Travel time savings for freight transport

October 15th, 2003

AVV Transport Research Centre
Drs. P.M.Wortelboer-van Donselaar

Inhoudsopgave

. . . . . .

1. Introduction

1.1 Background

In the Netherlands, Cost Benefit Analysis (CBA) is considered an indispensable tool in evaluating transport infrastructure projects. After elaborate discussions on the measurement of benefits in major transport infrastructure projects, a research programme on the economic effects of infrastructure (OEEI) was launched, resulting in guidelines about the way that the analysis needs to be calculated and presented. The timesavings resulting from an improvement in transport infrastructure are an important direct effect in the cost benefit analysis of an investment in infrastructure. In a recent evaluation of the OEEI guidelines it was advised to further improve the quality of input values for the most important direct effects, which include travel timesavings.

With the above-mentioned in mind, the Dutch Ministry of Transport, Directorate General of Freight Transport and AVV Transport Research Centre, have initiated a study for updating of Freight Value of Time (VOT), as the currently used values date from 1992. Apart from price indexation, the value attached to freight travel time and reliability of transport is expected to have changed as a result from logistical developments and from developments in research techniques.

Logistical developments
The logistical developments include the further increase of containerisation degree of transported goods, the increased importance of cargo volume instead of weight, and the developments in logistics production principles such as JIT and 3rd and 4th party logistics providers.

Reliability is an increasingly important determinant for logistical choices. Also, the 1992 study did not distinguish between carrier and shipper VOT. Estimates in the literature of the additional Value of Time based on the goods transported compared to the transport based VOT vary between 6 and 60%. The valuation of reliability could further influence VOT.

Finally, the casualness of measuring travel time savings in terms of savings of the transport unit per tonne or tonne kilometre has been reduced. Increasingly the *value* or *volume* of transported goods is of importance.

Research developments
Also from a research point of view, developments have taken place since 1992. A lot of progress has been made in the development and application of techniques in behavioural experiments, such as Mixed Logit and RP/SP modelling, which may lead to a more detailed assessment and better interpretation of the value of time.

1.2 Preparation to the Research

In preparation to the main research activities as described in this paper, a Research Plan was developed[1]. The plan was based on an extensive literature study and a workshop including an international panel of experts. The paper sketches the state of the art of freight VOT studies and provides a qualitative and quantitative comparison of outcomes from a large number of studies. It describes the dynamic logistic background of the VOT in freight, including linkages between VOT and "value of reliability". It explains the importance of understanding this logistics background for a correct interpretation of logistics costs and benefits in CBA. It summarises the approach and intermediate results of the new freight VOT estimates in the Netherlands. Finally, recommendations are provided for further research and application of these new statistics in policy analysis.

A number of options for the main research have been elaborated, from which the option of a factor cost analysis in combination with a comprehensive Stated Preference and Revealed Preference was selected as the soundest approach. The factor cost method is used to determine the unit costs of transport. In addition to this, extensive SP/RP research was done to determine the additional VOT of shippers and transporting companies. Also a proposal for the segmentation of values according to transport mode and freight segment has been put forward.

1.3 Importance of interpretation of the indicators

From the literature scan in the Research Plan it can be observed that quite some attention has been devoted to the calculation of freight value of time, and on the other hand there is very little guidance in the interpretation. For a widely supported Cost Benefit Analysis, practical guidelines for a proper and consistent application of the values are as necessary as the indicator values themselves, even more so in freight transport. Compared to passenger transport, the travel time benefits in freight transport are more difficult to interpret. Unlike the equivalent in passenger transport (passengers), the decision maker is not the transported product, but might be a complicated number of different actors (carriers, shippers) each with their own value of time.

Examples of questions and complications when applying VOT statistics in Cost Benefit Analysis are:

- Is reliability of transport included in the value of time or should additional calculations be made?
- Is there a regional segmentation in value of time (related to intensity of congestion, economic activity of the region)
- What is the impact on value of time if the frequency of the transport service is changed?
- Is there a difference between values of time for national or international transport?
- Is value of time a continuous value (is the VOT for 1 car x 60 minutes identical to 60 cars x 1 minute)?

[1] TNO-INRO, Mu Consult (commissioned by AVV Transport Research Centre, Ministry of Transport) "Plan van aanpak actualisatie kengetallen Reistijdwaardering Goederenvervoer", june 2002.

