

Controlling African road networks: Review of the onboard kit

(the SOURCE Plus operation, a joint undertaking with African road departments)

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How to control a country's road network (and prioritize maintenance activities in a time of budget shortages) without minimum information? Without access to a permanent road data base that is locally supplied and managed, regularly updated with standardized technical data? Of the 45 African countries interviewed in 1998, 41 responded that their inventories did not meet these criteria. More globally, as regards the condition of their trunk network, 20 of these road agencies could only provide figures that were "commonly accepted but with no precise statistical basis."

This widespread finding probably suggests some degree of failure in 40 years of technical assistance strategies, an issue that remains to be addressed. It also constitutes a direct appeal for the development of low-end methods which are simple yet well calibrated and which, without replacing the conventional tools of road engineering, can provide an overall shortcut assessment of the networks' situation in terms of the effective service-to-user.

SOURCE (*Standard Overall Ultralite Road Care Estimate*) is a standardized method for monitoring the performance of road networks which provides, at lower costs and without requiring any instrumentation system, a summary but accurate image of trunk road networks at the national scale (through combined speed-traffic measurements using a floating vehicle method).

The SOURCE method was designed, tested, and finalized by the Road Management Initiative (RMI) in 1998-2000. It is fully operational today.

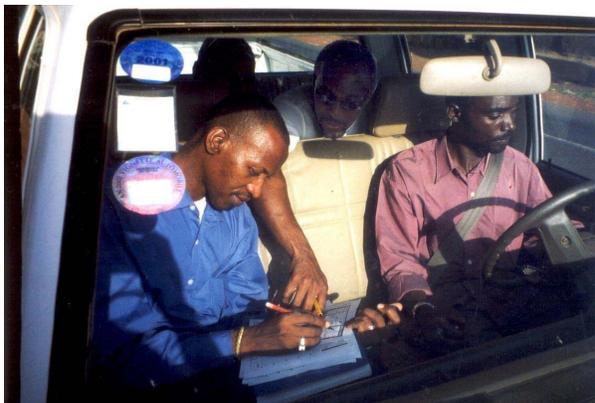


Figure 1: Training of SOURCE crews in Mali, provided by a Cameroonian engineering firm.

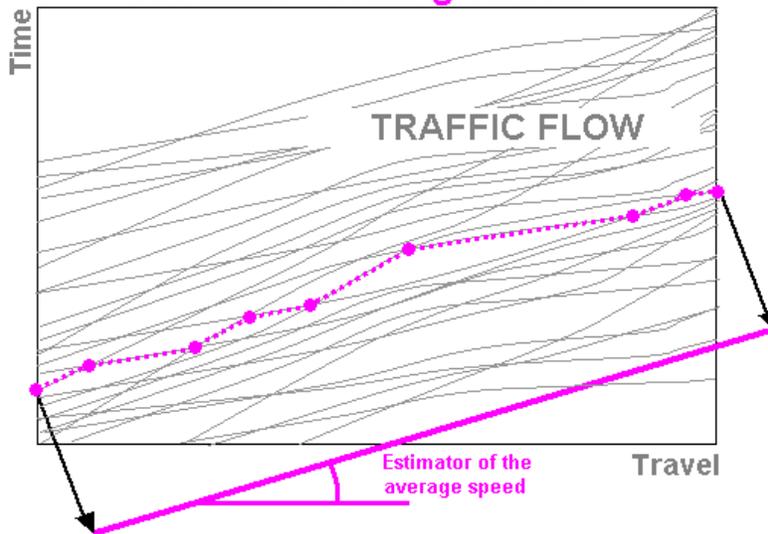
The RMI is a component of the SSATP (*Sub-Saharan Africa Transport Policy Program*), a joint program administered by the World Bank in cooperation with the various donors in the road sector and a group of African partner countries. The mission of the SSATP is to promote and facilitate transport reforms in African countries. The RMI component is specialized in road policy and road maintenance issues.

The initial development efforts for the SOURCE method, which were launched by the RMI in 1998-2000 under the guidance of L. Fernique, were financed by the trust fund that France provided the SSATP. The ISTED was responsible for coordination, while the LCPC handled the technical and road engineering aspects (both as service providers to the SSATP). Four test countries were involved in the operational research stage: Cameroon, Ghana, Guinea, and Madagascar.

The RMI is currently engaged in an operation to disseminate SOURCE widely in Africa as an essential management tool for road agencies and administrations, road funds, and their partners, for use in verifying the performance of their networks in terms of effective service levels.

