SURE (Users’ Safety on Existing Roads): A NEW METHOD IMPLEMENTED IN FRANCE TO IMPROVE SAFETY ON EXISTING ROADS

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Abstract:

This paper presents a new method to manage road safety on the existing network. The method derives from a common work developed in France and Germany since 2002, and is currently being applied at the national level in France. The main advantages of the method are, a thorough stake analysis leading to a prioritization of actions, crucial in a context of limited public funds; and an understanding of the road dysfunctions before taking remedial measures. As an illustration, two particular examples of its implementation are exposed.

1 POSITION OF THE PROBLEM

Currently, user's behavior is probably the most important source of improvement in terms of road safety. This is the priority in France. But this does not necessarily mean that measures taken to improve vehicles or the roadway infrastructure are unnecessary. Indeed, drivers, even when respecting the rules, unfortunately continue to make mistakes. Besides, systemic analyses of road accidents have revealed that the “infrastructures” factor was present in 40% of fatal accidents.

In France, for several years, new roads have been designed and built observing state of the art design rules, taking into account road safety. But a great part of existing roads has been built many years ago on previous guidelines that where not as fully aware (compared to today) of road safety issues. Investigations show that the main problem of road infrastructure safety concerns existing roads in France.

This paper aims at presenting a comprehensive road safety method, SURE (Users’ Safety on Existing Roads) which enables road administrations to detect sections within the network where an improvement of the infrastructure is expected to be highly cost efficient; and to implement remedial measures.

The SURE method has been elaborated since 2002 and is now completed, after testing series in 2004. The work is part of an international effort between France and Germany to come up with a reliable and cost effective method on the existing road network. The method has been initiated by the Highways Department (DR) and the Road Safety and Traffic Directorate (DSCR). Its aim is to reduce the number of road accidents and victims on the existing network by making changes to the infrastructures. SURE is a global process that includes the implementation and evaluation of concrete corrective measures, without omitting minor, immediate and even temporary solutions.

SURE is currently being applied nationally in France.

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1 The French Administration directly financed 44M€ of road work in 2005 (not counting local financing)
2 1992-1998 national investigation campaign
1.1 How to deal with the existing network?

For the roads in the process of being designed, countries globally agree on the importance of defining road design characteristics, adapted to each type of road, in order to build safe roads. The principle of comparing road drafts with these characteristics, either by audits or other inspection procedures, is an efficient way to make them respected. But such methods can present strong disadvantages if they are directly transposed on the existing network. Indeed:

- As they will show many divergences, they can imply considerable adjustment work and thus considerable financing without offering a satisfactory prioritization method
- They do not guarantee the best cost-effectiveness ratio
- They often propose actions only on the design of the road or on its equipment, though road operation can also be concerned

Besides, it is extremely delicate to determine infrastructure analysis decision criteria for which:

- A real link between infrastructure features and accidents is recognized
- Deviations are "measurable" and the inspection can be carried out on a large scale
- Deviations can be corrected without totally redesign the infrastructure

Consequently, in order to reduce accident statistics on the existing national road network, contrary to the "road safety audit" methods, it is better to start with the determination of sections on which a maximal reduction in accidents can be expected through an intervention on the infrastructure for a limited cost. Network Safety Management is to reduce future accidents by targeting remedial treatment to sections of the road network where accident cost reduction potential is highest.

This approach is possible when accident data exist and is particularly efficient if accidents are not equally distributed. This is the case in France, and this is why the French ministry has developed a new approach.

2 THE METHOD

SURE applies to a complete road network depending on the same road administration. Up to now, it concerns mainly the interurban road network, including crossing of small build-up areas.

Five fundamental principles guided the SETRA (Roads and Motorways Engineering Department) works, which were carried out with the assistance of the Center for the Study of Urban Planning, Transport, and Public Facilities (CERTU) and the support of the Public Works Regional Engineering Centers (CETE):

- Identification of those parts of the network where we could expect the greatest increase in safety by taking measures concerning the infrastructure
- Basing the method on an understanding of the roadway’s problems. Unlike a normative approach, this makes it possible to meet the wide range of situations encountered
- Complete this device by detecting configurations where the risk is known (especially the treatment of lateral obstacles)
- Privilege a route approach to give priority to providing the driver with a coherent overall perception of the road
Accompany the technical method by a real managerial project, being the only way in which to truly guarantee the success of the process.

2.1 Methodology

The method is based on the sequencing illustrated in Fig 1, in 4 stages.

