IQDE IMAGE QUALITY OF DEPENDENCES AND EQUIPMENT

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ABSTRACT

The definition of a road heritage management policy depends on the knowledge of this one. The Directorate-General of the Roads French already had tools to know the consistency and the state of the roadways (IQRN) and the structures (IQOA) of the National Road network but nothing concerning the road dependences and equipments.
Therefore, Sétra in collaboration with the Scientific and Technical Network has developed a methodology for the inventory and the statement of visual state of equipment and dependences of the road: the IQDE method (Image Quality of the Dependences and Equipment)
The IQDE method defines a method of inventory and indicators of visual state in statistical matter of evaluation of a whole of work.
The IQDE method is based on a visual examination (Quality Image). This makes it possible to state the majority of the dependences and equipment located on the roadway and the immediate surroundings of the road without embarrassment for circulation, Some more distant objects requiring manual statements (cleansing basin for example)

1. GENERAL PRESENTATION OF THE METHOD: OBJECTIVES AND STAKES

1.1. History

Sétra in collaboration with the various members of the French RST* has developed the IQDE method which makes it possible to a manager of the national road network to have an inventory and an formalized and reliable image of the equipment and dependence of its network.

After a period of development and experimentation, the IQDE method was brought up to date in 2005 and was used as a basis for "the exhaustive study" which, following the reorganization of the French road system and the transfer of the national road network to the new DIR*, the aim was to provide a compete qualitative inventory of their inheritance

1.2. Objectives and stakes for the IQDE method in 2007

The objective for 2007 is to realize an operational methodological chain for IQDE usable by any manager , using carried out work and the experiences brought by multiple experiments. An analysis work is too carried out on the various exploitations with this method; moreover, new experiments are in progress to evaluate the cost (material, personal, time) and the reliability of the method.

1.3. Presentation of the method: basic definition and concepts

The IQDE method is a fixtures inventory and the goal is to obtain, as its name indicates it, " a quantitative and qualitative image" of dependences and equipments of road network. The classification of the quantitative state is based only on a visual examination. It must be carried out in a short time. Thus, it is not a visit of monitoring and even less than one expertise.

The step is primarily applied to the backup tape of 7 m, where is concentrated the main part of the "problems" involved in the viability of the road and the safety of the users

- Objects taken into account by the IQDE method

This table carries out a census of equipments and dependences, which are to be taken into account in the various steps of the IQDE method. This list does not constitute an exhaustive inventory and regroupings were carried out, and it cannot be modified and completed according to the network and the local needs.

Field	Dependence/Equipment	Total quantity	
		km	unit
Cleansing	Covered ditch (zone A, B, median reservation)		■
	Weeded ditch		▮
	Other structure	■	
	Weeded basin	■	
	Sealed Basin	■	
	Raising station	■	
	Treatment station	■	

Field	Dependence/Equipment	Total quantity	
		km	unit
BDD (down Levelled Right Band, (except emergency stopping lane) zone A = 0 to 2,5 m from the verge of the carriageway	Mineral surface		■
	Weeded surface		■
	Planted Surface		
Median reservation	Mineral surface		■
	Weeded surface		■
	Planted surface		■
Plane crossroads	Mineral surface	■	
	Weeded surface	■	
Vegetation in current section (zone B, intermediate : 2.5 to 7m)	Weeded surface		■
	Shrub		■
	Tree		
	Timbering		■
Specific installation	Rest areas	■	
	Service areas	■	
	Place of stop/refuge	■	
	Slips access	■	
	Reinstatements of traffic	■	
	Forsaken ground (related to the public domain)	■	
Equipment of collection	Dustbin, container, ...	■	
Traffic Signs and	TS of police force	■	

Field	Dependence/Equipment	km	unit
Marker posts (zones A, B, median reservation and crossroads)	Mark out	■	
	Directional TS	■	
	High poles	■	
	Brackets	■	
	Gantries	■	
Safety fence, crash barrier Device of reserve (zones A, B, median reservation and crossroads)	Slide (metal/wood)		■
	Other devices		■
Equipment of exploitation	Terminals of emergency call	■	
	SIREDO stations	■	
	Weather stations	■	
	PMV*	■	
	Others	■	

Field	Dependence/Equipment	Total quantity	
		km	unit
Other equipment	Traffic lights	■	
	Fence		■
	Small works (opening or height lower than 2m.)	■	
	Anti-noise screens	■	▨
	Other works or equipment related to the infrastructure	■	▨
Earthworks	Work embankment or of cut a height equal to or higher than 9m.	■	
	Work embankment or of cut a height lower than 9m, presenting disorders of stability.	■	
Lightening (zones A, B, median reservation and crossroads)	Lamps poles	■	
	Associated equipment	■	

- Characterization of the objects state

After identification, the evaluation of the state of the object is made according to the following nomenclature: each object is evaluated according to three states

Good state	Medium state	Bad state
state of reference routine maintenance realised	minor degradations Intervention necessary, to repair	Serious degradations priority Intervention, to rehabilitate, this state is analysed as lack of normal maintenance.