This dissemination is being conducted in association with, among others, AGEPAR (Association of African Road Managers and Partners, the former ADAR--Association of African Road Directors), through a group of member countries whose road agencies have shown an interest in the introduction of SOURCE.

The basic "floating vehicle"



Here the FV (magenta dotted line), "floating" in the traffic flow, changed followed vehicle 7 times. The resulting slope of its overall path (magenta solid line) corresponds to its own mean speed over the traveled section).

For sufficient (or properly matching) distances and traffic levels, this physically achieves very good integration of the mean traffic speed (that is, the harmonic mean of vehicle travel speeds) for a much broader sample than just the group of the vehicles actually followed.

Figure 2: Measurement of the speed of light vehicles (LVs) only, by a floating vehicle, a conventional approach reinterpreted. Measurement of the level of LV traffic is based on simultaneous counting of oncoming vehicles.

Following the various training courses, measurement campaigns, and the technical discussions aroused, the idea took root of broadening the scope of SOURCE application by addressing the same constraints (low-cost, low-tech) in two different directions, in response to the demand expressed by user countries:

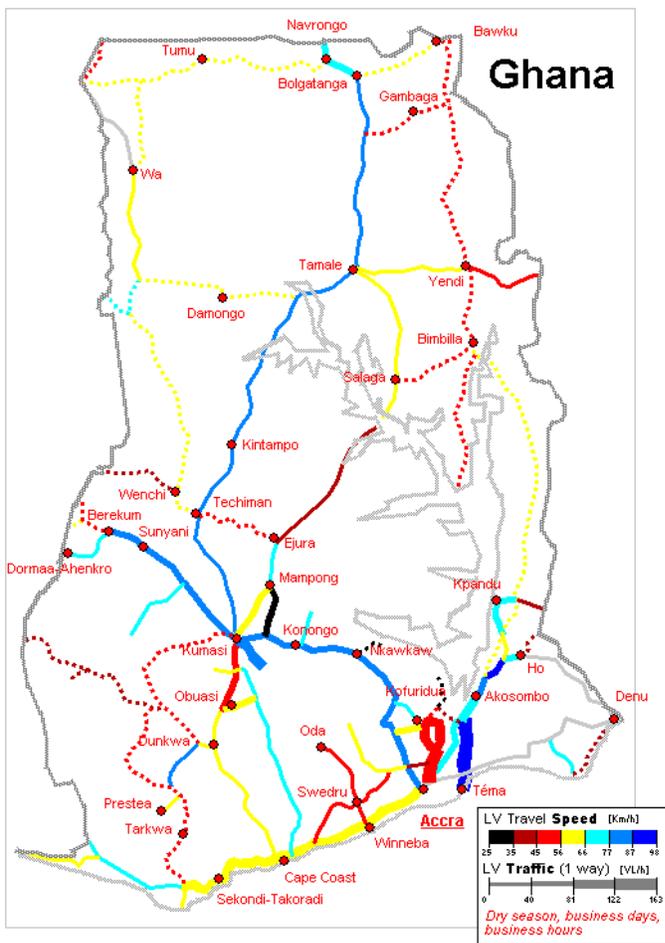


Figure 3: Example of a combined speed/traffic map illustrating the results of a SOURCE measurement campaign (data are processed and map automatically generated by using simple spreadsheets).

1. **Downgrade, that is, adapt SOURCE to low volume itineraries:** develop, validate, and justify a derived measurement protocol adapted specifically to sections with very low traffic levels, be they rural tracks (for monitoring tertiary networks) or major links in the trunk network (a special requirement for the Sahelian countries, particularly related to the growing interest in performance-based road maintenance contracts, which requires measurable service level indicators to be developed).

This specific approach, which requires fine-tuning the model differently in terms of the measurement protocol and the precision of the results, will involve testing in pilot countries: Burkina Faso, Guinea, and Chad. Cameroon, Cote d'Ivoire, Gabon, Mali, and Niger have also asked to be associated with the process as a whole.

This operation, known as "SOURCE low volume", will start in 2004.

2. **Upgrade, that is, refine the basic SOURCE model** to be able to extract, on the basis of simple double measurements of speed and alignment geometry, a “pseudo-roughness” indicator meeting the ordinary standards for HDM-4 input data.

