A Safer Road With No Accidents – A Case Study

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Abstract

"A Safer Road With No Accidents" is a major project developed and pushed forward by the county council of Seine-Maritime, France. The aim of this innovative and ambitious operation is to provide road users with the safest road on a 25-km rural section. Inspired from the Nordic Nollvisionen (read vision zero) in which no severe accidents should be reported on major roads prone to accidents. This project has been implemented for two years now and different innovative tools and methods have been used to improve safety in the short and the long term: accident studies, road inspections and several audits were carried out in the first stages of the process on existing roads and new projects; in the second step of the on-going process, speed measurements (including V85) are made to improve knowledge of driving speeds and define new safety plans; major and minor junctions were equipped with intelligent sensors and cameras in order to evaluate and calculate the risk associated to crossing movements and prioritise intersection improvements. A communication plan is also put in place to associate road users to the project.

Keywords: road safety; design roads; innovative tools, method; evaluation.

Résumé

« Une route plus sûre sans accidents » est un projet majeur développé et poussé en avant par le Département de Seine-Maritime, France. Le but de cette opération novatrice et ambitieuse est d'offrir aux usagers de la route la route la plus sûre possible sur une section rurale de 25km. Inspiré de la Nollvisionen nordique (lire vision zéro) dans lequel aucun des accidents graves doivent être signalés sur les routes sujettes à des accidents, ce projet a été mis en œuvre depuis deux ans maintenant et les différents outils innovants et les méthodes ont été utilisées pour améliorer la sécurité à court terme et à long terme: études des accidents, inspections de la route et plusieurs audits de sécurité ont été réalisés à différents stades du projet sur la route existante et sur les projets neufs dans les premières étapes du processus, dans la deuxième étape du processus en cours, les mesures de vitesse microscopiques (y compris V85) ont été faites pour définir les points de référence pour d'autres évaluations et de travailler sur les vitesses réelles sur différents sites, les carrefours majeurs et mineurs ont été équipés de capteurs et de caméras intelligentes afin d'évaluer et de calculer le risque associé à la traversée des mouvements et des améliorations à l'intersection des priorités. Un plan de communication a également été mis en place pour associer les usagers de la route au projet.

Mots-clé: sécurité routière; conception routière; outils innovants; méthodologie; expérimentations.

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1. Introduction

Road safety has been designated a priority issue in Seine-Maritime (France), where traffic on the department's 6,600 km road network averages 1,700 vehicles per day. This focus has seen some particularly innovative initiatives by the CDSR (County College of Road Safety), as well as safety improvements along almost 900 km of "strategic" roads.
As part of this modernisation programme, the "A safer road with no accidents" scheme – developed in partnership with the CETE Normandie-Centre civil engineering research centre – is being trialled on the 23 km main road between Yvetot and La Mailleraye-sur-Seine.
Traffic on this route (which includes the Brotonne Bridge) is dense and varied (5,000 to 10,000 vehicles daily, of which heavy vehicles represent between 10 and 17%), making it a suitable choice for this innovative solution, which not only aims to reduce the number of accidents but also features warning and communication systems to warn motorists when they do occur.

Seine-Maritime General Council identified six major strategic routes that, together with the motorways, form a backbone network serving the whole department. These very busy roads have a structural role and are therefore a natural focus area for road safety improvement efforts.
The Yvetot – La Mailleraye-sur-Seine road is one of these six key routes. Seine-Maritime General Council, working closely with CETE Normandie-Centre, set out to make this development a beacon project, implementing the new "A safer road with no accidents" concept developed in partnership with the science and technology network coordinated by the ministry for ecology, sustainable development and energy (MEDDE).
A dedicated, multidisciplinary method was devised in order to trial safer projects that include road safety considerations at the design stage. This method emphasises the role of innovation and includes input from national road safety strategies.
As well as harnessing the benefits of road safety research and enhancing the department's technical expertise, it is hoped that this novel approach will enable the stated "zero-accident" goal to be achieved.

2. Project overview

The Brotonne Bridge across the river Seine opened to traffic in 1977. As part of this project, major road development works were also carried out along a north-south route serving the Pays de Caux area and the wider region.
Research into road usage and behaviour patterns revealed the main peculiarities of this route: the road plays both a local and a regional role and is used by many different categories of road user, resulting in a diversified traffic composition. Typically, traffic density ranges from 5,000 to 10,000 vehicles per day, with heavy goods vehicles accounting for between 10 and 17% of that total. Large numbers of tractors and other agricultural machinery use the road at certain times of year. Similarly, cyclists are a common sight, owing to the region's tourist potential. Around 80% of the traffic on this route consists of local users from the Seine-Maritime and Eure departments, in most cases for home-to-work travel.
These developments, originally designed to be included in a long-term dual carriageway project, have lasted for 30 years.

