GAUTRANS ROAD SAFETY AUDITS

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ABSTRACT

A number of road safety audits were undertaken by the Gauteng Department of Public Transport, Roads and Works (Gautrans) according to the methodology developed by the National Department of Transport. Apart from the obvious reasons for undertaking road safety audits, the objective of the project was also to evaluate and test the road safety audit methodology.

The aim of this paper is to report on the findings of the project, as well as proposed modifications to the road safety audit methodology. An important conclusion of the project is that road safety audits can have significant advantages. All road authorities should consider implementing road safety audits on all projects involving changes to the road network. All projects should preferably be audited, from the smallest to the largest.

A number of modifications to the road safety audit methodology are proposed in the paper. The modifications include the provision of a methodology for the undertaking of site inspections, changes to checklists used for road safety audits, and a change to the approach to safety audits on existing roads.

1. INTRODUCTION

Road Safety Audits have developed over the past number of years as an essential tool to assist road authorities to plan, design and maintain their roadways to become safe and reliable facilities for road users. The South African National Department of Transport followed the example of the rest of the world and has developed the South African Road Safety Manual (SARSM) to assist practitioners in the undertaking of road safety audits.

A limited number of formalized road safety audits have previously been undertaken by the Gauteng Department of Public Transport, Roads and Works (Gautrans). A project was therefore initiated for the undertaking of a number of road safety audits according to the methodology developed by the National Department of Transport. Apart from the obvious reasons for undertaking road safety audits, the objective of the project was also to evaluate and test the methodology developed by the National Department of Transport.

The aim of this paper is to report on the findings of the project, as well as proposed modifications to the road safety audit methodology. These modifications are aimed at improving and streamlining the road safety audit methodology. An important conclusion of the project is that road safety audits can have significant advantages, and that road authorities should consider implementing road safety audits on all projects involving changes to the road network.

2. ROAD SAFETY AUDIT METHODOLOGIES

The road safety audit as a safety check for new and road improvement schemes, was originally developed by British traffic engineers in the early 1980's (Proctor, 2001). The Institution of Highways and Transportation (IHT) published Guidelines for the Safety Audit of Highways in 1996.

Austroads, the association of Australian and New Zealand road transport and traffic authorities also developed a road safety audit manual in the 1990's. The second edition of the manual was published in 2002 (Austroads, 1994, 2002). The document describes the current practice in Australia and New Zealand on the formal conducting of road safety audits.

The South African National Department of Transport published the South African Road Safety Manual (SARSM) in 1999 as a best practice guideline to road safety engineering. The road safety audit process is covered in Volume 4 of said manual.

The methodology as described in SARSM was mainly followed during the project, with some adjustments based on the British and Austroads methodologies. Some of the changes to the South African methodology proposed in this paper are based on these other methodologies.

3. AIM AND DEFINITION OF ROAD SAFETY AUDITS

The Road Safety Audit process was developed with the aim of improving the safety of the road system. The purpose of a road safety audit is to evaluate a project for safety deficiencies before a project is actually implemented. The advantage of a road safety audit is that significant road safety improvements can be achieved if safety problems can be avoided before they are built. The philosophy is that it is easier to change pencil lines on a plan than reconstructing an unsafe section of road.

The different road safety manuals have adopted similar definitions for road safety audits. A safety audit is generally defined as '*an examination of any project that may affect road safety by a independent and qualified audit team with the purpose of identifying aspects or elements of the project that have a high accident potential'*.

The aim of a road safety audit is only to examine a project in order to identify safety deficiencies and it is not an accident or hazardous location investigation. It can neither be used to assess or rate a project as good or poor, nor can it be used to prioritise or rank projects in terms of needs. It does not replace other accident studies and investigations or even the need for such studies, and is undertaken in addition to existing investigations and studies.

A number of important aspects have been highlighted in the definition of a road safety audit and are discussed in following sections.

4. PROJECTS THAT REQUIRE ROAD SAFETY AUDITS

Road safety audits are undertaken on any project that may affect road safety and are therefore not only restricted to roads. Audits can, for example, be undertaken for land developments that may indirectly affect safety on adjacent roads. The projects are also not restricted to those aimed at improving road safety, but can be undertaken on any project, irrespective of the aim of the project.