The aim here is to lower the cost of the “entry ticket” into HDM to make easier for African road agencies, in terms of costs and measurement campaign technology, the access to the initial data that is the most sensitive and the most penalizing to acquire by conventional methods.

HDM = Highway Development and Management. A model for comparative analysis and strategy optimization for road programs or projects. The HDM entry variable that is least accessible for most African road agencies, be this on an ongoing or occasional basis, is the measurement of surface roughness, which is relatively expensive as regards field costs and requires high technical skills from the operators (roughness is expressed by the IRI, the international roughness index).

This specific approach makes it necessary to conduct a series of field measurement campaigns of very high quality, combining on the one hand speed measurements and alignment straightness measures using derived SOURCE methods and on the other hand conventional roughness measurements (using a bump integrator) in order to assemble an impeccable data set that makes it possible to fine-tune a rigorous formulation of “pseudo-roughness” and then validate it (as regards the regularity and accuracy of the pseudo-measurement).



Figure 4: Rudimentary patching in Madagascar in 1997. When routine maintenance budgets are grossly insufficient, for traffic levels that are generally less than low, you cannot expect a complex and expensive network monitoring mechanism to last.

The pilot countries involved for the tests are Burkina Faso, Guinea, Mali, and Morocco. Cameroon and Guinea-Bissau have also asked to be associated with the process as a whole.

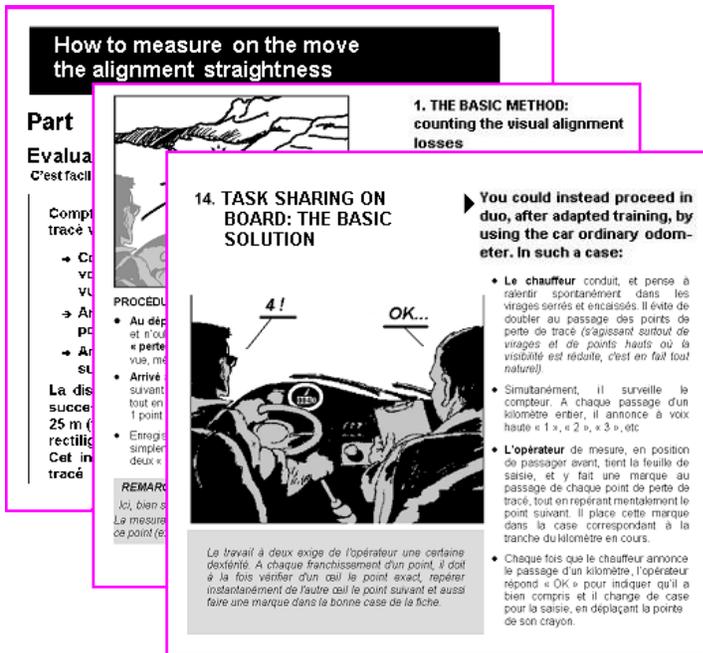
This operation, known as “SOURCE Plus”, is already underway.

The SOURCE Plus methodology and the protocols for gathering and assembling the field data for this experimental measurement campaign in four countries were developed jointly with the Road and Traffic Directorate of Morocco during a workshop held in September 2003 in Rabat (Morocco is also contemplating various derivative uses of the SOURCE toolkit, in particular in the area of road safety).

This operation was started with the assistance of the French Roads Division, through funding from French Foreign Affairs.

SOURCE Plus: practical modeling of the speed/roughness/straightness trio

With SOURCE, there was already a simple and thoroughly tested method for the measurement of the mean speed of light vehicles over major road links. But the binary speed/roughness correlation, while established, does not permit to predict roughness on the basis of speed alone. Hence the attempt to introduce a new variable (alignment straightness), on the assumption that a model with 3 variables will be sufficiently robust to predict roughness on the basis of the [speed] + [alignment straightness] pair with a sufficient precision with regard to the anticipated usage.



A visual index of alignment straightness combining horizontal bendiness with vertical undulation, based on the frequency of losing sight of the alignment (expressed in meters), has been prepared and already tested using on-the-move measurement protocols that meet the SOURCE criteria:

- No instrumentation required
- No prior documentation required
- Marginal cost for a combined measurement campaign

< Figure 5: Excerpts from the instructions for the visual measurement of alignment straightness

This crude measurement protocol has been backed up by developing a substitutable reverse index, the **alignment spin index** (in radians/km), which is calculated instantaneously from geometric data recorded by a small trip GPS device (costing about € 200), downloaded and copied to a simple spreadsheet. This provides a straightforward “passive” alternative to visual measurement, which itself mobilizes an operator. Moreover, during the research phase, the intensive use of small GPS devices makes it possible to accumulate speed/spin data series without a paper interface, with a high throughput and without particular technical skills on the operators' side.