- What is the relationship between the value of time and total trip length (is a 10 minutes saving on a total trip length of 30 minutes more valuable than 10 minutes on a trip length of 4 hours)?
- Which value related to value of time per type of transport mode in case of the valuation of modal shift?
- Which value to use for calculation of future travel timesavings?
- Is segmentation according to time of day necessary?
- How to deal with delivery time windows in city centres?

In short, the main research results will emphasize not only the accurate figures of value per unit of time. The study will also provide a practical guideline for the proper appliance and interpretation of freight value of time.

1.4 Structure of the paper

The current research (and this paper as well) focuses on road cargo transport. In the next few months, new VOT calculations will also be made for the modes rail, inland shipping, sea shipping and air cargo. These modalities have a similar interest in the development of correct travel time savings figures. However, due to budgetary reasons it proved impossible to combine all modalities into one research effort.

The SP/RP experiments have not been executed by AVV Transport Research Centre itself, they were commissioned to consultancy company Rand Europe in association with market research bureau Veldkamp/NIPO.

This paper will give insight into the approach to calculating (road) freight VOT in the Netherlands, and will compare preliminary results with calculations in other European countries and earlier Dutch research.

Chapter 2 shows the research approach to the calculations. Chapter 3 gives an overview of the calculation results and conclusions.

2. How to calculate freight travel time savings?

. . . . . .

This chapter is based on the paper from author and De Jong, "Nieuwe waarderingen van reistijd en betrouwbaarheid voor het goederen wegvervoer".[2] It gives insight into the way the new travel time indicators have been assessed.

2.1 Requirements to the analysis

2.1.1. Segmentation

The travel time savings financial indicators need to be further segmented into areas of road cargo transport or type of product transported. The modality used has been selected as the main item of segmentation rather than the type of cargo transported. This was done under the assumption that most cost-benefit analyses are connected to a specific modality and not to a specific type of cargo. For instance investment in road development benefits all types of goods transported.

It has been argued that the segmentation should provide further detail. However, the value added of such a level of detail is constricted by the level of detail in the application for which the travel timesavings are needed (detail of traffic models and statistics, detail of the cost benefit analysis, etc.). It should also be noted that the budgetary consequences of additional segmentation with the instruments of stated and revealed preference, are steep.

The main research of truck freight travel timesaving will therefore focus on the following road freight segments, and use the price level of January 1st, 2002.

- Containers;
- Low-value raw materials and semi-finished products, non-containerised;
- High-value raw materials and semi-finished products, non-containerised;
- Finished products with risk of value loss during transport, non-containerised;
- Finished products without risk of value loss during transport, non-containerised;

After developing the Research plan, the cost components of transport were calculated (NEA, TNO-INRO, Transcare, 2003). Factor costs include:

[2] De Jong, G (Rand Europe) and Wortelboer, P (AVV Transport Research Centre) "Nieuwe waarderingen van reistijd en betrouwbaarheid voor het goederen wegvervoer", CVS paper 2003.

- fixed costs (depreciation, interest, insurance);
- variable costs (repair, maintenance, tires, fuel);
- labour costs (wage, social burdens);
- specific travel costs (material, inspection, permits)
- general costs (offices, computers, etc.)

Table 1 shows the results of the earlier developed factor costs analysis, with the chosen road cargo segmentation. The below calculations are the starting point for the main research involving stated and revealed preference. It is assumed that the travel timesaving indicators may end up higher but also lower than the indicated factor cost levels. Lower because of the inclusion of fixed costs elements in the factor costs calculation and higher because of additional arguments logistical arguments and the value of goods transported.

Table 1. Results from factor costs analysis cargo road transport (in €/tonne km, price level January 1st , 2002)

			per km

Source: NEA, TNO-Inro, Transcare, 2003

2.1.2. Shippers versus transport companies

Various assumptions with respect to differences in valuation between shippers and transport companies will need to be tested.

It is assumed that shippers will put a different value to travel time savings than transport companies. Whereas a shipper, in the cases that he doesn't have his own transport means, will only value the time that his cargo is under way and/or too late, transporting companies bear the costs of non-productivity of their transport fleet. Other assumptions include the following:

- The option that transporting companies may also take into account the travel time valuation of his shipper, for reasons of reputation and the competitivity of the market.
- Shippers with their own transport means may have a higher valuation because they want to be 'in control' of the transport.
- Shippers on the receiving end of the transport may have higher costs of time loss due to delays in the production process
- On the other hand, shippers on the sending end of the transport may loose business opportunities for market development.