Road safety audits are undertaken during various phases of a project:

- During the *planning and design phases* of a project, the plans and designs of the project are examined for possible safety problems. The audits can be undertaken during the various planning and design phases, such as the preliminary or feasibility phase, draft design or basic planning and the detailed design phases (these phases correspond with the *Stage 1 to 3* safety audits of the SARSM). More than one audit can be undertaken during the planning and design phases to ensure that road safety needs are adequately addressed.
- During the *construction phase* of a project (SARSM Stage 4 safety audit), only aspects related to construction activities are examined. The audit team may report on some design deficiencies that may be noticed during the examination, but this is not the purpose of the audit (design deficiencies should have been identified during the planning and design phases of the project). The South African Road Safety Manual (1999) also provides for a *Stage 5 pre-opening* road safety audit during which a final audit can be undertaken before a road is opened.
- According to the South African Road Safety Manual (1999), a *Stage 6* Road safety audit can also be undertaken for an *existing road* as part of the planning and design process.

5. INDEPENDENT AND QUALIFIED AUDIT TEAM

The road safety audit is carried out by a team that is *independent* of the professionals that are responsible for the planning, design and construction of a road. This is to ensure that each project is viewed by independent persons fresh to a project. The process cannot be an "audit" unless the examination is undertaken by a team that is independent of the design process. The design team can undertake a process similar to a road safety audit, but this would be a *road safety assessment* rather than a road safety audit.

It is important that a qualified examination team with appropriate experience and training should carry out a road safety audit. The reason for this requirement is that the road safety audit is not simply a design check against current design standards and procedures. The team must have knowledge and experience beyond that reflected by current design standards and procedures.

According to the Institution of Highways and Transportation (1996), expertise in safety engineering is a combination of competence in the techniques of accident investigation and remedial design. This competence is largely the result of hands-on experience, for "safety engineering has to be learnt – it cannot be taught". The attendance of courses is essential and important, but is not a substitute for experience. The audit team requires a high level of experience in road safety engineering.

The above requirement is confirmed by the South African Road Safety Manual (1999) which states that the audit team must have:

- Expert knowledge in road safety engineering with at least three years of experience.
- At least conducted five road safety audits as a Road Safety Auditor under a Senior Road Safety Auditor.
- Should conduct at least one road safety audit annually.

A problem in South Africa is that accident investigations and road safety audits are not often undertaken (Labuschagne et al, 2002). Proper before- and after-studies of road improvement projects are seldom undertaken and are often not possible due to the lack of reliable accident data. There is thus little opportunity for engineers in South Africa to become experienced road safety experts.

The above indicates that more opportunities should be created in South Africa for professionals to become road safety auditors. A transition period is required during which it must be assumed that road safety audits are undertaken by teams that do not have the desirable level of expertise.

6. ELEMENTS WITH HIGH ACCIDENT POTENTIAL

The road safety audit must only examine a project for aspects and elements with a *high accident potential*. The audit is not an evaluation of the project in terms of other norms or criteria, such as economic and social benefits and no comment can be made on the desirability of the project in terms of such considerations.

The road safety audit is not simply a check for compliance with design standards or design procedures, since such standards and procedures may not necessarily be safe. The audit team may report that a particular element of a road has a high accident potential, even if the element meets design standards. The audit team may check a design against standards should the team agree that non-compliance with the standards could lead to hazardous conditions.

There are various reasons why the simple compliance to standards does not necessary mean that a road is safe.

These include the following (Austroads, 2002):

- Standards may have been developed for reasons other than road safety, such as operation efficiency and traffic capacity.
- Standards cover general or common circumstances and may not be applicable to all conditions.
- Standards are often a minimum requirement. Combining a number of minimum standards leaves no room for error on the part of road users.
- Individual elements when designed to standard may be safe in isolation, but when combined with other elements may create unsafe conditions.
- The standard may in fact be unsafe and could be based on inadequate research or investigations.

7. STUDY METHODOLOGY FOLLOWED DURING PROJECT

The methodology as described in SARSM was mainly followed during the project, but it was also found necessary to consult the British and Austroads manuals during the project. The SARSM does not provide detail information on all aspects of road safety audits, and such information had to be obtained from the other manuals. Some additional development of the methodology was also required during the project.