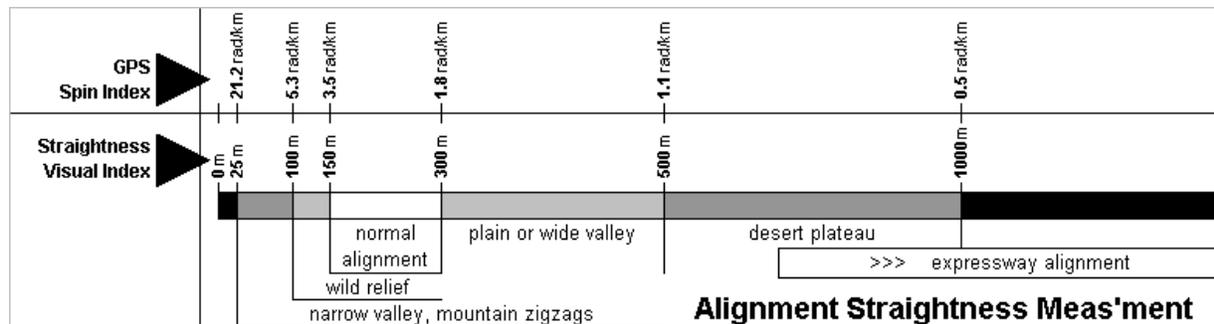
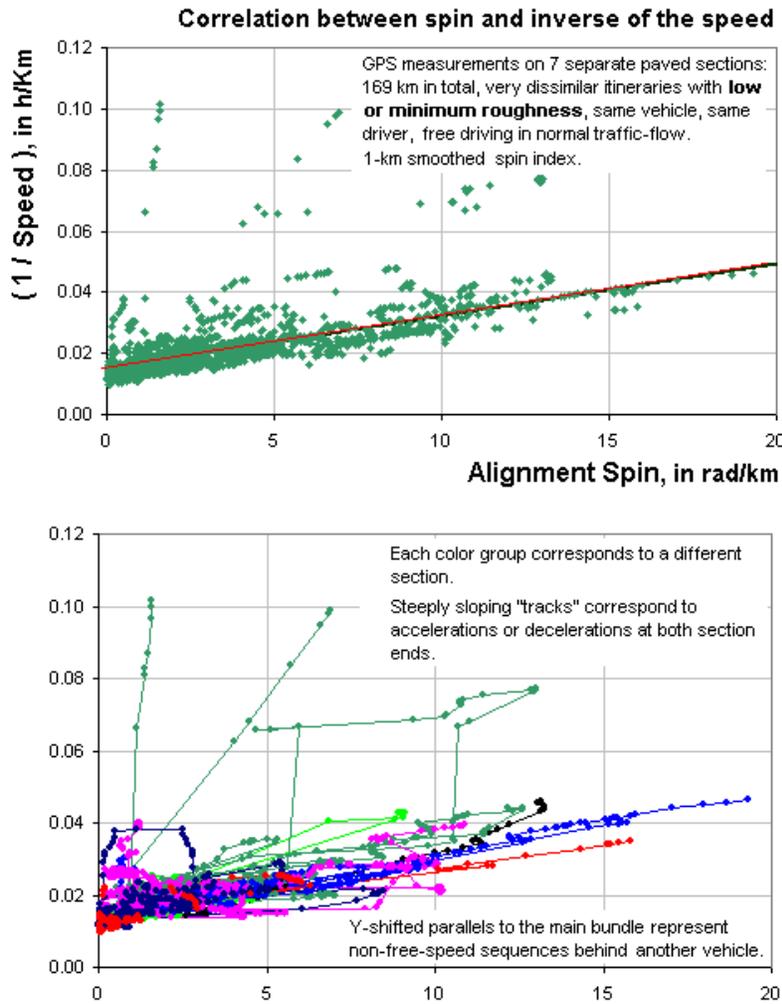


Figure 6: Provisional conversion table between the straightness visual index and the calculated “spin” index. The correlation between spin and the inverse of straightness is excellent. Provisionally, the following simplified formula is used: Spin = 530/Straightness.