2.1. Overview of the Preliminary Design

The geometry of this route, originally designed to accommodate an upgrade to dual carriageway, encourages high speeds and the road gradually became more dangerous as traffic levels increased. As a result, in 2007, Seine-Maritime General Council considered a project to improve safety along this route.
A preliminary design assessment was carried out by a firm of engineering consultants, ERA Ingénieurs Conseil. This analysis, which covered the whole route, focussed on the following basic principles:

- Reduce the number of intersections (41 intersections on a 23 km road);
- Decrease speeds and improve safety at intersections;
- Standardise the normal road width to 6.50 m (including edge lines), with 1.20 m multi-purpose shoulders to each side;
- Create parallel service roads for certain road users such as tractors and sustainable means of transport.

The council is currently implementing some upgrades, and others are at the project stage, based on priorities assigned by the steering committee as well as the specific constraints inherent to each upgrade (cost, land and environmental issues, etc.). The detailed design studies inevitably led to renewed debate about some of the choices advocated by the preliminary design assessment, without closing the door to innovation (examples include chicane-type intersections and the slow vehicle lane on the Brotonne Bridge).

3. Innovative approach

For the Yvetot – La Mailleraye road development project in Seine-Maritime, this all-round strategy was adopted in order to incorporate recent advances in our understanding of the role of infrastructure in road accidents. This resulted in infrastructure design and/or development activities intended to create a more "forgiving" road that mitigates the consequences of human error sanctioned by accidents.

However, in a systemic approach to road safety, it is assumed that appropriate road infrastructure upgrades may be able to reduce accidents resulting in injuries by 50% to 60% on a particular road or route. It is not possible to totally eliminate serious and fatal accidents just by modifying the infrastructure. Similarly, awareness-raising initiatives aimed at road users cannot eradicate accidents. The impact of the infrastructure changes is a significant stimulant for social communication, however.
An all-round strategy appears to be the most appropriate, using a range of tools, methods, initiatives and solutions that simultaneously impact the road infrastructure and users' behaviour.

3.1. Goals

The main aim of the strategy is to provide the full spectrum of road users with an intrinsically very safe road on which they can drive with minimal risk of being involved in a serious accident.

The two main levers for achieving this goal are as follows:

- Provide a safe infrastructure, by removing all features liable to cause or aggravate accidents and by designing intrinsically safe road features;
- Modify user behaviour, through awareness-raising campaigns during the main phases of the project actions and by defining communication initiatives that engage with road users and encourage them to become stakeholders in the success of the road safety improvement scheme.

In this respect, the proposed strategy differs somewhat from the "Vision Zero" approach devised and implemented in Sweden since 1997 (Vägverket, 2006; Wiles, 2007), although it shares the same aim of creating road infrastructure that is as intrinsically safe as possible while also including road users in the safety process.

Lastly, assessments and monitoring initiatives were carried out during the various phases of the project, to evaluate the safety impact of the measures implemented along the route. This was achieved using methods based on national policy and experimental tools based on relevant research. Similarly, these monitoring initiatives provide an objective basis on which to define and implement a suitable solution for monitoring and sanctioning inappropriate driving behaviour and non-compliance with regulations.

3.2. Safety diagnostics

In order to take the most effective action possible on the road infrastructure and implement appropriate upgrades, a variety of diagnostic analyses were performed to define the current situation, recommend suitable counter-measures and predict the impact of such upgrades. This diagnostic process covered various areas and was based on an existing methodology (described below).

Existing accident data relating to the route was subjected to several additional analyses covering a range of topics:

- **Study of accidents resulting in injury** that occurred along the route over a five-year period, using the SURE method developed by the MEDDE (Medde, 2012). This method analyses accident reports to define a set of standard scenarios, identifies accident factors, locates problems and assesses the influence of road infrastructure in the studied accidents;

- **Road infrastructure safety inspections** in accordance with the ISRI inspection strategy developed by SETRA (SETRA, 2008), which aims to detect infrastructure-related flaws liable to increase the risk of accident, independently of actual accident data and user behaviour;
- **Better understanding of road use and user behaviour**, obtained through in situ observations and measurements of traffic volumes, speed and other parameters.