- **Stake Analysis**
  - Road sections to address in priority are identified, relying on the analysis of the accident report of the last five years on the whole road network, and in terms of efficiency regarding accident reduction.
  - Cooperation between member countries to improve road safety is encouraged within the Union. This resulted in France and Germany setting up a technical cooperation structure many years ago and, in particular, the two countries have worked together to finalize a joint method that will establish the “safety potentials” to be used to rank the routes in the “stake analysis” of the SURE method.
  - This first SURE stage is fundamental as it permits the identification of areas where actions can have a real influence on the number of accidents and their severity. As a result of this cooperation structure, the calculation for determining what areas require priority treatment was inspired by the works carried out by our German colleagues. This cooperation led to a common Franco German method called NSM (Network Safety Management); we can say that the stake analysis stage of SURE is the French development of NSM.

- **Diagnosis and Action Guidelines**
  - Exploit accident reports: Look for accident factors, identify layouts recognized as accident-inducing, develop security objectives, identify action guidelines.

- **Choice, Study and Implementation of the Measures**
  - Elaboration of a pluriannual action plan (security, operation, maintenance, ...), Studies on action projects implementation.

- **Controlling Assessment**
  - Efficiency assessments (before-after), Actions adjustment, 3y evaluation...

Figure 1. SURE’s methodology.

2.1.1 Stake Analysis

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Primarily based on observing accidents, SURE is not a standardizing process. SURE draws its efficiency from its capacity to adapt solutions to the specific nature of each encountered road and context. It represents a realistic and efficient alternative to the abandoned “infrastructure
The purpose of the described approach is

- To determine sections within the road network with a poor safety performance based on accident data and where deficits in road infrastructure have to be suspected and
- To rank the sections by potential savings in accident costs in order to provide a priority list of sections to be treated by road administrations

The safety potential SAPO is calculated as the difference between the current accident cost density of the section ACD within the period under review and the basic accident cost density bACD:

\[ \text{SAPO} = \text{ACD} - \text{bACD} \]  \hspace{1cm} (1)

The basic accident cost density bACD represents the anticipated average annual number and severity of road accidents (represented by the accident costs) per kilometer, which can be achieved by a best practice design at the given average daily traffic ADT. It can be calculated as the product of basic accident cost rate bACR and average daily traffic ADT.

At the end of the stake analysis stage, the road administration has a list of ranked road sections where it is known that they represent a certain potential to save accidents costs.

### 2.1.2 Diagnosis, understanding of the dysfunctions observed

The following task is to analyze the accident structure of the sections in order to detect abnormal accident patterns which can lead to possible improvement measures, and finally to offer the possibility to compare the costs of improvement measures to the potential savings in accident costs to rank measures by their benefit-cost ratio.

First, identification of the uses and functions of the road section: with the support of local authorities, all the necessary information (transit traffic or access road, kinds of users, local specificities linked to tourism, agricultural activity etc.) is compiled in order to understand how the section operates in the present context as well as its possible evolutions following various urban or road projects etc.

Then, the determination of accident factors linked to the infrastructure: accident police reports are analyzed to determine accident-inducing factors linked to the infrastructure. Observations, measures and supplementary investigations are carried out on site to validate or not these accident factors.

Last, identification of layouts recognized as accident-inducing (e.g. in Fig. 2): this consists in a systematic inspection of the section, focusing on those themes that represent stakes at the national level and on which a link between the infrastructure features and safety has been demonstrated:

- Curves
- Junctions
- Shoulders (including fixed roadside obstacles)
- Vulnerable users
2.1.3 Choice, Study and Implementation of the measures

Actions ensue from safety objectives that are identified taking into account those three elements together:

- Uses and functions
- Validated accident factors
- Accident-inducing layouts

Corrective measures can be of different type: road equipment or road marking modifications, road geometry improvement, skid resistance improvement, road operation measures, …

Most of the time, these actions require more advanced definition studies to be developed through that stage. These studies are processed as usual, following design and operation existing guidelines. At that stage, indicators to assess these actions are also defined; Figure 3 presents the potential efficiency of some actions.
### 2.1.4 Assessment of actions

The assessment consists in the analysis of the before and after measures of indicators predefined (ex: speed; road holding, deaths etc.), in the before and after accident report and possibly in a new diagnosis in the case of an unfavorable report.

The overall method will also be assessed after 3 to 5 years of application.

### 2.2 An Example

As an illustration, a national route from central France will be analyzed. The route is 70km long and comprises two Highland domains, separated by the "col de Fix" (1112 m), as shown in Figure 4.

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**Table 1: Potential Efficiency of some actions**

<table>
<thead>
<tr>
<th>Action on infra</th>
<th>Efficiency or model projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic circle</td>
<td>Accident nb = J x 0.15 x 10^{-4} x TE</td>
</tr>
<tr>
<td>Level junction</td>
<td>Accident nb = J x 2.73 x 10^{-5} x Ts^{0.62} x Tp^{0.51} x Fbra x Fvoie x Fc</td>
</tr>
<tr>
<td>Hard shoulder</td>
<td>-20 à 30% ram off roadway accident and frontal collision (width 0.6m à 1.2m)</td>
</tr>
<tr>
<td>Traffic island</td>
<td>-30 à 80% accidents by shear (80% if poor legibility at junction)</td>
</tr>
<tr>
<td>Left turn file</td>
<td>-80% on back collision accidents</td>
</tr>
</tbody>
</table>

Figure 3. Potential Efficiency of some actions.

