BASIC QUALITY CRITERIA FOR ROAD LIGHTING

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The application of the results of the Visual Performance Committee in public lighting relates to two distinct questions:

- which types of road require public lighting,
- if public lighting is required, what should be the quality and quantity of it.

As public lighting is expensive, warrants should be based on cost-effectiveness considerations. Costs may be expressed in monetary and energy terms; the effectiveness can be expressed in terms of road safety, of driving comfort, esthetics and amenity, of civil safety and of economic benefits. It is generally accepted to concentrate on road safety.

When only a few aspects, or even one, determine both costs and benefits, and when furthermore both can be quantified, cost-effectiveness considerations can be straightforward and simple. In practice, however, many aspects are involved at the same time, aspects that cannot be expressed always in the same dimensions, and sometimes cannot even be quantified at all. Cost-effectiveness considerations can only be part of the information needed by the policy makers when a decision must be made regarding certain countermeasures - or regarding the choice between alternative countermeasures. In road safety this is usually the case, as costs and particularly benefits are related to monetary values and casualties, and effects like human suffering, which cannot be quantified are involved. Finally, usually budgets are quite restricted so that other aspects play an important role in the decision-making process as well. Summing up, cost-effectiveness considerations can be set up by researchers, but they will be applied in conjunction with other (political) issues by the policy makers when coming to decisions regarding road-safety measures.

When the effects on road safety are large, the cost-effectiveness assessments can be based directly on accident studies. This is the case for the question whether major urban and suburban roads should be lit. Many studies point out a 30% reduction in night-time injury-accidents. The two questions given above, however, require knowledge of the <u>derivative</u> of the cost-effectiveness function - in other words: small increments of the effectiveness.

For this, accident surveys cannot be applied as the samples required are excessively large. Two approaches are possible:

1. Model considerations, in which it is postulated that the cost-effectiveness relation can be split up in a causal chain, based on the supply-and-demand concept (supply must at least equal demand). In this chain the intermediate variable is some measure of conspicuity. The chain looks as follows: Costs - Installations parameters - Supplied conspicuity // Demand conspicuity - Driver behaviour - Accidents.

In relation to the results of the studies of TC-3.1 a number of remarks should be made:

- conspicuity as introduced here differs from visibility as defined in TC-3.1; at present it is not known how;
- the model proposed by TC-3.1 pertains only to the supply side;
- critical situations (potential or actual collisions) are not strongly related to critical visual-task elements;
- the system suggested by TC-3.1 is at present too complicated for practical application; furthermore, it is primarily aimed at office tasks.

When these difficulties are solved, however, the visual performance approach can yield important contributions.

Here, the visibility distance approach as worked out by Economopoulos should be mentioned. Although here the visibility of objects is measured, also here the results cannot be applied directly for nearly the same reasons as given above.

From these considerations, the SC-1 of TC-4.6 concluded that both the visibility level approach and the visibility distance approach are useful, the first for further fundamental assessment, the second for comparisons between alternative lighting schemes. Both, however, require further elaboration before they can be applied, and, more fundamental, both are restricted to the supply side only.

2. The alternative approach is to apply conflict analyses. Here, the cost-effectiveness relationship is not split up into a chain, but the effectiveness is expressed in terms of the reduction in the number of conflicts instead of the number of accidents. Obviously, a <u>known</u> relationship between conflicts and accidents is

presupposed. The advantage is that the number of conflicts is usually a great many times larger than the number of accidents, so that the sample size can be reduced down to quite manageable dimensions. This is illustrated in the pioneering study of Gallagher: the number of conflicts collected in a couple of nights would require many years if accidents were used. The conflict-analysis method has three major drawbacks which make it at present rather useless.

- The relationship between conflicts (in the past) and accidents (in the future) is unknown, but in all likelihood it is very weak. More particularly, for the frequent conflicts (weak conflicts) it is nearly non-existing. (This is not surprising: it is well known that even accidents in the past are only a poor predictor for accidents in the future!)
- The observation techniques for conflict analysis are still under development. As all techniques applied at present involve subjective assessments by observers, it is very difficult to deduce quantitative data that can be generalised.
- At present, conflict techniques use off-the-road observers, who assess the behaviour of drivers. The study under consideration, however, requires insight in the experience of drivers. It is well known that the relation between experience and behaviour is often ambiguous - if it does exist in the first place.

Conflict studies can be applied in the field of road lighting provided that the above drawbacks are overcome.

In conclusion, it can be stated that for the future the approach of the Visual Performance Committee will be essential for road lighting questions; at present, however, the applicability of the results of that group are very limited. Furthermore, provided the methods are drastically improved, conflict analyses can offer important alternatives.

From the work of TC-4.6 two specific questions of a more fundamental nature do arise:

- In the area of tunnel lighting, it is of primary importance to be able to assess the state of adaptation of the visual system in different situations, particularly when the foveal area is dark in a field with very bright surroundings. The question is whether the well-known glare formulae (e.g. Holladay) are valid and whether these (or similar) formulae can be integrated over large areas in the field of view. An answer to this question is also important for a further specification of glare-restriction requirements in road and vehicle lighting.

- In order to set up more precise recommendations for tunnel lighting, it is necessary to investigate in more detail and on a more fundamental level the time-dependent phenomena within the visual system (adaptation effects) particularly in large fields with very high luminances and in the 100 millisecond region.

These two points show on the programme of SC-3 (Tunnel Lighting) of TC-4.6. They will be investigated by this SC in a practical way, as time is pressing to issue a statement regarding tunnel-entrance lighting. However, the two questions seem to be of interest in this aspect as well. It is hope that other CIE TC's will tackle them as well, on a more fundamental basis.