3.2.1. Study of accidents involving injuries (SURE method)

The accident study revealed that the accident frequency and especially the accident severity rates for the studied route were high (see Table 1). Over the period 2001-2010, a total of 37 accidents involving injuries were reported, resulting in 14 fatalities and 24 injuries requiring hospital treatment. It would appear that although the accident frequency rate is comparable to that of similar routes in the national network, the number of fatal accidents (14) is particularly high.

Table 1. Accidents involving injuries – 2001-2010 (CETE Normandie-Centre)

Period: 2001-2010	Accident frequency rate	% of fatal accidents
National network (two-way roads)	6.0	18.8%
Yvetot – La Mailleraye	5.2	**29.4%**
Statistical risk	Normal	**Significant**

An analysis of accident categories revealed that:

- 55% of accidents occurred at intersections (compared with a national figure of 10%), due partly to the large number of intersections along the route and partly to the particularly high speeds observed;
- 28% of accidents were caused by a loss of control resulting in a head-on collision or collision with an obstacle. Such accidents tend to be extremely serious;
- 17% of accidents belonged to less common categories, such as rear-end collisions, overtaking manoeuvres and collisions involving pedestrians.

3.2.2. Road infrastructure safety inspection (ISRI method)

The safety inspection brought to light the following significant weaknesses along the route:

- Roadside obstacles with inadequate or no protection;
- Part of the route is cambered to one side only;
- Grassy verges that prevent drivers from returning to the carriageway;
- Poor visibility or situational readability at certain intersections and drive entrances;
- Intersections with non-perpendicular side-roads;
- Unclear road markings and signage.

3.2.3. Speed statistics

Measurements revealed an average speed by free-steered light vehicles (FSV) of 93 km/h (compared with a national average of 81 km/h on two-way roads in 2009), a V_{85} (85^{th} percentile on the speed distribution curve) of 105 km/h, and more than half (54%) of road users exceeding the 90 km/h speed limit (compared with a national average of 24% on two-way roads in 2009) (ONISR, 2011).

4. Proposed upgrades and assessments

4.1. Planned upgrades

The various diagnostic analyses were studied in order to assess the safety issues, prioritise the necessary measures and propose a range of infrastructure upgrades.

Note that particular attention was paid to any residual problems and difficulties associated with the proposed upgrades that would prevent the road safety objective from being achieved. In such cases, innovative solutions were considered.

The preliminary design was adapted to form several construction projects, which were checked using the national RPSM (Road Project Safety Monitoring) road project safety monitoring method developed by SETRA (SETRA, 2005). The proposed upgrades can be organised into three categories:

- The main measures relating directly to actual accidents concern intersections, which may be closed, replaced by roundabouts or redesigned, as appropriate;
- Measures to reduce the number and severity of loss-of-control incidents included speed calming measures and a proposal to standardise the road width and redistribute its profile by adding multi-purpose shoulders (Fig. 1.a);
- The difficulties posed by the diversity of uses were addressed by creating parallel service roads for certain road users (e.g. agricultural machinery and cycles) and devising solutions for the main pedestrian crossing points (Fig. 1.b).


Fig. 1. (a) Multi-purpose shoulders; (b) La Mailleraye footbridge (CG 76, 2013).

In the "A safer road with no accidents" forward-looking study, the question "does the project solve the problem?" was addressed as part of the assessment process. This analysis took into consideration:

- Recent advances in road safety research;
- Accident data for the Seine-Maritime department, which was analysed to assess any features specific to the studied route and to estimate the risk of accidents occurring in similar infrastructure configurations.

This forward-looking assessment highlighted certain aspects requiring additional measures and in some cases innovative solutions, in particular in the following situations:

- Sections of road that slope to one side only, increasing the risk of loss of control: create rumble strips along the road edge and centreline to prevent road users from leaving the carriageway (Anelli et al., 2012), or separate the traffic flows by creating a single-carriageway road with a central reservation, based on SETRA's technical guide (SETRA, 2011);
- Creation of roundabouts offering adequate day-time and night-time visibility and readability: create specially-landscaped and lit roundabouts (with particular focus on the central island - Fig. 3.a);
- Treatment of roadside obstacles: totally eliminate all obstacles, either by removing them or by using passively safe supports (Bisson & Rongrais, 2009a, 2009b) (Fig. 3.b).


