A technology for measuring and controlling vehicle emissions in real time

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Lysanda

I'm Simon Harris and I'm co-founder of Lysanda, the brainchild of my colleague Alex Willard, one of the country's leading automotive combustion engineers. I'd like to take a look with you at some of the ways we currently tax or otherwise charge road users for cluttering up our roads and polluting our atmosphere. We'll then take a look ahead to where road charges may be heading, and give you a glimpse of what we are cooking up.

Lysanda is a Cleantech company developing a technology which we think is going to play a big part in the way we use and pay for vehicles and roads in the future.

Vehicle Excise Duty – or 'CarTax'

In the beginning there was the Road Fund Tax, which goes right back to the early days of the automobile in the 1890s when "light locomotives"– as they were first called – attracted a tax of 20 shillings a year. A flat rate system remained in place right the way through until 2001, when an emissions-based banding system was introduced.

The present Graduated VED is based primarily on a vehicle's level of CO_2 emissions. Codes A to F are used on a scale from no duty at all for a vehicle with a stated emission level of less than 100 grams of CO_2 per km to £210 a year for one emitting 225 grams per km.

These figures are quite laughable when you consider, say, the Porsche Cayenne Turbo S. This King of the Road (if not the off-road) puts out 520 bhp, can top 170 mph and has a CO2 emission of well over 500 grams per km on a gentle throttle. Porsche has sold 100,000 Cayennes, mostly in the US..

To get his hands on one of these on, say, 50% finance your City Trader is paying at least £800 per month in interest. What does he care if his annual tax disc is £165 or £210 or twice that? It's still less than 5% of his annual finance bill. Hence, the latest proposal to wind the higher levels of VED up towards £2,000 a year.

There's a plan mooted by David Miliband where we each have a personal carbon tax. Under this a vehicle's CO2 output multiplied by its annual mileage would equate to an extra item of tax. We assume it would be collected as part of the self-assessment process, but is very controversial and more an idea for debate than a serious proposal.

Road tolls follow In the long tradition of the English Turnpike, the first of which was set up in 1663, and later examples caused riots, as shown here in Wales in the 1840s, where farmers dressed up as women and children to attack the toll gate and the constables.

The best known is of course the London Congestion Charge, based on number plate recognition, with its own dedicated cameras, charge collection and enforcement system. Cameras are however a very expensive option, and the wider the area, the more cameras required.

Trucks in Germany are charged by a system called Toll Collect where on autobahns they pay between €0.09 and €0.14 per kilometre depending on their emission levels and number of axles. Trucks are equipped with On Board Units used for positioning, monitoring and billing. Additionally the OBUs have infrared communication with stationary control bridges on the motorways. This expensive scheme suffered numerous delays before coming into use, and has been the target of wide protest. Possibly in anticipation of this, the government here announced in July 2005 that a proposed UK lorry road user charging scheme would not go ahead.

Low-tech infra-recd readers are used for a good number of toll routes, on motorways, on access areas such as airport approaches, and at the Dartford Crossing. But of course you need an expensive infrastructure to collect the money.

Facing rising levels of congestion, European governments are giving serious consideration to nationwide road pricing schemes which would exploit the new Galileo system, which will be ten times more powerful than the US GPS sytem. Every vehicle might in the end contain a satellite tracking device which knows which roads you are driving along, for how far and at what time of day. This information would then be sent to a central computer system.

- Number plate recognition:
"Where is your vehicle and what make, age or weight is it?"
- Pay as you pollute:
"Where is your vehicle and *how much pollution is it emitting ?*
- Requires real-time emissions measurement. How?

The fair and accurate way to tax as you pollute is not to ask:

Where is your vehicle is and what make, age or weight is it?

but

Where is your vehicle and how much pollution is it emitting?

Pay As You Pollute is the Holy Grail to contain emissions and tackle road transport's contribution to climate change. But in order to charge you, they need to know how much pollution your vehicle is emitting. At present they have very primitive methods:

The VED Certificate (primitive)

Annual MOT (slightly less primitive)

Number plate cameras (expensive and error-prone)

People assume that when you talk about capturing emissions on the move you mean capturing and analysing the gases coming from the exhaust pipe. Well, you *can* do it this way, and many have tried, but it is very difficult, very expensive and not at all reliable. Sensors cost a lot and have to survive in a very hostile environment of several hundred degrees. Exhaust systems need to be replaced, and with them the sensors. So there's a technology gap here that somehow has to be bridged. Well, it can be done, and strange to say, that's what we are engaged in and that's what we have done.