The study methodology followed during the project included the following:

7.1 Project identification

The first phase of the Gauteng project involved the identification of a list of road projects for the road safety audits. The projects were selected in co-operation with officials of Gautrans.

The selected projects covered the following range of road safety audits stages as defined by SARSM:

- Stage 3 - Detail design stage (14 km total)
- Stage 4 - Construction stage (6 km total)
- Stage 6 - Existing roads (16 km total)

The Stage 6 existing road safety audits constituted less than half the total length of roads audited during the project, but required most of the work due the large number of safety deficiencies identified on these roads. The roads included in the project were selected on the basis of a broad assessment of safety problems on a list of candidate roads.

An attempt was first made to identify existing roads by means of *the SARSM road safety assessment* methodologies described in Volumes 2 and 3 of SARSM (note that the term "SARSM road safety assessment" is used to differentiate it from the traditional road safety assessment methodology). It, however, became evident that these assessments would be prohibitively expensive, even when undertaken on a limited scale. Due to the limited funds made available for this project, it was not possible to undertake these assessments, and an alternative approach was followed.

The approach first involved the establishment of a relatively long list of candidate roads in co-operation with officials of Gautrans. The project team then inspected all these roads, and a broad assessment was made of safety problems at each site. These assessments were then used to select a final set of roads for the Stage 6 existing road safety audits. The roads selected for the audits were possibly those with the largest number of safety deficiencies.

The audit team came to the conclusion that the road safety assessment methodologies described in Volumes 2 and 3 of the SARSM should be reconsidered. An alternative approach may include the use of traditional hazardous location studies for the identification and prioritising of road safety projects. Such studies utilise actual accident statistics for the identification of hazardous locations. Once such locations have been identified, *traditional road safety assessments* can be undertaken with the purpose of pinpointing specific safety problems (these traditional types of assessments differ from those described in the SARSM).

7.2 Site inspections

A road safety audit involves one or more site inspections of each road audited. The site inspections are undertaken during peak hours as well as at night. All elements of the road and its environment are inspected for possible safety deficiencies. Elements that may contribute to accidents are noted and photographs are taken of each such element.

Various approaches to site inspections were attempted during the project, and a methodology was developed which significantly simplified the site inspection process. The methodology is similar to the one described in the Austroads manual (SARSM does not provide such a methodology). The methodology involves the use of strip maps showing outlines of important features such as the roadways, bridges and the road reserve boundaries. These maps are used during the site inspections to indicate any safety deficiencies. Due to space constraints, more information on the methodology cannot be provided in this paper. Details of the methodology can, however, be provided on request.

7.3 Checklists

Checklists are used in road safety audits to assist an audit team in identifying possible safety deficiencies during site inspections and when auditing a plan or design. Such checklists were found to be extremely useful and important during the project, and it became clear during the project that the success of a road safety audit depends on the availability of a well-designed and comprehensive checklist.

Existing checklists were initially used during the project, but the audit team experienced various problems with these checklists. The checklists provided by all the available manuals were tested during the project and were found to be relatively similar.

None addressed all the needs of the audit team, and a new checklist had to be developed during the project that addressed most of the concerns of the audit team. All roads in the project were subsequently audited by means of this new checklist.

One of the problems experienced with the existing checklists is that they create the impression that items can be simply checked as being acceptable or not acceptable. The checklists in fact provide spaces for check marks, although such spaces are provided for another purpose, namely to indicate that an item has been audited. The manuals make it clear that the lists are only provided to remind the audit team of items that should be audited and the lists should not be used for checking off safety deficiencies. The reason for this is that it not possible to provide a checklist that exhaustively covers each possible deficiency. The new checklist developed during the project has been renamed to a "reminder list" to emphasise this point. It is proposed that this term should be adopted in future road safety audits.