Those evaluation of an object is based on an image. Some verifications (base plates for the PPHM for example) require detailed inspections, which are not taken into account by the IQDE method. It is then necessary to refer to the specialized technical guides.

A guide was written for the IQDE method with examples to make the operator able to classify correctly each equipment based on a rapid visual analyse (as on a digital image for example). Moreover cards of statement were realized to allow the practical statement of some equipment (cleansing stations for example…)

Table1:Example of standard methodological card for the analysis of the state of equipment

|		
1.1→ *TRAFFIC·SIGNS·AND·MARKER·POSTS*¶ 1.2→ *Vertical·indication·of·policing*·□	1.3→ –Regulation·panels·and·danger·panels·;·¶ 1.4→ –The·Entry·and·exit·of·agglomeration·panels·are·panels·of·policing·(they·modify·speed).·They·are·evaluated·in·this·heading·□	
¶ **2**→GOOD·STATE¶ *(current·maintenance·assured·)*¶ ¶ -·Identical·to·the·state·of·reference.¶ -·Quite·visible·Panel¶ -·Without·damage·and·degradation.¶ □	¶ ¶ □	
¶ MEDIUM·STATE¶ *(intervention·necessary)*¶ ¶ -·Presence·of·graffiti·or·small·poster.¶ -·Slightly·deformed·panel¶ -·Verticality·of·the·supports·to·redo.¶ □	¶ -·To·repair,·to·clean.¶ □	
¶ **3**→BAD·STATE¶ *(priority·intervention)*¶ ¶ -·Defect·of·fixing·of·the·panel·on·the·support·¶ -·Diluted·panel·(message·badly·perceived·or·not·perceived).¶ -·Panel·and·support·very·twisted.¶ □	¶ -·To·replace.¶ □	

- Numbers of passages

The statement can be realised according to one direction of circulation or in the two directions. This depends directly on what the manager intends to do of "IQDE" results

Thus, if the manager intends to have a "full" inventory of his dependences and equipment, the statement is to be made according to 2 directions' of circulation on bi-directional roads. For the evaluation of average state on a network and to limit the costs, the statement can be made according to only one direction of circulation, it is statistically estimated that the 2 sides of the road present similarities and that the percentage of state good average and bad of equipments are nearly the same ones

2. APPLICATION OF THE IQDE METHOD ON A ROAD NETWORK

If the principle of the IQDE method (census and statement of state) is not complicated, the application of the method in the fields presents some difficulties. The objective of this part is to present the stages to establish a standard methodological organisation as well as their technical details material, human means) to apply the IQDE method to a given network.

