THE USE OF A SIMULATOR TO OPTIMISE THE SELECTION OF A HAULAGE VEHICLE/ROUTE

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Introduction

In the sugar industry, transport accounts for over 30% of production costs. A tool has therefore been developed to facilitate the optimum selection of vehicle and road parameters to minimise these costs. This tool takes the form of a PC based simulator that enables the user to evaluate various scenarios, in terms of cycle time and fuel consumption, before selecting a particular system. Factors that are accounted for include transmission losses, wind resistance, rolling resistance, grade resistance and acceleration.

The simulator has been evaluated and, although further development is required, it has proved to be a good indicator of performance. Future aspects of research will include improving the predictions, the determination of axle loading, traction, gradability, compaction, maintenance, guidelines for driver training and costing. Results of an evaluation and a simulation are briefly discussed in this paper.

Evaluation of the simulator

The system was evaluated using different vehicles and routes. The results of one test are illustrated in Figure 1, where both the simulated and measured fuel consumption and speed of a 6 ton rigid truck, operating over a 7,7 km section of the route between La Mercy and Mt Edgecombe, are shown.

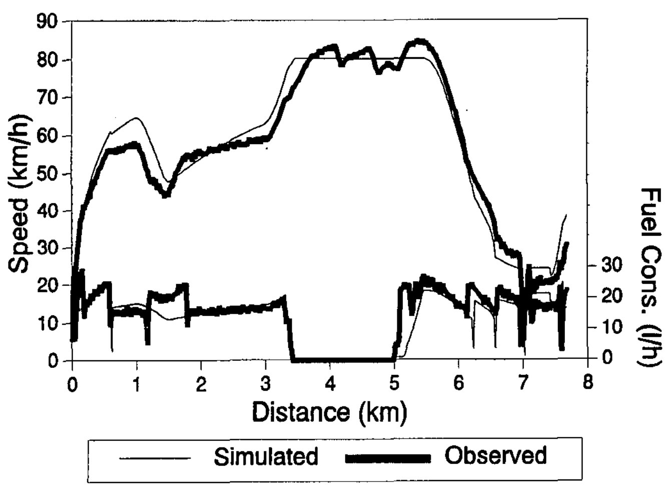

FIGURE 1: Simulated and measured performance of a rigid 6 ton truck operating with a full load on a good tar surface.

It can be seen that the simulation provides a close approximation of the actual performance of the vehicle. Evaluations on other routes have also given relatively accurate results. The main problem areas encountered were quantifying the road surface roughness, the transmission losses and the vertical profile of the road.

Simulating a vehicle's performance

The value of the program lies in being able to investigate and quantify the effects of changes in vehicle/road parameters without having to run actual tests. Figure 2 shows an evaluation of the effect of road surface on the fuel consumption of a tractor/tandem trailer rig with a 20 ton payload, operating on a level road and travelling a distance of 20 km in a round trip. The road surface condition varied over the route from a smooth tar surface to a firm sand. The speed of the vehicle was limited to a maximum of 30 km/h.

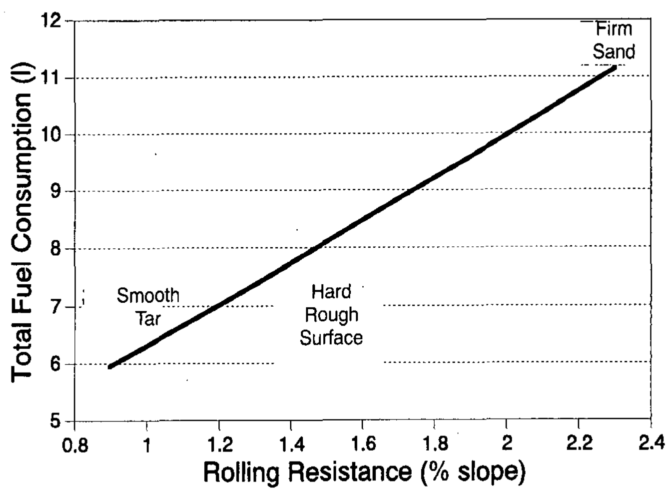

FIGURE 2: Effect of road surface on the fuel consumption of a tractor/tandem trailer rig.

The vehicle was able to maintain an average speed of 30 km/h over all the surfaces, although the fuel consumption almost doubled. These effects can thus be taken into account in the analysis and costing of a particular system.

Conclusions

The program is able to generate approximations of a vehicle's performance that are sufficiently accurate for comparative purposes. Further work is required to improve absolute accuracies.