A further problem with existing checklists is that different checklists are provided for the different audit stages, although many of the items to be checked remain the same for the different stages. The different checklists had the effect that the audit team had to become acquainted with a new checklist each time a different road safety audit had to be undertaken. The danger of such an approach is that items can easily be missed or misunderstood by the audit team. A *single checklist* was therefore developed that combined all items from different checklists (a number of new items were also added to the list during the project). The audit team easily became acquainted with the combined checklist, and it was found to have significant advantages. Some items on this checklist are obviously not applicable to all stages of the process, but an audit team should be experienced enough to be able to identify those items that are not applicable to a particular audit stage.

7.4 Check against standards

The SARSM allows for the checking of a road against design standards. The Austroads manual, however, makes it clear that the simple compliance with design standards does not necessary guarantee a safe road. A number of examples were found during the project where designs have been implemented according to design standards, but where the road safety audit team came to the conclusion that the standards were inappropriate. Many of these design standards have since been modified, but some roads have been constructed according to these standards. Examples of such standards include minimum access spacing, design of right-turn auxiliary lanes at intersections and bus stop designs.

8. ROAD SAFETY AUDIT FINDINGS

A large number of safety deficiencies have been identified during the project. It is not possible to list all these deficiencies in detail in this paper.

The following is a list of the most common deficiencies that were found:

- *Levels of congestion* on some Gauteng roads are very high. Such congestion leads to driver frustration, which in turn contributes to higher accident rates.
- Poor *access management*, with the result that an excessive number of accesses occur on some of the roads (access control is generally good on Gauteng roads, but was poor on some of the roads audited).
- Lack of formal *public transport transfer facilities* on most of the roads audited, with the result that the road shoulder (and other available elements) is inevitably used as bus stops.

- Lack of *pedestrian* and *cyclist* facilities on many of the roads that were audited. This has resulted in a situation where persons have to walk and cycle on the road shoulder, which in many cases are unpaved. In some cases, relatively large volumes of pedestrians have to cross the road, often in the absence of any pedestrian facilities. At some locations, pedestrians cross the road at night, while no street lighting is provided.
- Lack of *street lighting* on most of the roads**,** particularly at critical locations such as intersections and at pedestrian crossings.
- Presence of various types of *hazardous objects* adjacent to most of the roads audited, and the lack of safe recovery areas. These hazards include drainage structures and ditches, embankments, high fills, loose material and stones, poorly placed traffic signs and advertising billboards, pavement edge drop-off etc.
- *Guardrail installations* on some roads do not provide adequate protection against hazardous objects. In some cases, guardrail supports have been damaged by fire to such an extent that they no longer provide any support to the guardrails.
- Faded *road markings* on many of the roads audited, to the extent that could result in dangerous conditions, especially under wet conditions or at night. A number of incorrectly applied pavement markings have also been identified during the project.
- Non-compliance of *road signs* with the requirements of the National Road Traffic Regulations and the South African Road Traffic Signs Manual (SARTSM). There are many examples of incorrectly installed road signs on the roads.
- *Animals* have also been found grazing in the *road reserve*. Animals could cause serious accidents on high-speed provincial roads.
- Insufficient attention is given to safety requirements during *construction projects.* The impression was gained during the project that contractors consider construction efficiency more important than road safety.

The above represents only a few of the deficiencies that have been identified during the project. It became evident during the project that there are numerous safety deficiencies on nearly every road in our road system. Road authorities face a massive task in addressing and rectifying these deficiencies.

9. DISCUSSION OF STAGE 6 EXISTING ROAD SAFETY AUDITS

Most work during the project went into the Stage 6 auditing of existing roads, although these roads consisted less than half the total number of kilometres audited. These audits are specifically allowed for by SARSM and the first edition of the Austroads manual, but not by the British Manual and the second edition of the Austroads manual. The second edition of the Austroads manual provides for an existing road safety *review* but no longer an existing road safety *audit*. The British manual allows for a pre-opening road safety audit, but no provision is made for the audit of existing roads.

The value of the existing road safety audits was questioned during the project. According to the SARSM, such audits can be undertaken as part of the planning and design process in order to identify safety deficiencies. This approach, however, is contrary to one very important principle of road safety audits, *namely that audits should be undertaken independently of the planning and design process* - it can no longer be called an audit when it forms part of a planning and design process.