- Not to measure the gases as they come out at the back
- but predict what they will be from what goes in at the front

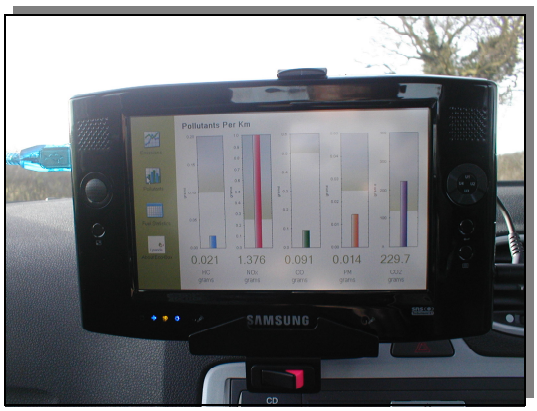
The modern internal combustion engine is an extremely powerful computer integrated into a heat engine. Every operating parameter is controlled by the engine ECU. There is a big opportunity to exploit some of this data for the purposes of emissions analysis, if you've got the smarts to know how to do it.

Our development, which we call the Eco-Log, uses the data contained within the engine's nervous system to predict emissions. We have found that in order to succeed in this quest to calculate emissions, certain key problems must be solved. You need to know

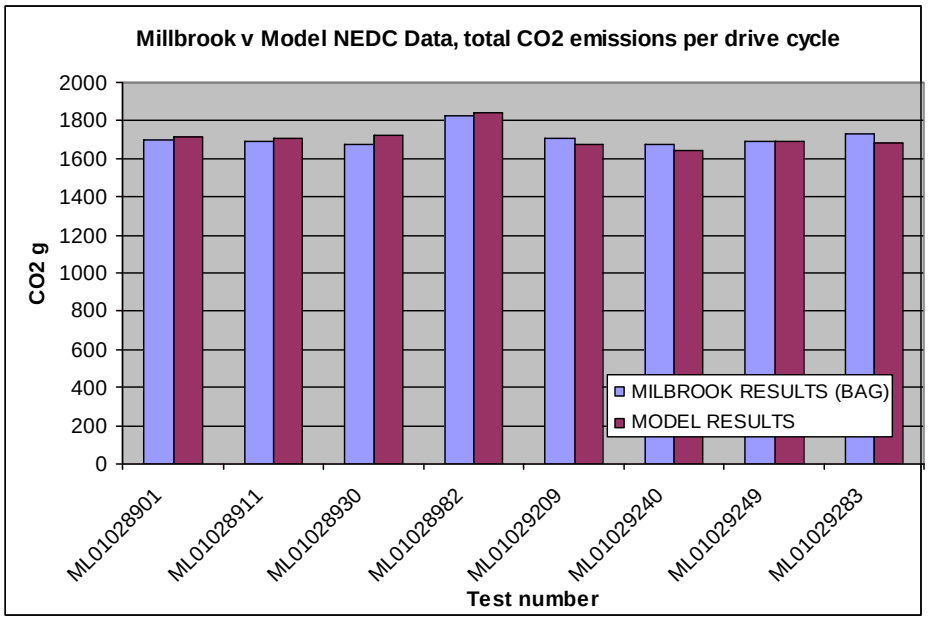
- Kinetics – time, distance, speed, acceleration
- Driver demand – load, throttle angle
- After-treatment – recyclers, filters, catalysts
- Combustion events – power, torque, combustion chemistry