Fig. 3. (a) RD131-RD490 roundabout; (b) Passively safe sign posts (CG 76, 2013)

Appropriate intersection development is a key lever for improving safety, in particular by reducing the number of interchange points. The planned intersection upgrades along the studied route fell into three categories:

- Redevelop major intersections as roundabouts;

- Upgrade intersections that are hazardous or a source of concern, both to improve their visibility and readability and to decrease approach speeds on the main road;
- Close secondary intersections located near redeveloped intersections wherever possible, and divert the corresponding traffic to the redeveloped intersections.

4.2. Multi-facetted assessment

4.2.1. Assessment of the intersection upgrade programme

Assessing the impact of the proposed upgrades is no easy task, however, as the small number of accidents occurring at a particular intersection limits the relevance of statistical analyses. This limitation revealed two additional requirements:

- Produce an indicator that enables intersections to be ranked hierarchically and classified based on their potential dangerousness;
- Assess whether the upgrades – once implemented – effectively improve safety.

To this end, a prototype system (Subirats et al., 2010a), based on the SARI research project (Automatic road condition monitoring to provide information to drivers and road managers – Tools for Diagnosis) was implemented at several intersections along the route. This system provides diagnostic data by detecting and recording side-impact collision situations. Side-impact collisions occur when a vehicle on the secondary road enters the intersection while another vehicle is approaching along the main road and reaches the intersection before the first vehicle has had time to move clear. This situation may be particularly critical when driving speeds on the main road are high and the crossing time is short (Fig. 5).

Fig. 5. Potential side-impact collision situation (CETE Normandie-Centre)

The benefit of the new system is to rapidly provide data relating to a significant number of potential accident situations, enabling a risk indicator to be calculated. Such risk indicators can be used to compare and rank intersections (table 2), and to assess the impact of an upgrade at a particular intersection based on the "before" and "after" data thus obtained. Regarding the risk indicator high level, the RD104 and VC2 will be change from intersections to roundabouts.

Table 2. Safety indicator based on data relating to side-impact collision situations at intersections (CETE Normandie Centre)

Intersection	Number of collision situations (24h)	Severity rating	Mean risk rating	Accidents (6 years)
VC8	2.75	0.36	1.0	0
RD104	20.00	0.27	4.9	2
VC2	20.00	0.36	8.3	2

4.2.2. Assessment of the impact on driving speeds

The diagnostic process highlighted fast driving along the studied route as a key safety issue. In order to successfully reduce and control vehicle speeds, speed measurements are necessary in order to assess the related impacts, in particular as part of a multi-criteria approach covering safety, network operation and environmental considerations.

Accordingly, an experimental method (Subirats et al., 2010b) was used to estimate the V85 speed along the whole route. This method uses a combination of roadside spot speed measurements and continuous speed

measurements made by a suitably equipped vehicle travelling in the traffic flow. This yields spot speed distribution data that can be used to calculate V85 and a set of speed profiles on a continuous basis. V85 can then be estimated for the full route by translating the speed profiles to fit the spot V85 value. Figure 3 illustrates the principle behind this approach.

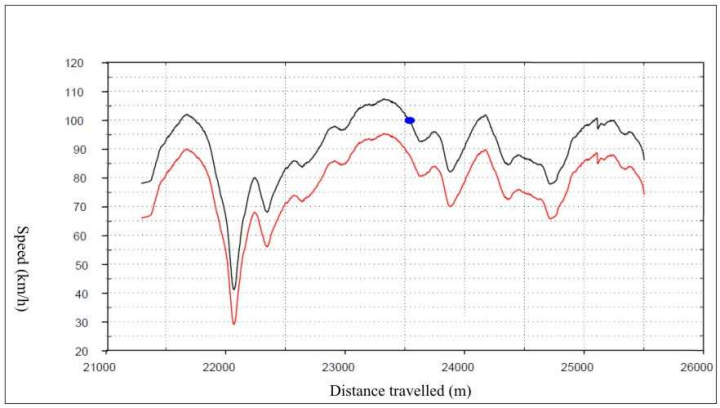

Fig. 3. Principle for estimating V85 along a route: spot V85 (blue dots), measured profile (red curve), estimated V85 profile (black curve) (CETE Normandie-Centre, 2012).