2.1.   . Functional diagram of the IQDE method
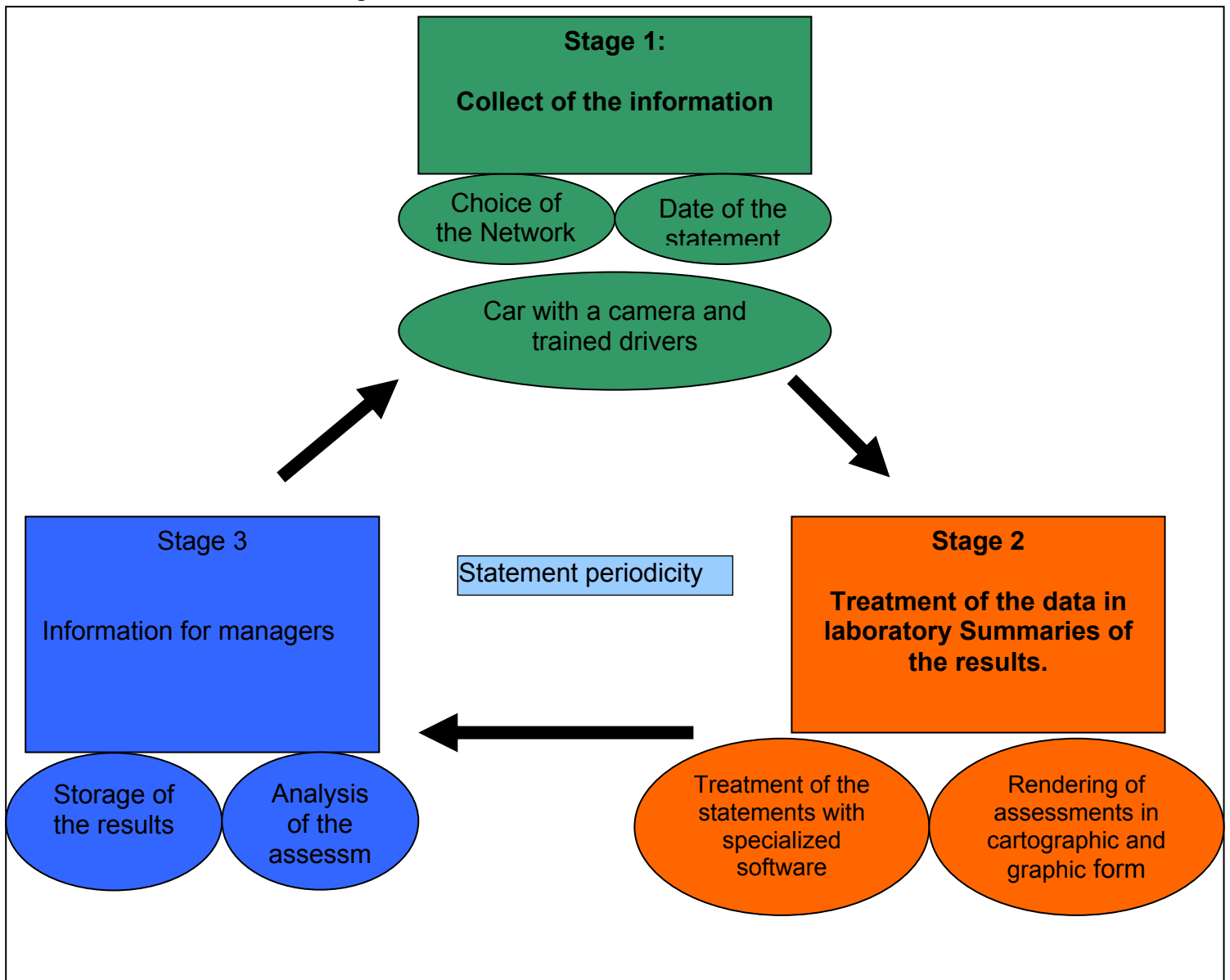
2.2. Application of the IQDE method on a given network

The objective of this part is to define precisely each point of the preceding diagram in order to apply and adapt in a simple way the IQDE method on a road network

2.2.1 Stage 1: Collection of the information

- Type of statement

The statement of image can be conduced in 3 different ways:
-

Type of statement	Video (IRCAN*)	Computer-assisted statement	Manual Statement (Paper)
Speed of statement in the field	Authorized maximum speed on the road where the statement takes place	0 to 15 km/h	Frequent stop

It is envisaged to apply the method on areas in which the circulation speed is on average high (national road network). Indeed, for these roads, it needs a mode of high-output statement with a minimum of embarrassment for users and owners of the road.

Thus, the information collection is realized by a statement campaign of IRCAN* image (completed by visits in the fields for the devices which are not visible from the road or for some points for which the imagery did not give sufficient results). A vehicle is equipped with a camera carries out and the statement of image of the roadway and of its approaches.

The camera collects images of the road and its environment. One image is realised every "n" meters.

Figure 1 : Image collected by an IRCAN camera on a car.

IRCAN technique is adapted because the vehicle doesn't disturb the circulation and recorded images are not affected by high speed. Moreover, as the images have a very good resolution, it is possible to zoom in the image to detect some precise equipment.

Note: this image data bank carries out both safety studies and analyses for the management of the heritage (management of the roadway, of the equipment…)

The aim in the framework of the IQDE method is then to locate the equipment and dependence of the road and to analyse the filmed images in laboratory

- Period *of statement*

As images are taken by a numerical camera IRCAN, the quality of images depends on climatic conditions and on the sun inclination. Moreover, during summer, some equipments and dependences are little visible, (hidden by vegetation. Taking into account those considerations for the IQDE method, the optimal periods to carry out the statements is autumn.