A tight work schedule mobilizing 5 countries, taking advantage of previously planned measurement campaigns

The SOURCE Plus activity schedule runs from November 2003 to June 2004, with 4 main phases:

- First collection of triple data (Morocco, Burkina Faso, Mali, Guinea)
- Processing, modeling, and specification of the probative measurement campaign
- Second data collection (Cameroon) for model validation
- Finalization of the SOURCE Plus model (with post-validation of the finalized model, preparation of the final research report, and external quality review)



A progress report, including the presentation of intermediate results, will be provided during the annual AGEPAR technical seminar scheduled for April 2004 in Lomé, Togo.

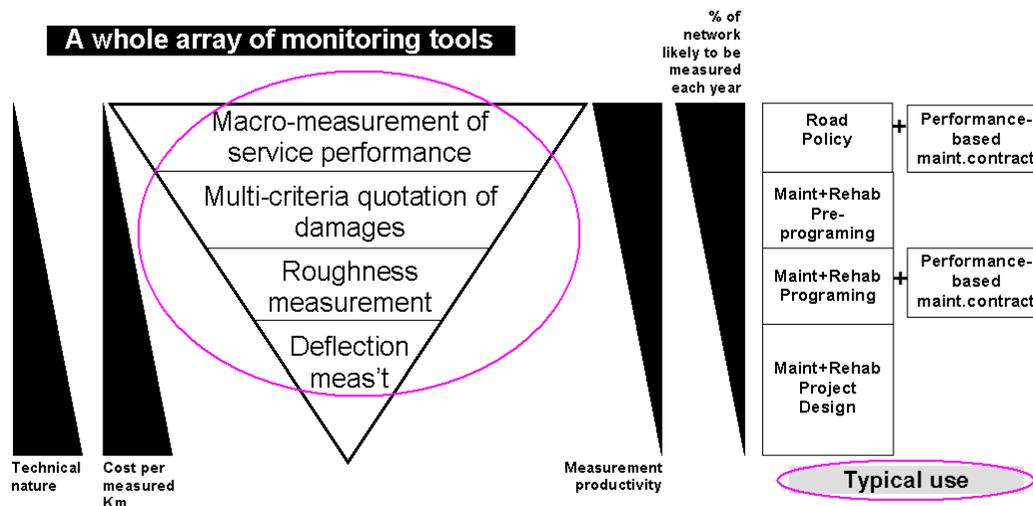
In case of success, this process will be followed by the manufacture and testing of SOURCE Plus tools (handbook, small processing program, training aids, etc.), again, with the same concern for simplicity. While the technical underpinnings may be complex, the tools for day-to-day usage must be eminently easy to use.

SOURCE Plus could thus be operational and ready for dissemination by December 2004.

< Figure 7: A first test of speed/spin behavior for a high-end roughness range. Do you find the cluster linear enough?

Disposable tool versus "Babel Tower"?

With this type of approaches (SOURCE, SOURCE Plus), African road agencies (and African engineering firms) seek to gain access to a range of light, easy-to-use tools that are "disposable" (in the sense that they require no or very little technical capitalization or material investment) and are better adapted to the prevailing conditions in sub-Saharan government services, where technical departments and their local branch units are subject to impoverishment and dismantling, and in fragile new agencies heading for the same structural problems. And doubtlessly, to break the logic of these methodological "Babel Towers" which, among other things, lead to dependence.



< Figure 8: Toolkit and range of uses.

At the same time, there are obvious limits. You would not draw up periodic maintenance programs, nor decide rehabilitation designs and specifications, on the sole basis of speed measurements adjusted by using a mountaineer's GPS unit.

After the onboard toolkit and multipurpose pliers have come into play, there is still the conventional mechanical shop. In other words, road agencies definitely need to make a technical recovery, though it is often out of reach.

Service, service, service!

The emergence of easy pseudo-technical tools goes hand-in-hand with the introduction of service indicators accessible to the general public.

Road maintenance in Africa, under pressure from donors, is more and more often being financed off-budget through a variety of user fees (fuel additional fees, truck road discs, pooled road tolls, etc.), that are collected by ad hoc Funds, jointly managed with road user representatives; now a reality in 22 Sub-Saharan countries.

The verification of service performance, in order to report intelligibly to users/payers on the utilization of the funds mobilized, is also an emerging requirement for the stakeholders in African road activities.

The instant measurement, open to everybody, of standard travel times, traffic magnitudes, and surface driveability (through adjusted speeds) meets this demand as well.