Three spot measurements and four speed profiles were used on this 23 km route to generate a usable V85 profile. Applying this method to the Yvetot – La Mailleraye route produced a speed profile that could be used directly to monitor driving speeds during each phase of the development programme, and to assess the impact of the upgrades on driver behaviour and safety. Figures 4 (a) and 5 (b) illustrate how the V85 speed profile can be used in conjunction with the intersection accident risk indicator before and after a particular road feature is removed. From a practical perspective, new V85 profiles are estimated annually after conducting significant upgrade works.

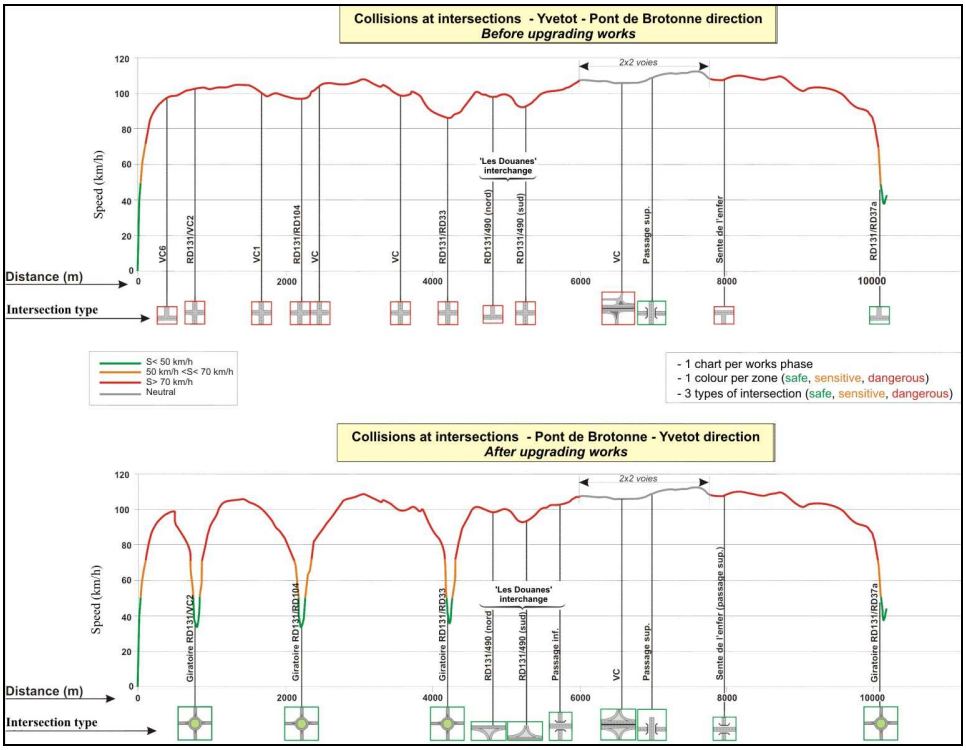

Fig. 4. (a) Estimated intersection accident risk based on the pre-upgrade V85 on the main road; (b) Estimated intersection accident risk based on the post-upgrade V85 on the main road (CETE-Normandie-Centre, 2012).

4.2.3. Multi-criteria analysis

Although roundabouts deliver proven safety benefits when located in accordance with the existing technical guidelines (SETRA, 1998), they may also have a variety of collateral impacts. In this respect, the roundabouts on the Yvetot – La Mailleraye route are being used for research and trials with the aim of conducting an overall assessment of this type of upgrade that focuses on road operation (time lost, time saved, overall increase in journey times, influence on traffic micro-flow, and in particular, the impact on traffic bunching) and environmental aspects (fuel consumption, emissions and noise). The aim is to identify and clarify the zone of influence exerted by roundabouts, in particular regarding the impact on overtaking slots.

Most indicators are calculated using data from in situ measurements that define the nature of traffic movements (traffic composition and properties, driving speed, road user origin/destination matrices, journey times, etc.) as well as the type of upgrade planned (geometric features, intersection design, etc.).
Although some data is used in the same way in different applications, the data's properties may vary according to requirements in terms of precision, observation period, aggregation, etc. A shared data acquisition solution may therefore be desirable. In the case of speed data for example, a single roadside traffic micro-measurement station may be combined with a dynamic profile of the processed speeds, presented in the format required by each using business. The approach adopted for this study uses existing methods and tools for the various study topics, and places particular emphasis on the indicators that must be produced and the data required in order to do so. Sharing data collection processes and procedures is a key issue for this research. Such an approach offers numerous benefits, by optimising and limiting the cost of data collection, and breaking down institutional barriers between the specialist fields concerned.