2.2.2 *Stage 2 Data processing in laboratory/Summaries of the results.*
- *Treatment in laboratory of the IRCAN date bank image*

Once realized the bank of data image of the network, the analysis can be done using professional software . Specialized software has been developed for this aim and allows a data processing homogeneous and effective. This software allows a semi-automated input of the equipment, that can be located on the images. This is described in the following stages:

- o *Image processing to allow measurement in 3D "*
  First phase: Calibration: with the camera parameter and the position of the camera compared to the ground level.
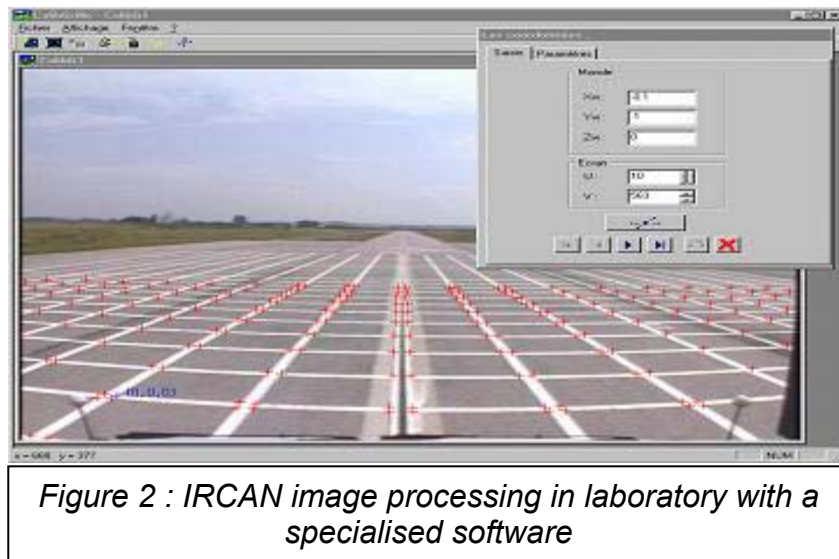