In order to test these hypotheses, SP interview respondents were selected amongst transporting companies, shippers with own transport facilities and shippers without transport facilities alike, and 'sending' shippers versus 'receiving' shippers.

2.1.3. Importance of reliability

Improvements in road infrastructure not only has its impact on the travel time of traffic participants, but may also lead to higher reliability (in the sense of predictability and punctuality) as a result of reduced congestion.

In evaluations of infrastructure projects such benefits are generally not taken into account because of the difficulties with assessing the impact of reliability and because of the absence of estimations of unreliability. The following arguments need to be taken into account when trying to estimate reliability:

- It must be made clear to the respondents that the attribute travel time does not contain any elements of reliability.
- Reliability must be presented in a comprehensive way to the respondents. The use of statistical terms such as variance or deviation should be refrained from. In this research, reliability was defined as '% of transports not in time'.
- Both frequency and length of the unexpected delays is of importance (Cook et al., 1999). Early delivery may also result in additional costs, the issue is the deviation from the optimal moment of delivery.
- The attitude to risk (f.i. neutral or risk-aversity) of the respondent may influence results (Senna, 1991). Possibilities for companies to take into account unreliability are 'safety margins' around a departure time and availability of 'back up' transport. These biases must be taken into account when interpreting the results.

Reliability must be defined in such a way that the values resulting from the research can be applied in cost-benefit analysis. This implies that an overlap between value of travel time and value of reliability must be prevented at any time to avoid an over-estimation of benefits.

2.2 Aspects of SP/RP experiments

2.2.1. Sample size and choice

The Research Plan defined the necessary response per segment as 50 companies, taking into account the type of modelling (mixed logit), the number of attributes and other characteristics of the research.

For budgetary reasons, the number of responses per segment where however limited to 40. This increases slightly the risk of non-significant coefficients but this is within reasonable limits. The total number of interviews is 200 (5 segments times 40 respondents).

The respondents where selected from the databases NIPO Shippers Monitor and for the transporting companies, NIPO Business Monitor.

2.2.2. Main elements of the questionnaire

The SP/RP questionnaire was computer programmed. Separate questionnaires were developed for shippers and transport companies because of slight differences in the focus of the questions (for instance transport costs versus tariff). The structure of the questionnaire is as follows:

- Questions about the company;
- Questions about a 'typical transport';

- Recording of RP choice for this transport and attribute values for the chosen and not chosen alternatives. If there are problems with estimating costs for this typical transport, values from the factor cost analysis are suggested for comparison with the situation of the respondent.
- Within mode SP experiment about first transport;
- Between mode SP experiment about same transport (if relevant);
- Questions about second 'typical transport';
- Recording of RP choice for this transport and attribute values for this second transport.

Within mode experiments are suitable for finding significant values of time. However this research uses both 'within mode' as 'between mode' experiments following the below rules:

- Companies that have the possibility to use another modality for their typical transport: within mode and between mode;
- Companies that can only use road transport for their typical transport: within mode.

In order to improve the realism of the within mode experiment, the first SP experiment can indicate the reason for variations in the attributes (for instance increased costs). Examples to be used are the choice of transport companies by a shipper, with different dimensions of quality and costs. For transporting companies a situation can be described in which an extra charge on transport is being applied. However this could also create resistance to the experiment.

In the second Stated Preference experiment (between mode) a comparison between different modes is made based on the most likely other transport alternative as indicated by the respondent.
The SP experiment then slightly decreases the attractivity of the road mode alternative, and slightly increases the attractivity of the other modality. This way, the trade-off between the two modalities can be shown.

The Stated Preference experiment is contextual or (in other words) customised. This means that the context in which the SP alternatives are presented, and the attributes and their levels are based on information from the respondent. The questionnaire starts with asking information about a 'typical' transport, which is then being applied to further questions asked. The most important advantage is that the experiment becomes more realistic and more fitting to the situation of the respondent. In freight transport, with a high heterogeneity of transport, customisation is even more important than in passenger transport.