5. Communication initiatives

Road users' behaviour can be modified through information campaigns as well as by developing appropriate road infrastructure. Conventional forms of communication may be supplemented with innovative techniques such as "binding communication".
The traditional media used for this purpose include institutional materials published by Seine-Maritime General Council and widely distributed to road users and the general population. Seine-Maritime's monthly news magazine features articles about safety improvements and upgrading works on the department's roads. Similarly, targeted information leaflets describe the road safety strategy and explain how to use the new road features.

However, when it comes to encouraging road users to adopt safer behaviour, thereby becoming active stakeholders in achieving road safety goals, an alternative method of communication is more appropriate. With support from the road safety and road user behaviour research teams from CETE de l'Ouest, the strategy adopted for improving safety along the Yvetot – La Mailleraye route was based on the concept of binding communication (Girandola & Joule, 2008).
This concept, illustrated in figure 6, associates "conventional" communication with acts of commitment. More specifically, it sets out to inform by passing on knowledge (persuasive communication) while also soliciting simple acts, performed voluntarily in a particular context, with the combination of the two resulting in the desired behaviour. Binding communication serves both to inform and to modify behaviour through acts of commitment.

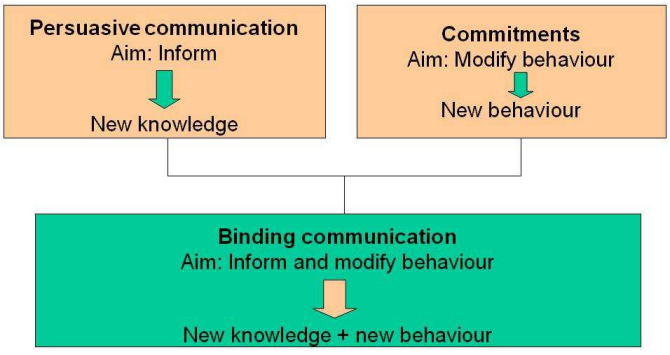

Fig. 6. Concept of binding communication (CETE de l'Ouest, 2012).

This approach will be applied to the Yvetot – La Mailleraye route in 2013 by organising an informative event on the topic of road safety, to be held at a rest area on the road in order to directly involve the target population. The event will inform participants about Seine-Maritime's road safety policy and safety upgrade works, stressing the innovative nature of certain approaches (persuasive communication). In addition, participants will be asked to complete a questionnaire about road infrastructure, prompting them to think about their driving behaviour.
Based on this questionnaire, a pledge form containing a small number of simple actions to which road users can commit themselves will be presented. Motorists who sign up to this voluntary, public undertaking receive a sticker and a special key ring reminding them of their pledge. Similar initiatives have proved effective in changing participants' behaviour (Girandola & Joule, 2008).

6. Conclusions and outlook

The Yvetot – La Mailleraye development project is currently in the works phase, and various modifications and adaptations to the road infrastructure have now been implemented.
Note that no accidents have occurred in the sections of the route that have been upgraded since 2010. The assessment process associated with the project has yielded data relating to impacts on both road safety (accident statistics and risk indicators) and on user behaviour (notably, driving speeds).

Table 3. Accidents evolution after 2 years (CETE Normandie Centre)

Road sections	Number of accidents before Period: 2002-2010	Number of accidents after Period: 2011-2012
Already safety improvements	16	0
Future safety improvements	32	4
Total of accidents	48	4

In addition to the planned upgrades designed to make the infrastructure as safe as possible, a special effort will be made to eliminate any residual flaws having a potential impact on the route's overall safety performance (for example by replacing non-compliant safety barriers and roadside obstacles, and ensuring that road markings and signage are consistent).
Looking forward, there remain several objectives for this project, the most important of which is to finalise the upgrading programme, where appropriate creating multi-purpose shoulders, introducing rumble strips and/or modifying the road profile to calm traffic speeds.
Seine-Maritime General Council has tackled the challenge of making the Yvetot – La Mailleraye route safe by rolling out an innovative strategy in a full-scale project, with the aim of creating a "fifth-generation road" (Hautière et al., 2013) from a road safety perspective.
An overall assessment of the safety upgrade project will be conducted when work is complete. If justified by the results obtained, the new method may be rolled out to all modernisation projects involving strategic links in the Seine-Maritime department's road network.