A further problem with the use of road safety audits for the identification of safety deficiencies is that such audits tend to produce very long lists of possible problems. This while adequate funds are not available to address even a small portion of all these problems. Furthermore, the identification of road safety deficiencies by means of a road safety audit is not necessarily an indication a dangerous situation.

Road safety audits may then result in limited funds being spent at locations that may not have the greatest need for safety improvements. Locations with the greatest need for improvements can best be determined by means of traditional hazardous location studies and road safety assessments.

The above does not imply that a road safety audit cannot be undertaken of an existing road. Such audits can still be valuable, but as part of *planning or design phase audit*. Site inspections during such an audit are important to establish whether the proposed plan or design has addressed all existing safety problems. This, however, is not an *existing road safety audit*.

10. CONCLUSIONS AND RECOMMENDATIONS

The Gauteng project was probably the first major application of the SARSM in South Africa. The project provided an opportunity to test various stages of the road safety audit methodology in great detail.

A number of important conclusions and recommendations have been made during the project, including the following:

- *Value of road safety audits*
  Road safety audits can be of great value in improving road safety in South Africa. Road authorities should consider implementing road safety audits on all projects involving changes to the road network. All levels of projects should preferably be audited, from the smallest to the largest. Road safety audits should, in fact, become a standard practice with the intention that all plans and designs for changes to the road network must be audited.
- *Road safety assessments*.
  The identification of projects for road safety audits by means of Volumes 2 and 3 of SARSM can be a costly undertaking. Consideration should be given to other methodologies for this purpose, such as *traditional hazardous location* studies, which are used for the identification and prioritising of road safety projects. Once such locations have been identified, *traditional road safety assessments* can be undertaken with the purpose of pinpointing specific safety problems. The term *"Road Safety Assessment"* should also be reserved for the traditional approach to the safety evaluation of existing roads.
- *Site inspection procedure*.
  The SARSM does not provide detailed instructions regarding site inspections during road safety audits. A procedure was developed during the project which was found to be both practical and of great assistance in identifying safety deficiencies. Consideration should be given to the implementation of this procedure as a standard method during road safety audit projects.
- *Checklists*
  No road safety audit should be undertaken without reference to a checklist. Various problems were, however, experienced with existing checklists during the project, with the result that a new checklist had to be developed. This checklist addressed most of the concerns expressed by the audit team. A single checklist can now be used for all stages of road safety audits, while the term "reminder list" has been adopted to replace the term "checklist". It is proposed that consideration should be given to incorporating this reminder list in local audit methodologies.
- *Check against standards*
  An important conclusion of the project was that a road safety audit is not simply a check against design standards. Such standards may be appropriate under specific conditions, but may not be applicable to all situations.
- *Existing road safety audits*
  Consideration should be given to the use of the traditional hazardous location study and road safety assessment methodology rather than road safety audits for the location and prioritising of roads in need of safety improvements. Road safety audits should be restricted to planning and

design projects only (as well as construction activities), and should only be undertaken on existing roads if such an investigation forms part of a planning or design phase audit.

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Biography

Christo van As is a traffic engineer with experience in the field since 1969. He specialises in traffic engineering, although he has experience in fields such as geometric design, network planning, road safety studies, traffic demand modelling, computer applications, statistical analysis, etc. He is a part-time professor at the University of Pretoria where he was involved since 1980 in the presentation of various post-graduate subjects, including Statistical Methods and Traffic Flow Theory. At the university, he was and is also involved as the study leader of PhD and MEng students in the field of transportation engineering.

He has completed a number of research reports for various organisations, including the National Department of Transport. One report is on the setting of South African speed limits in which he originally proposed the 100 km/h speed limit for coaches, buses and mini-buses that is now implemented in the country. He is also a co-author of the Volume 3, Traffic Signal Design of the Road Traffic Signs Manual.

He is also a co-author of the book “Traffic Flow Theory” which is aimed at explaining fundamental principles in the field of traffic engineering. The book also provides a summary of South African research results, particularly of the research that was undertaken at University of Pretoria and the research organisation VIAED of which he was the executive director. Christo van As in 2000 received the Chairman’s award of the Division Transportation Engineering of the South African Institute of Civil Engineering for contributions to the profession.