The system provides a useful tool for evaluating different vehicle/route parameters and for obtaining a measure of the relative performance of the different systems. This information is necessary if the transport systems are to be optimised. There is also tremendous scope for including additional features in the future.

GLOBAL POSITIONING SYSTEM (GPS): A PRACTICAL TOOL IN TRANSPORT MANAGEMENT

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Abstract

The increasing cost and technical complexity of modern transport demands precise management control. Satellite mapping of transport routes and loading zone locations using global positioning system (GPS) technology provides a map of the project and a route profile which can be used to select suitable vehicles, plan operations programmes, determine costs, quote on contracts, compile time-tables and monitor the efficiency of transport and operations. Using GPS technology and digital terrain modelling all the necessary information can thus be made available for management planning. The capability of this technology and its practical use in transport management is discussed and an example of its application in the Umbumbulu district of KwaZulu-Natal is given.

Introduction

In September 1994, Illovo Sugar Ltd introduced GPS technology in their Pez'Kwomkhono small grower division for the purpose of quickly and accurately determining the area of small scale grower operations. When the Illovo mill was relocated to Eston in 1995, Illovo Sugar Limited had the responsibility of compensating those growers who now had to travel considerably longer distances to the mill, for additional transport costs incurred. The GPS was used for accurate measurement of the extended distances.

Application of GPS

The immediate application was to establish an accurate database of comparative loading zone distances, showing the variances generated by the mill relocation. A secondary application was to obtain a profile of each route which would be used to assess vehicle performance.

Distance measurement

Previously, measurements were done using a light delivery vehicle (LDV) fitted with a specially designed measuring device (odometer) and distances were listed, accurate to the nearest kilometer (Hellmann *et al.*, 1995). An improvement was to plot the hilo routes on a 1:50 000 topo-cadastral map. The limitation of this map is that it identifies route locations only, but cannot be used to determine distances, while the distances measured by odometer are dependent on the vehicle used and do not have the accuracy acceptable to the engineering surveyor.

GPS technology, however, involves computation of position and height by triangulation, using a message string, codes and a time message accurate to one millionth of a second, transmitted from any four of the 24 navigation satellites that orbit the earth every twelve hours and four minutes. At any time eight satellites are visible from anywhere on the globe, and only four are needed to obtain accurate readings within seconds.

The method used was to travel the haulage routes with the GPS receiver in the back of the LDV, logging data at five second intervals, at speeds that varied from 30 km/h on winding gravel roads to 60 km/h on tarred main roads. During this process the positions of all loading zones were logged. The data captured comprised 4 336 positions, giving a measured distance of 128,7 km and an overall mean of one position for every 29,68 metres of road. The breakdown by road surface was:

Tar	1 264 positions over 55,4 km; mean interval 43,82 m
Gravel	2 619 positions over 62,2 km; mean interval 23,75 m
Tar/Gravel mix	275 positions over 6,9 km; mean interval 24,97 m gravel over short interval 23,70 m

Table 1 shows comparative distances between individual loading zones and the weighbridge at the Illovo mill and the weighbridge at the new Eston mill. This data, plus the resulting map of hilo routes and loading zone locations (Figure 1), illustrates the use of GPS technology for transport management.

Table 1

Example of comparative distances : Illovo vs Eston

Zone	Illovo (Kms)	Eston (Kms)	Variance Eston-Illovo
42	13,1	36,7	23,6
82	14,5	38,1	23,6
83	15,3	38,9	23,6
41	16,7	34,2	17,5
44	19,0	30,1	11,1
45	21,1	28,0	6,9
55	25,6	28,7	3,1
79	29,1	32,2	3,1
80	32,1	35,2	3,1

Determination of route profile

As the GPS system captures data in 3-D (x, y and z parameters) the possibility arose of using the data to generate a route profile, which could then be used to determine suitable vehicle types, operating costs, and route timetables, together with generating operations programmes and efficiency standards for monitoring a transport operation (Anon. 1995).

Figure 2 shows a typical route profile using the GPS receiver. The data was captured by mounting the receiver on the labour rail at the back of the LDV, set to log data at five second intervals, and the route travelled at approximately 60 km/h. Over the 12,7 km route 567 positions were logged, with a mean interval of one position for every 22,46 metres of road. The road traverse was completed in half an hour.