References

P. Anelli, F. Pardo, & E. Violette (2012). *Roadsense, Prévention des sorties involontaires de voie par alerte routière audio tactile* (Roadsense - Prevention of involuntary lane departure warning by road audio touch alert warning lines). ATEXPO, ATEC-ITS International Conference, 1 February 2012, Versailles, France. http://roadsense2013.eu/

O. Bisson, & M. Rongrais (2009a). *Expérimentation des supports d'équipements routiers à sécurité passive, Document 1: cahier des charges et fiche de suivi* (Experimentation with passive-safety roadside equipment. Document 1: Specifications and tracking sheet). Normandie-Centre civil engineering technical research centre (CETE), Infrastructure operation, safety and management division, Grand-Quevilly, Seine-Maritime, France, November 2009.

O. Bisson, & M. Rongrais (2009b). *Expérimentation des supports d'équipements routiers à sécurité passive Document 2: préconisations de sélection et de pose.* (Experimentation with passive-safety roadside equipment.

Document 2: Selection and installation recommendations). Normandie-Centre civil engineering technical research centre (CETE), Infrastructure operation, safety and management division, Grand-Quevilly, Seine-Maritime, France, November 2009.

F. Girandola & R-V. Joule (2008). *La communication engageante*. (Binding communication). Revue Electronique de Psychologie Sociale, 2, 41-51.

N. Hautière, C. de La Roche, & H. Jacquot-Guimbal (2013). *La "route" de cinquième génération (R5G): Quelle infrastructure dans vingt ans et quels services en attendre?* (The fifth generation road: What infrastructure and what services are expected in 20 years?) Revue Générale des Routes et de l'Aménagement (RGRA), n°910, March 2013, pp 28-35.

Medde. (2012). *Démarche d'amélioration de la sécurité des infrastructures routières: SURE - Sécurité des usagers sur les routes existantes*. (Road infrastructure safety improvement strategy: User safety on existing roads (SURE)). Ministry for ecology, sustainable development and energy (MEDDE), Paris, France. http://www.sure.equipement.gouv.fr/accueil-r50.html

ONISR. (2011). *La sécurité routière en France: bilan de l'année 2010*. (Road safety in France – 2010 annual assessment.) National interministerial observatory for road safety (ONISR), La Documentation Française, Paris, France, 2011.

Setra. (1998). *Aménagement des carrefours interurbains (Guide technique)* (Development of Intercity Road Intersections – Technical Guide). Transportation, roads and road development research department (SETRA), Bagneux, France, December 1998.

Setra. (2005). *Contrôle de sécurité des projets routiers (CSPR): éléments de démarche qualité pour une meilleure prise en compte de la sécurité (Guide technique)*. (Safety monitoring for road construction projects – Guidance for including safety considerations in quality strategies – Technical guide). Transportation, roads and road development research department (SETRA), Bagneux, France.

Setra. (2008). *Démarche ISRI: guide méthodologique*. (Road safety inspections – Methodology guide). Transportation, roads and road development research department (SETRA), Bagneux, France.

Setra. (2011). *2 x 1 voie, route à chaussée séparée (Guide technique)*. (Single-carriageway roads with central reservations – Technical guide). Transportation, roads and road development research department (SETRA), Provins, France, septembre 2011.

P. Subirats, G. Louah, E. Violette, C. Le Lez, D. Doucet, & A. Hublart (2010b). *Estimation de la vitesse pratiquée sur un itinéraire par fusion de mesures embarquées et bord de voie*. (Estimating driving speeds using a combination of vehicle-mounted and roadside measurements). Infrastructure dialogue conference – Vehicles for enhanced road safety (DIVAS), 19-20 October 2010, Nantes, France.

P. Subirats, E. Violette, F. Conche, D. Doucet, & G. Dupré (2010a). *Développement d'un système de détection de quasi-accidents en carrefour*. Minutes of the risk prevention and driving aids conference (PRAC2010), 6 May 2010, Paris, France.

Vägverket. (2006). *SAFE TRAFFIC – Vision Zero on the move*. Swedish Road Administration, Borlänge, Sweden.

Wiles, D. (2007). *Sécurité routière: la vision suédoise fait des émules*. (Road safety – Emulating the Swedish vision) http://www.sweden.se/fr/Accueil/Travailler-vivre/A-lire/Securite-routiere—la-vision-suedoise-fait-des-emules/