2.2.3. Interview technique

A high level of customisation can only be reached with computer aided interviews. This can be done by telephone, via computer-assisted personal interviewing (CAPI), by a visit to the selected company or via internet or diskettes. In this case, interviews by telephone where impossible because the respondent had to weigh options in choice screens. The use of internet was a technical possibility, however it was expected that the response rate would drop significantly and that explanations to questions would be missed. For this reason, the CAPI instrument was used in personal interviews, after an inquiry by telephone to select the proper respondent. The interviews where held in the office of the

respondent; the respondent was invited to look at the questions on the laptop and to make a choice from the presented situations. The interviewer types in the answer and gives an explanation when necessary.

2.2.4. The attributes in the SP analysis

The following attributes (characteristics) have been included in the Stated Preference experiments.

- Transport tariff (for shippers without own transport) or transport costs (shippers with own transport and transport companies);
- Transport time (door to door);
- Reliability of transport time (operationalised as percentage 'not in time' at place of delivery, in the questionnaire the average length of the delay is also asked.
- Frequency;
- Damage risk;
- Travel mode (for the between mode experiments).

In earlier research from HCG, RTC en NIPO (1992), the factor reliability was already taken into account. Model results where that a 10% higher risk of the shipment not being in time, was valued to correspond to 5-8% higher transport costs. In this research, the relative weights have been calculated in the same way. For mode choice en choice of transport company, the flexibility in terms of short lead time was proven to be an important factor.

The following levels have been chosen for the attributes in the SP experiments:

- 5 levels for costs, time and reliability;
- 3-5 levels for other attributes.

2.2.5. Analysis of the SP/RP experiments

A simultaneous model with RP and SP data is developed, comparable to earlier developed models for interpreting freight transport information with SP/RP experiments.

The advantage of combining SP and RP data in a simultaneous model is the link between actual preferences from the RP survey. This helps in estimating reliable results. The SP information is necessary to model the trade-offs between attributes or between modes. This results in proper parameters for time and costs. The applied model is mixed logit which has a high level of flexibility regarding correlation problems.

A usual problem with SP data is recurrent measurements from the same respondent for several hypothetical choice situations. This may result in overestimations with variables showing exaggerated significant results. This problem is dealt with by distinguishing individual components and by applying specific methods for partial samples (jackknife method).

3. Preliminary results

. . . . . .

At this moment, the research into the travel time values of road transport has not been finalized yet. The preliminary results and conclusions are indicated in this chapter and will be updated and specified during the ECTRI young researchers seminar.

3.1 New indicators for valuation of road freight transport time

Table 2 shows the preliminary results of the SP/RP experiments that have been calculated as described in chapter 2. For the segments finished products and containers, the quality of the results did not allow for a separate estimation. The factor costs in the second column are multiplied with the elasticity time/costs from the SP/RP segments and then multiplied to arrive at the VOT. The elasticity can be interpreted as follows. The value 0,78 indicates that an increase in travel time with 10% is comparable to an increase in transport costs with 7,8%.

Table 2. Preliminary results from SP/RP experiments: value of travel time

Segment	Factor costs per transport unit, per hour (€ price level 1-1-2002)	Elasticity time/costs	Travel time valuation (€ price level 1-1-2002)
Low-value raw materials and semi-finished products, non-containerised	Truck Combination: 56	0,78	44
High-value raw materials and semi-finished products, non-containerised	Single Truck: 37 Truck Combination: 52	1,00	Single Truck: 37 Truck Combination: 52
Finished products with risk of value loss during transport, non-containerised	Small: 27 Single Truck: 37 Truck Combination: 52	0,84	Small: 23 Single Truck: 31 Truck Combination: 44
Finished products without risk of value loss during transport, non-containerised	Small: 27 Single Truck: 37 Truck Combination: 52	0,84	Small: 23 Single Truck: 31 Truck Combination: 44
Containers	Single Truck: 36 Truck Combination: 51	0,84	Single Truck: 30 Truck Combination: 43

Source: Rand Europe

The table shows that the VOT's (from transporting companies and shippers with own transport facilities) are equal to or lower than the factor costs calculations per hour. As the factor costs include costs that are not variable (administration costs, etc) which are not influenced by variations in travel time, it is not surprising that the results are lower.

In addition to differences in value of time by freight type, some other observations were consistently observed as well:

- Short distance transports have a higher value of time
- Large companies have a higher value of time
- Large shipments have a higher value of time.