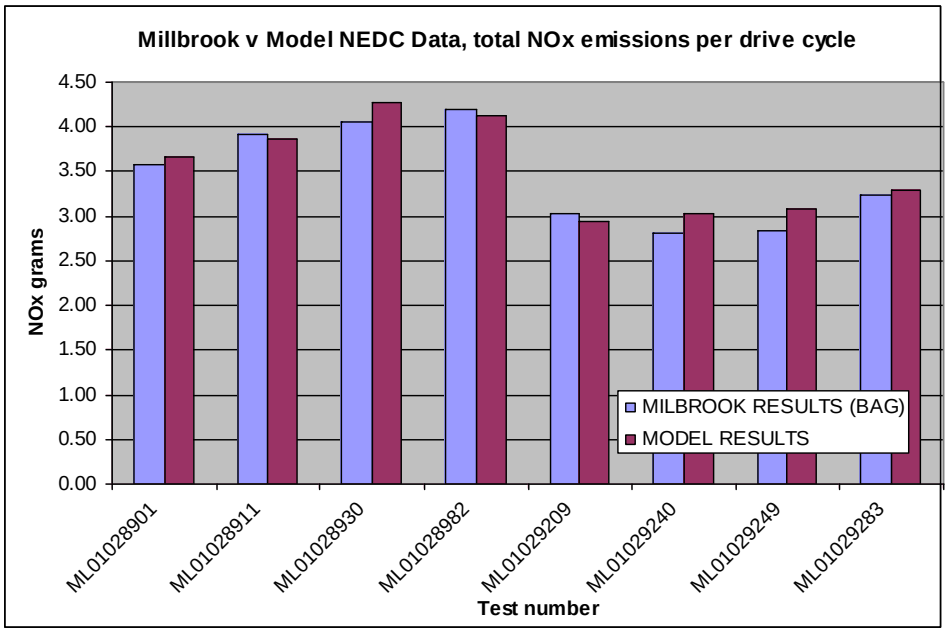
1. Kinetic data – time, distance, speed, acceleration
2. Driver demand – load, throttle position
3. Combustion event – power, torque, combustion chemistry
4. After-treatment – recyclers, filters, catalysts

When you have answers to these you can attempt an emissions calculation.



We have fitted out a test vehicle, and recently completed a validation exercise on an emissions cell at the Millbrook Proving Ground. The vehicle has performed a series of EURO and Federal Drive Cycles, and then we have compared this ‘native’ data with data generated by our Eco-Box. These are the results.


Millbrook v Model NEDC Data, total CO2 emissions per drive cycle
CO2 g
2000
1800
1600
1400
1200
1000
800
600
400
200
0
MILBROOK RESULTS (BAG)
MODEL RESULTS
ML01028901
ML01028911
ML01028930
ML01028982
ML01029209
ML01029240
ML01029249
ML01029283
Test number


Millbrook v Model NEDC Data, total NOx emissions per drive cycle
NOx grams
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
MILBROOK RESULTS (BAG)
MODEL RESULTS
ML01028901
ML01028911
ML01028930
ML01028982
ML01029209
ML01029240
ML01029249
ML01029283
Test number

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After-fit

OEM

So, we have a system which calculates CO2, NOx, HC and PM in near real-time.

How do we get it on to the vehicle? We can either provide a black box which bolts on to a GPS/GPRS tracking system and connects to the Diagnostics Port, or we provide a built-in solution which gets fitted to the vehicle on the production line. Whichever route we take, After-fit or OEM, it will be inexpensive, accurate and very rugged, which the direct sensing method can never be.

Environmental benefits

- Emissions pattern
  - Operators know their fleet's volume and type of emissions day by day, hour by hour
- Clean bill of health
  - Provides evidence to allow vehicles to enter city centres or low emission zones
- Corporate Social Responsibility
  - Evidence to support environmental credentials
- Taxation and Road Pricing
  - Genuine "Pay-as-you-pollute" becomes possible for the first time
- Carbon Trading
  - Accumulation of accurate data for fair carbon trading

- Reduced fuel consumption and engine wear
  - reveals many aspects of driver behaviour
  - encourages a more sympathetic approach to driving
- Better route planning
  - reduces engine idle time and wasted miles
  - shows which vehicles are best suited to which routes
- Reduced serious failures
  - forewarns of imminent engine problems
- Planned Maintenance
  - vehicles can be serviced when they need it, not when the service book says so

We are extremely excited about the potential of this project. It gives vehicle operators, especially large fleets, lots of ways to save costs and improve vehicle efficiency. And it gives legislators and tax-gatherers lots of ways to make the motorists pay, not just for using the road, but in direct proportion to the amount of pollution they produc.

That's it. Thanks.

Lysanda

innovative vehicle engineering