This enables maintenance tasks which occur in different years to be compared on a common basis. When comparing two maintenance tasks or two maintenance life-cycle profiles, the economically preferred task or profile is the one with the lowest total discounted cost.
- 2.12 When assessing profiles of maintenance cost over the economic assessment period, the traffic delay costs are assessed using forecasts of future traffic. QUADRO2021 incorporates a single 'central' default traffic growth profile consistent with the DfT Road transport forecasts 2018 Scenario 1 (Ref 5.6).

Application of QUADRO

- 2.13 For **individual maintenance tasks**, it is only worth applying QUADRO if both the task and the associated traffic flow are sufficiently large to affect traffic significantly over a reasonable period of time. The program may contribute to the following decisions:
- i) selection of life-cycle maintenance strategy for the existing road;
 - ii) the appropriate type of maintenance. For example, there may be a choice between frequent but cheap works and infrequent but expensive works. There may also be a choice between high priced works with minimal traffic disturbance and cheaper options with more costs being incurred by the road user;
 - iii) the timing of maintenance operations in the life-cycle context, given future developments of the road network and traffic flows;
 - iv) traffic management arrangements (considered broadly) and the scheduling of works in the context of the road network and traffic flows (through the day and year), for example, the consideration of night-time working.
- 2.14 In the consideration of **new road schemes**, QUADRO estimates of full maintenance costs can be incorporated in economic evaluations. It must be remembered that when a new road is built, the maintenance requirements of the surrounding network must also be considered. The maintenance cost aspect can have a role in the following decisions:
- i) **whether or not to proceed with a scheme.** In some cases the assumption that

maintenance costs on a new road will be offset by savings on the old network will apply, but in the majority of cases, and notably road widening schemes, the costs of maintenance in the future without the improvement can be crucial;

- ii) **the choice between scheme options.** Differences in future maintenance costs may be sufficient to swing the balance in a few cases, but generally they will not be significant;
- iii) **the choice of carriageway standard.** In marginal cases, future maintenance costs may favour the provision of an extra lane (or hard shoulder);

2.15 It should be noted that it will not be necessary to run QUADRO for some new road schemes where no significant savings or extra cost of traffic related maintenance is expected with the addition to the network, or where such considerations will have little impact on standards (because, for example, diversionary routes are readily available). In such cases, reasons for not undertaking a QUADRO analysis should be clearly stated in the economic analysis report.

2.16 QUADRO is a powerful assessment tool but it has some limitations that the user should bear in mind. Improvements in some of the relationships specified within the program have been noted above, but the uncertainty inherent in all forecasting applies in this field as elsewhere. The program cannot be used for detailed assessment of traffic management arrangements, since it is not able to distinguish fine differences in site layout. Also, schemes where works severely affect junctions are usually not suitable because the QUADRO method is link-orientated. The program was developed primarily for use in rural areas, and although it can be used with urban schemes, detailed representation of complex diversion possibilities is not practicable. In urban areas, delays to traffic resulting from construction and/or future maintenance can sometimes be computed by using the same congested assignment package as used to predict the overall traffic effects of the scheme. Standard economic parameters can then be used to value these delays by inputting the traffic details into TUBA (Ref 0.11).

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PART 6. HOW TO USE THE QUADRO PROGRAM

None

PART 7. QDIV (QUADRO DIVERSION)

None

4. ENQUIRIES

All technical enquiries or comments on the QUADRO Manual should be sent to:

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ANNEX A. ABBREVIATIONS

| | |
|-----------|---|
| AADT | Annual Average Daily Traffic Flow |
| AAHT | Annual Average Hourly Traffic Flow |
| AST | Appraisal Summary Table |
| AT | Accident Type |
| ATC | Automatic Traffic Count |
| COBA | <u>C</u> ost <u>B</u> enefit <u>A</u> nalysis computer program |
| CPI | Consumers Price Index |
| DCO | Data Check Only |
| DETR | Department of Environment, Transport and the Regions |
| DfT | Department for Transport |
| DM | Do Minimum |
| DMRB | Design Manual for Roads and Bridges |
| DOT | Department of Transport |
| DTLR | Department for Transport, Local Government and the Regions |
| DS | Do Something |
| GDP | Gross Domestic Product |
| GNATA | Guidance on the New Approach to Appraisal |
| GOMMS | Guidance on the Methodology for Multi-Modal Studies |
| HA | Highways Agency |
| HETA | Highways Economics and Traffic Appraisal Division (now ITEA Division) |
| HVDF | Heavy Vehicle Diversion Factor |
| INCA | <u>I</u> ncident <u>C</u> ost <u>A</u> nalysis computer program |
| ITEA | Integrated Transport Economics and Appraisal Division (formerly HETA Division) |
| LGV | Light Goods Vehicle |
| MCC | Manual Classified Count |
| NATA | New Approach To Appraisal |
| NPV | Net Present Value |
| NRTF | National Road Traffic Forecasts |
| NTS | National Travel Survey |
| OGV | Other Goods Vehicle |
| OGV1 | Other Goods Vehicle - Category 1 |
| OGV2 | Other Goods Vehicle - Category 2 |
| PCU | Passenger Car Unit |
| PH or PHV | Percentage of Heavy Vehicles (OGV1+OGV2+PSV) |
| PIA | Personal Injury Accident |
| PSV | Passenger Service Vehicle |
| PVB | Present Value of Benefits |
| PVC | Present Value of Costs |
| PVY | Present Value Year |
| QDIV | <u>Q</u> UADRO <u>D</u> IVersion computer program |
| QUADRO | <u>Q</u> Ueues <u>A</u> nd <u>D</u> elays at <u>R</u> Oadworks computer program |

| | |
|--------|---|
| RPI | Retail Price Index |
| TEE | Transport Economic Efficiency |
| TEN | Transport Economics Note |
| TRL | Transport Research Laboratory (formerly TRRL) |
| TRRL | Transport and Road Research Laboratory |
| TUBA | <u>T</u> ransport <u>U</u> ser <u>B</u> enefit <u>A</u> ppraisal computer program |
| VIEWER | Computer Program for viewing QUADRO output |
| VOC | Vehicle Operating Costs |
| VOT | Value of Time |
| WebTAG | Web based Transport Analysis Guidance |
| WLCM | Whole Life Cost Model |