From the SP/RP experiments a value for reliability of transport can also be deduced. The elasticity in the third column shows the appreciation of the respondents for 'being in time'.

Table 3. Preliminary results from SP/RP experiments: value of reliability

Segment	Elasticity in time/not in time	Additional component value of reliability	Travel time valuation, including reliability (€ price level 1-1-2002)
Low-value raw materials and semi-finished products, non-containerised	0,18	1,18	52
High-value raw materials and semi-finished products, non-containerised	0,22	1,22	Single Truck: 45 Truck Combination: 63
Finished products with risk of value loss during transport, non-containerised	0,46	1,46	Small: 34 Single Truck: 45 Truck Combination: 64
Finished products without risk of value loss during transport, non-containerised	0,46	1,46	Small: 34 Single Truck: 45 Truck Combination: 64
Containers	0,46	1,46	Single Truck: 44 Truck Combination: 63

Source: Rand Europe

There is a heated discussion if the above component of reliability may be taken into account in cost-benefit analysis. Because of the way the questions were put to the respondents and the accompanying explanations, there seems to be little risk of double-counting benefits of reliability. On the other hand, by using the reliability value as a mark-up over freight travel time, a fixed relationship is assumed between value of travel time and reliability. This implies that any investment in infrastructure resulting in time savings, will have the same relative impact on reliability.

3.2 Comparison with other travel time research

The preliminary results can be compared with earlier research of Dutch freight VOT, and with results from other (European) countries.

In 1992 (HCG, 1992), similar research of freight values of time took place in the Netherlands. The results are indicated in table 4.

Table 4. Results of 1992 HCG study Dutch Freight value of time

Segment	Factor costs per transport unit, per hour (€ price level 1-1-2002)	Elasticity time/costs	Travel time valuation (€ price level 1-1-2002)
Low-value raw materials and semi-finished products	34	1,03	35
High-value raw materials and semi-finished products	36	1,08	39
Finished products with risk of value loss during transport	35	0,93	32
Finished products without risk of value loss during transport	36	0,83	30
Average			33

Source: Rand Europe

Compared with the results of the earlier research (with prices indexed to the level of 2002), estimations of the freight value of time are higher due to higher estimated factor costs. On the other hand, the observed time/costs elasticity's are lower. This may imply that costs of transport have become increasingly important compared to transport time.

From various publications, the Research plan had also identified freight values of time in other European countries. The below table shows main results from other European research, in average values for road transport.

Table 5. Average VOT values for road transport in €/hr, price level 1-1-2002

Country	Year	Method	Travel time valuation per transport unit
Sweden	1992	Logit	22
Great Britain	1995	Logit	117-151
Norway	1994	Box-Cox Logit	0-224
Norway	1995	Box-Cox Logit	0-146
Denmark	1996	Logit	101-229
Sweden	1998	Logit	0-315
Denmark	1998	Logit	7-24

Source: TNO-Inro en Muconsult (2002)

The table shows a high diversity between countries. Usually the differences seem to be the result of the specific structure and analysis method chosen. Even within a country,

consecutive research leads to quite different results. It is good to notice that the comparison between the Dutch research results of 1992 and 2003 does not show such a big diversity.

The preliminary indicators from the Dutch 2003 research are within the lower end of the range indicated in the above table and thus not inconsistent with the above results. The comparison of values has however important implications for the use in cost-benefit analysis. Infrastructure investment with the same characteristics would receive a much more favourable cost-benefit result in for instance Denmark than it would in the Netherlands if time savings are an important aspect in total benefits. It is unlikely that this can be explained by the difference in wage levels. In the past, guidelines for European values of time were developed (EUNET/SASI, 2001) with a distinction between 'drivers wage costs' and 'goods costs which are the value to the user' but they show the same fluctuation in outcome between countries.

3.3 Preliminary conclusions

Conclusions can be drawn with respect to the research sample population and with respect to the preliminary indicators of freight VOT and reliability.

Research samplepopulation
Interesting though not immediately representative for the entire road freight transport sector in the Netherlands are some characteristics of the sample population:

Transport mode choice

- 73% of the respondents have own transport facilities (all road freight units, 1 inland ship).
- None of the respondents has a railway connection, 2-3% have a loading facility inland shipping or sea shipping.
- For 21% of all transports an alternative modality was considered feasible: 22% railways, 17% inland shipping, 2% sea, 13% air; 46% other types of road transport The interviewed shippers and transport companies, who make use of road transport for the in the SP experiment defined 'typical transport', generally don't see an option for the use of other transport modes (railways, inland waterways, sea shipping, air transport). This implies that for their situation, no modal choice situation applies. In these cases, between mode experiments cannot be executed.