Figure 2 : IRCAN image processing in laboratory with a
specialised software

Measurements are done on the ground level and the grid let the user compensate for the effects of distortion.

- o The image by image analysis of the equipment and dependences

Starting from a list of elements, the operator can define a visual state for a precise equipment and locate its position precisely
 With this specialized software, the treatment of those images is semi-automated, which is an invaluable help for the manual operators
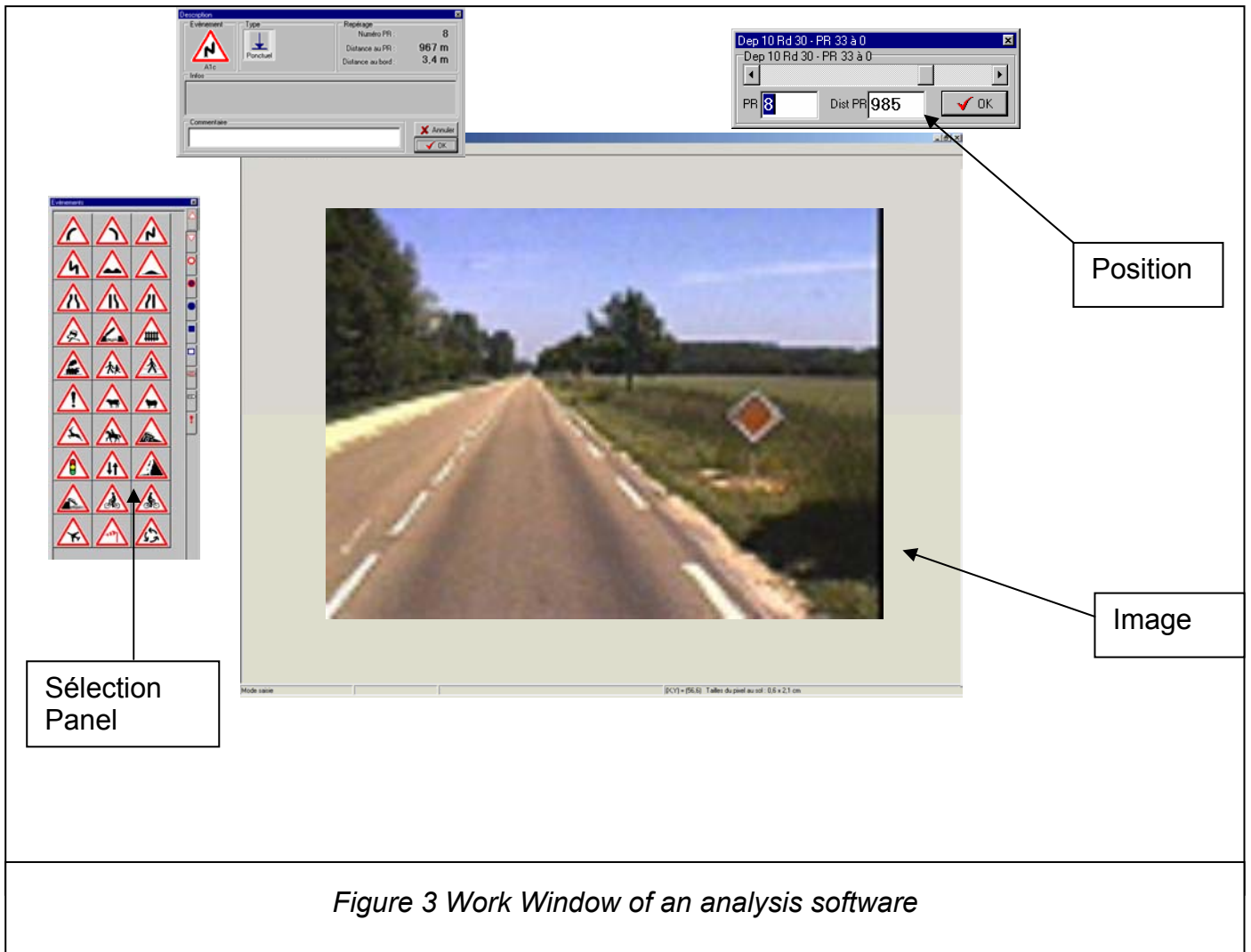
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Figure 3 Work Window of an analysis software