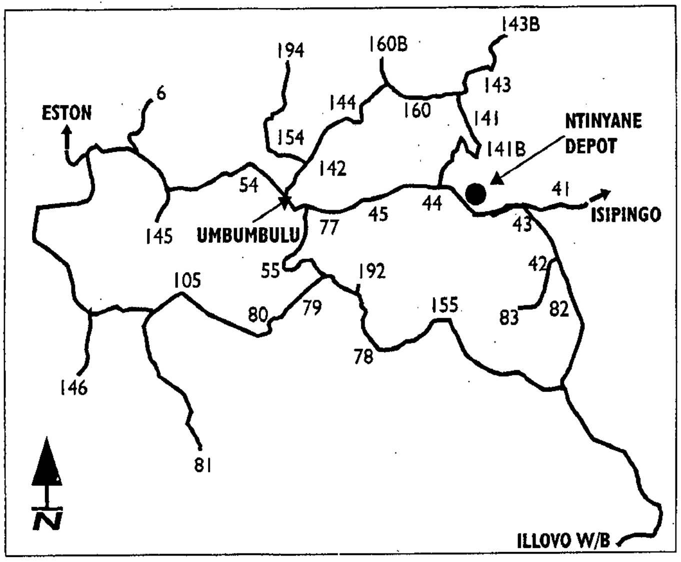

FIGURE 1: Map of hilo routes and locations of loading zones (numbered) between the Illovo mill and the new Eston mill

The basic information given in Figure 2 and in Table 1 is, in itself, valuable control data, but needs further processing to provide the basis for the detailed financial and technical analysis necessary for the complete planning of a transport operation. This is the subject of another paper discussed elsewhere in the congress proceedings.

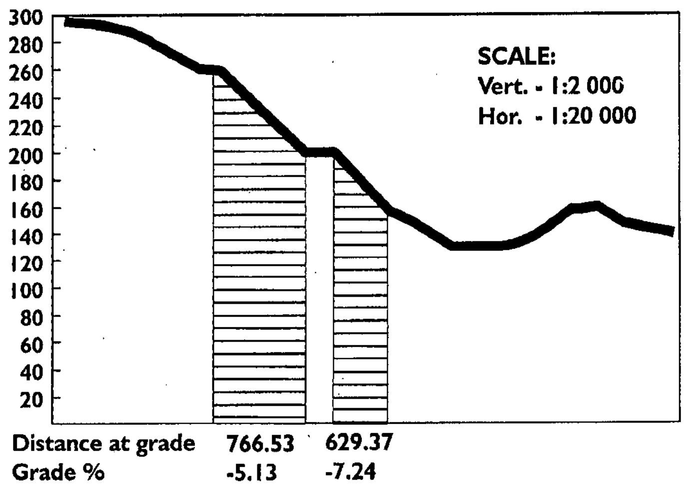

FIGURE 2: Route profile, generated with hand-held GPS receiver

Accuracy of GPS

The question arose of whether a hand-held GPS receiver was capable of capturing data to an appropriate degree of accuracy for the precise and detailed analysis required.

In a demonstration performed for the Natal Provincial Administration Roads Department, a route profile was generated on the Poly Shorts section of the old main road near Pietermaritzburg (Fuelling *et al.*, 1994). This was compared with the road construction diagrams, and comparative data was captured at the four control points established for the construction of that section of the road. There was no significant difference between the GPS generated route profile and the construction diagram, and the maximum mean height variance at the four control points was 320 mm ([1]personal communication).

As an indication of the accuracy of the route profiles generated over the 128,7 km Umbumbulu project, the position intervals between points were determined from the 4 336 positions logged, giving an overall mean of one position for every 29,68 metres of road.

Accuracy check

To further check the accuracy of the data captured as part of the Umbumbulu project, a comparison was run using two GPS receivers simultaneously over a 12,7 km stretch of road. A Geo-Explorer and Trimble Path Finder PRO XL were used in the test. The Geo-Explorer is a simpler version of the PRO XL, being a hand-held six channel receiver with lesser data dictionary and memory capacity. The PRO XL is an eight channel receiver with an external antenna, and is capable of accepting a great variety of manual data input. Although the capacity and manner of 3-D data capture is the same for both receivers, the PRO XL has the additional capability of accepting data from external distance or depth measuring sensors and is more robust than the Geo-Explorer in tree canopy situations. Route profiles were generated, one using data captured by the Geo-Explorer and the other by the PRO XL. Repeating the traverse with the Geo-Explorer produced remarkably repeatable data, ie with very little variation.

Conclusion

The experience gained in the Umbumbulu project has illustrated the ease and speed with which GPS technology allows the generation of road profiles and determination of distance. This information is essential in the determination of management parameters which can help move the transport industry forward in technology and efficiency.

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