Transport pattern

- Median transport distance of road transport: a little more than 50 km.
- Route choice is done by the transport company in 50%of the typical transport, in 20% by the shippers and 30% by the truck driver (indicating a non-specified route).

Transport organisation

- Shippers: 41% delegates transport organisation to a transport company. 23% has own facilities.
- Transport costs are usually paid for by the shipper who sending away its finished products.

- Over 30% of the respondents cannot indicate transport costs without help from the factor costs analysis. After information from the factor costs analysis, half of the remaining respondents is able to give an answer, 18% remains unaware of the costs.
- In-time delivery is necessary in 34% at arranged time, 3% at time window, 35% without time arrangement

Transport performance and satisfaction:

- Only 19% of the typical transports is never too late. On the other hand: for 80% of transport flows only 10% is too late.
- Median delay percentage in relation to total transport time is 5%.
- 87% of the respondents is satisfied with the road transport option, 3% is (very much) dissatisfied.
- For road transport, the attribute frequency seems of lesser importance than the other attributes. Usually, most shipments transported by road depart 'on-demand'. It is expected that this attribute will be of more importance for the other modalities.

Freight value of time

Comparison with 1992 research results indicates that costs of transport are becoming even more important compared to other transport aspects. Compared in identical (2002) price levels, the factor costs have also increased significantly during the last 10 years. Comparison with European values of time has proven to be difficult due to the different approaches to calculation. Attention is necessary for the consequences when applying these values in cost benefit analysis. Outcomes of identical infrastructure projects are more favourable in countries with a high value of time.

Further steps in the development of freight value of time indicators

The Dutch 2003 research study of freight value of time has not finished yet. This makes the formulation of recommendations rather precocious. For sure, more effort must be put into the interpretation of the 'reliability' indicator and its appropriateness for cost-benefit analysis. Also, the questions as described in paragraph 1.3 with respect to user guidelines still need to be addressed in the next few months.

4. Literature list

- Adviesdienst Verkeer en Vervoer (2001); Adviesnota strategische modellen goederenvervoer; AVV, Rotterdam.
- Adviesdienst Verkeer en Vervoer (2003); Probleemstellende notitie hoofdonderzoek reistijdwaardering goederen wegvervoer; AVV, Rotterdam.
- Cook, A.J., P. Jones, J.J. Bates, J. Polak en M. Haigh (1999); Improved methods of representing travel time reliability in SP experiments; European Transport Conference – 1999, Cambridge.
- Eijgenraam, C.J.J., C.C. Koopmans, P.J.G. Tang and A.C.P. Verster (2000); Evaluatie van infrastructuurprojecten: leidraad voor de kosten-batenanalyse; Onderzoeksprogramma Economische Effecten Infrastructuur; CPB en NEI, Den Haag en Rotterdam.
- EUNET/SASI (2001), Final Report EUNET.
- Hague Consulting Group, Rotterdam Transport Centre en NIPO (1992); De reistijdwaardering in het goederenvervoer, Rapport Hoofdonderzoek; Rapport 142-1 voor Rijkswaterstaat, Dienst Verkeerskunde, HCG, Den Haag.
- Hague Consulting Group (1992); Study into the social benefits of goods transport by road, the conjoint analysis; Rapport voor de International Road Transport Union, HCG, Den Haag.
- Jong, G.C. de and Wortelboer, P.M. (2003); Nieuwe waarderingen van reistijd en betrouwbaarheid voor het goederen wegvervoer, CVS paper 2003.
- NEA, TNO-Inro en Transcare (2003); Factorkosten van het goederenvervoer: een analyse van de ontwikkeling in de tijd; Rapport voor AVV, NEA, Rijswijk.
- Senna, L.A.D.S. (1991); Risk of delays, uncertainty, and travellers' valuation of travel time variability; 19th PTRC Summer Annual Meeting, Brighton.
- TNO-Inro en Muconsult (2002); Actualisering van de kengetallen voor tijdwaardering in het goederenvervoer: plan van aanpak, Eindrapportage; TNO-Inro rapport 2002-34, Delft.