The operation principle of the software for the input is as follows:
-   The operator can scroll the images in a window furnished with this aim: by reaching directly a point specified by its PR* and the distance to this PR*.
-   When an interesting object is met (fig.3 : case of the statement of traffic indication), the operator indicates it with the icons accessible in a tab box (to show the selector of events).

Note :There are modules for each category of equipment and dependences of the IQDE method

Figure 4 : semi-automatic selection of equipment and dependences
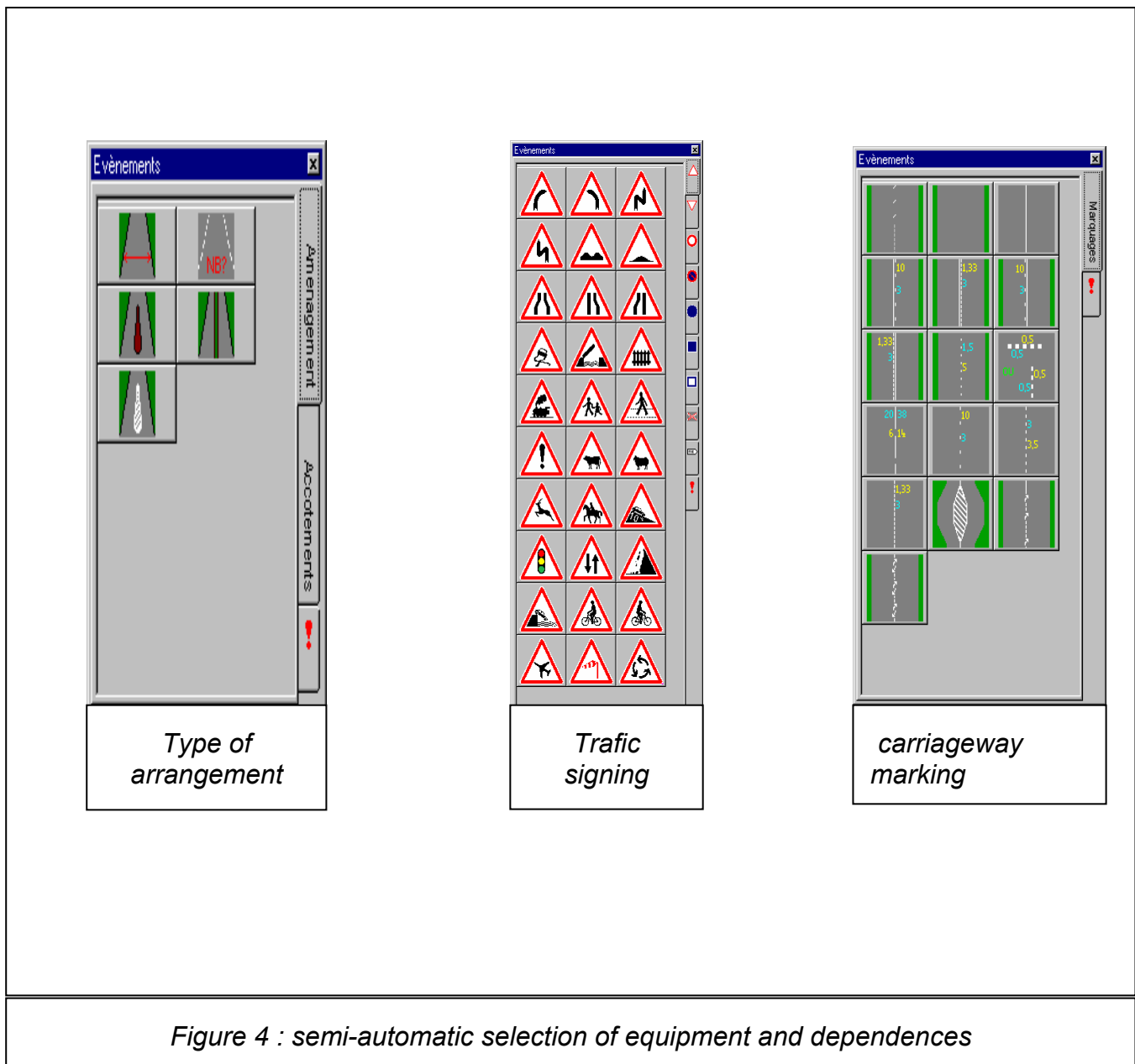
- This leads to the posting of a box of description of the events.
  The operator can enter there additional information (ex: nature of a verge, type of intersection…) and a comment.
- The last operation consists in locating the event by stretching a reference mark to the edge of the covered carriageway. A system of detection of the edge by image processing makes possible the automation the operation: only one mouse click of mouse is enough to stretch the reference mark to the covered edge of the roadway. The treatment is based on an analysis of the pixels colour

- *Periodicity of the statement.*

The period of renewing the information of the IQDE method is directly dependant on the user wants about making exploitation of the information. Thus, information on positioning does not vary a lot. Information on the visual state requires a more important period of renewing.

2.2.3 Stage 3 : Backup of the information to the manager

- *Storage of the elements*

Storage of the collected information in a database is necessary to store in a formalized way to formalized information on the dependences and equipment once it has been treated in laboratory. This conduce to have a simple accesses to the information and then to provide the manager automatically to make syntheses (tables, cartography)

- *Restitution of the analysis; diagram, cartography.*

After the phase of data collection gathering, i.e. the position of the equipment and their visual state, it is necessary to carry out a rendering of the results for an effective and relevant exploitation. A summary of the results can be carried out according to the needs and uses of the manager. Thus for a network a synthesis by types of equipment and dependences can be established gathering by the following information:
- The quantitative of equipment
- The average state of the equipment

For this purpose, the data can be integrated in a cartographic database, that allows obtaining a map with various levels of details (roads, communes… territory).