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3 J: number of years; TE: incoming traffic; Ts secondary traffic; Tp principal traffic; Fbra number of branches; Fvoie number of lanes; Fc annual constant.

Figure 4. RN102.
2.2.1 Stake Analysis

Over 5 years (1998-2002) on 33.6km, there were 97 accidents, from which 49 serious. There was 22 fatalities, 50 seriously injured, and 105 slightly injured.

Figure 5 presents the 3 high-risk road sections as well as the rate and density concerning each section. The average daily traffic is on the 3 sections, respectively, 8700, 4300 and 6800 (vehicle/day).

The route has either 2 or 3 lanes.

![Figure 5. RN102 Stake analysis.](image)

The national references regarding rate and density are:
- Sections 1 and 2; rate =12, density = 0.35
- Section 3; rate = 9.7, density = 0.43

The stake analysis revealed that the safety potential is about €450 000 for those three sections.

2.2.2 Diagnosis, understanding of the dysfunctions observed

There are 7 high-risk road sections and 3 accident types:
- In curve
- On wet driveway
- In slope

The accidents were regrouped in families (Fig. 6) for detailed analysis, and identification of the factors.
After further analysis of each scenario (identification of factors...), action guidelines are proposed, as shown in Figure 7.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Nb</th>
<th>Action guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor grip in curves w/ radius &lt; 250 m</td>
<td>14</td>
<td>- Cross town</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Maintain CTF &gt; 0.5 in curves w/ radius &lt; 250 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Outisle build up areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Maintain CTF &gt; 0.5 in Chazotte, des Carrières de la Denise et de Pouzols</td>
</tr>
<tr>
<td>Poor geometry</td>
<td></td>
<td>According to each location (local clusters)</td>
</tr>
<tr>
<td>Poor legibility, excess right of way</td>
<td>4</td>
<td>Check trees alignment and marker posts</td>
</tr>
</tbody>
</table>

Local clusters were also identified, and dealt with accordingly. Figure 8 presents a junction, were 5 serious accident occurred, and the junction was analyzed as accident inducing, especially because of legibility.
After the detailed analysis (accident factors, layout…), action guidelines were proposed (Fig. 9).

<table>
<thead>
<tr>
<th>Factors</th>
<th>Nb</th>
<th>Action guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity – multiple traffic islands</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Poor legibility for secondary road user</td>
<td></td>
<td>Creation of a roundabout</td>
</tr>
<tr>
<td>Poor configuration for right turn (tangential)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Important flow on secondary road</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Ambiguous marking</td>
<td>1</td>
<td>Modify marking</td>
</tr>
</tbody>
</table>

Figure 9. La Pierre Plantée, action guidelines.

2.2.3 Choice, Study and Implementation of the measures

The actions are currently being implemented regarding both particular examples, and should be finished by the beginning of 2006.
2.2.4 Assessment of actions

Great care was taken in assessing the situation before implementing the measures, and a continuous monitoring is planned.

3 THE CURRENT PROGRESSES

In 2004, the method has been implemented on 15 sections on a simplified way, to demonstrate its feasibility. Less than one year has been necessary to realize the whole method, up to the definition of corrective actions. The more efficient actions have then been programmed for 2005, with a special budget of six million euros, in addition to the existing budget. Some actions have already been implemented, and others are still being implemented (cf. Chapter 2), showing that SURE can lead to concrete results in a rather short time. Organizational feedback, as well as method improvements encouraged the French administration to extend SURE at the national level. SURE is now implemented by each local division of the national road administration. Discussions will be engaged in order to extend and adapt the method to other types of roads. Another 10 million euros has been programmed to finance corrective measures in 2006.

4 CONCLUSION

The originality and the advantages of the approach concerns several purposes:

- It aims at understanding the real dysfunctions specific to each type of road (through the detailed analysis of the development of the accidents that have actually happened) and at providing a realistic solution
- Its efficiency is based on the establishment of priorities between actions to be carried out on the network, according to the expected reduction in accidents
- It proposes a global approach that includes identification of the stakes, diagnosis, proposition and implementation of corrective actions, assessment of these actions
- It integrates a preventive element (as it includes a systematic inspection of the road), adaptable to the context of each country and focused on the infrastructure features that have an impact on safety and on which an adjustment action is possible and recognized as efficient
- It applies as well to the management of "black spots" as to more diffuse accidentology
- It associates road administrations and local communities, and establishes a dialogue on road safety issues

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