For the whole of a network, the restitution with graph or histogram seems adapted.
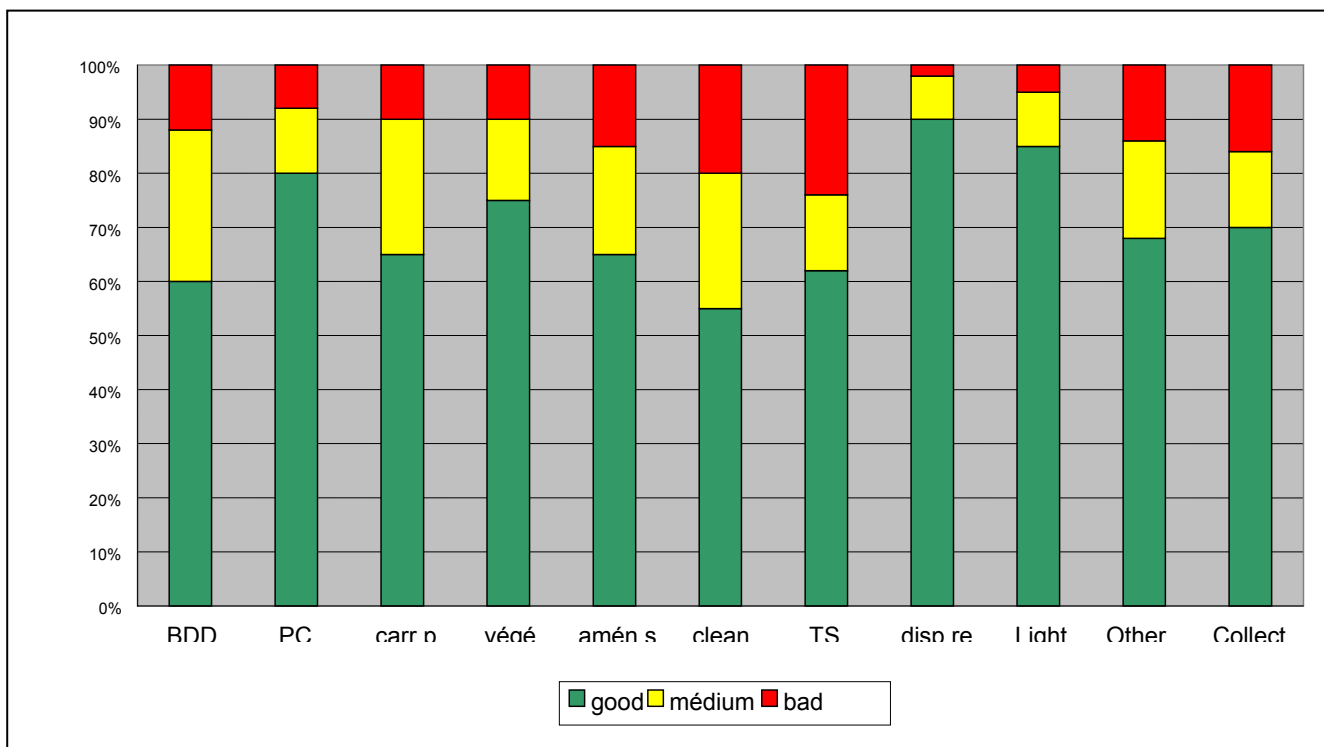
Cartographic rendering is however a relevant tool to know rapidly the state of a given equipment in a precise zone. For each category of equipment, it is possible to publish statistics and charts located on a network. For a category of equipment representing the network, it is possible to superimpose information on indicated. equipment and dependences
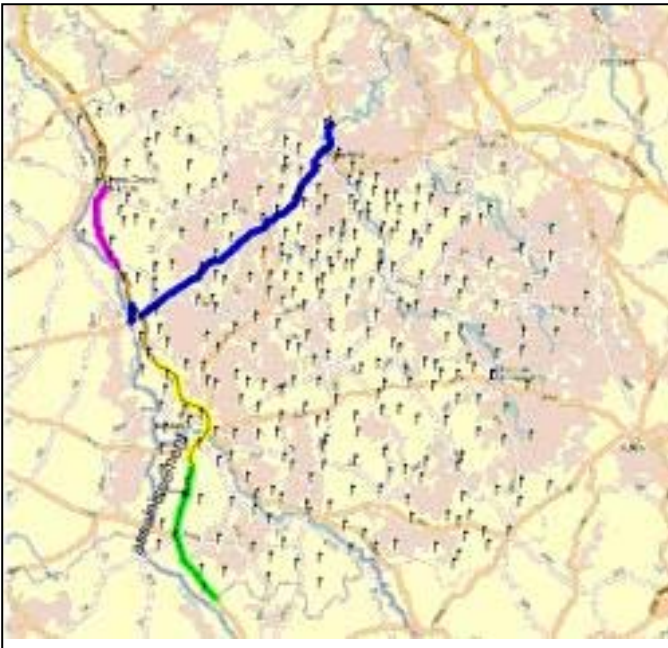
In a map, It is possible to represent:

- a road network
- equipment characterized by a state
- a comment

in an automatic way after data processing in laboratory

Figure 5: relevance of the cartographic tool for the synthesis:

Simplified example of representation of a device

Which data syntheses to represent for each equipment :
The equipment and dependences of the road varies in their nature and in their quantity.
Thus, for bulky and very few equipments, it is interesting to think about a cartographic map for representing the position of each one (PPHM for example)
For other equipments which are more numerous (carriageway markings for example), it appears more interesting to retain an average on a route (for example 30% of panels in "good" state on a section…)
The linear elements are easier to represent under a cartographic format. It is possible to publish a quite readable chart, varying colour in function of the equipment state for example.
Finally, by a global image of a network can be obtained easily with representation of the qualified states of an equipment type. using a SIG* based on a national data base,

- *Condition of success and limits:*
- The statement work is a tiresome one which can conduce to error because of its repetitivity. For that, tools were developed to propose a panel of element selection to the person in charge of the statement, which allows to state the equipment more easily
- A training of the personnel is necessary, indeed filming the road with a camera, requires a driver having an adapted formation. Image analysis in laboratory realised by a semi automation method thanks to specialized software, requires a formation of the personnel to minimize the errors of analysis and to optimise the use of the functionalities of the software. In addition, the rather tiresome and finicky work requires a computer equipment of good quality concerning the display.
- the operators in charge of the analysis in laboratory of the images have to profit from a formation to minimize the errors of analysis and to optimise the catch in hand of the functionalities of the software
- Because of the camera processing, there is a small distortion and the distances have a margin of error. However, as the made analysis is mainly quantitative and qualitative, this margin of error has no real importance in the IQDE method

3. USE OF THE IQDE METHOD BY MANAGERS

Because of the number of equipment and dependences on a network and in spite of semi-automated methods of treatment, the IQDE method remains a heavy process to set up. However, it appears interesting for a good management of the equipment and t dependences of a road network . Talking only about programming the rounds of inspection and the maintenance of the equipment which requires it (visit and controls of PPHM for example) the knowledge of the heritage is essential. The IQDE method is not a individualized management tool of equipment, the recognition of the visual state gives a first indicator and makes it possible to have an idea for the global management of the categories of equipment.

We can foresee two large axes for the use of the results obtained using the method IQDE:

3.1.   Orientation of the local policies of maintenance:

> - At the local level, it is used as essential supports for the maintenance work and the inspections (to be able to do an effective management of the equipment, we need to get clear information on their localization)

> -The IQDE method can also make it possible to orient the policies of maintenance So, a category of equipment having a strong rate of bad condition should be the subject of financial efforts the following year or of a particular monitoring during detailed inspections. Moreover, the knowledge of the inventory of the heritage is essential to organize the effective intervention on the territory .

3.2.   *On the national level

> -The IQDE method permits to have a national vision of the state of the road inheritance. This makes possible to be able to estimate the investment with regard to the replacement of equipment.
> - It is possible with this image quality of the network to see whether the actions of maintenance and exploitation which can be effective on the network. Moreover, one assessment can be made on a type of an equipment on the network after exceptional events, which can hurt equipments (storms, floods…)

4. . THE EXPERIMENTATIONS

Sétra launched, at the beginning of 2007, on behalf of the Directorate-General of the Roads an experimentation of statement "IQDE" by exploitation of digital images (IRCAN) to evaluate on a network of approximately 600 km:
> - the cost (working time, personnel, material) of the method on a given network
> - the validity of the method (reliability, check of some sections with visits…)
> - relevance of the exploitations which one can carry out from "IQDE" results.

The results of these experiments will be available towards semi-2007 and will make it possible to refine the IQDE method and to propose optimised costs of operation.

5. CONCLUSION

The IQDE Method, as described in this document, makes it possible to the manager of a road network to have in a way formalized an inventory and a " quality image" of its road equipments and dependences . The experiments in progress will make it possible to consolidate the method with regard to its cost and its reliability*
The IQDE method is brought to evolve progressively with its use by the managers of the French national road network and will be also influenced by he procedures implemented in other countries.

6. GLOSSARY

* RST : Scientific and Technical Network

* IQDE: Image quality of the dependences and equipment

* IQRN: Image quality of the national network system of evaluation and follow-up of the roadways of the national road network not conceded

* IQOA: Image quality of the structure: system of follow-up of state of the structures?

*IRCAN: Numerical Camera Imagery (can be used on a vehicle and allows high speed statements)

* PR: Reference Position: Is used to locate equipment or dependence on a road

* PMV: Panel with variable messages

* PPHM : frames, hoists and masts

* SIG : Geographical information system.

* DIR: Interdepartmental direction of the Roads: new managers in load of the French national road network not conceded