FUTURE FORESTS RESEARCH

HARVESTING TECHNICAL NOTE

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# On-Board Monitoring Systems

## Summary

On-board monitoring systems (OBMS) enable machine performance data to be extracted from a machine's electronic control system. Harvesting contractors can use Information from these systems to aid maintenance, improve machine efficiency and help with operator training. There is also potential to use the information for management, planning and research. Many of the major forest machine manufacturers now produce machines that have these new systems installed. However, in the forest industry there is a predominance of older machines and most of these monitoring systems cannot be retro-fitted. This report describes four of the monitoring products that are available for use with new excavators and wheeled loaders – Komatsu Komtrax, Volvo MATRIS/Care-Track, Caterpillar Product Link, and Hitachi e-Service.

## Tony Evanson, Scion

## Introduction

Most new or near-new excavators and wheeled loaders have electronic control systems – also called ECM or engine control modules – comprising micro-computers or controllers. Can-bus or Controller Area Network, is an example of an industry standard for internal communication in these systems. In addition to controlling machine operation, these systems also enable on-board monitoring of machine and/or engine performance. The mining industry has been at the forefront of demand for management information derived from these systems because of its intensive use of machinery.

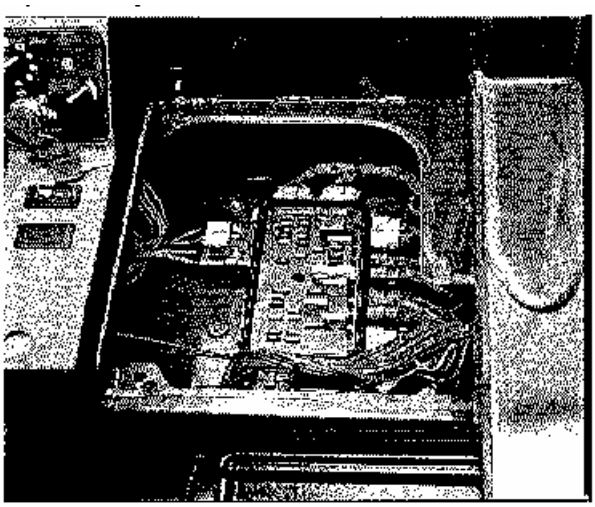

**Figure 1. Control/Monitoring hardware**

Data reporting from monitoring systems is aimed at both the machinery owner and service support so maintenance can be scheduled and possible problems flagged for attention. It also assists operators of the machine in correct and efficient use of the asset. Information supplied can include data on machine location (GPS), fuel consumption, machine utilisation and engine performance.

Systems are being improved, with software upgrades available, and development of reliable satellite upload services. Benefits of this kind of monitoring include: maximising equipment utilisation, improving maintenance scheduling, productivity measurement, monitoring fuel consumption, machine security and operator performance analysis.

One recent study in Canada evaluated the accuracy and precision of truck engine control modules (ECM) concerning fuel consumption data. The study showed that ECM data precision and accuracy vary not only among engine manufacturers, but also among engine models from a single manufacturer. ECM fuel data were found to be more reliable when averaged over longer periods or with a larger number of tests or trips (Surcel and Michaelsen, 2009).

## Method

Examples of on-board monitoring systems (OBMS) were identified, including:



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- Volvo MATRIS
- Komatsu Komtrax
- Hitachi e-Service
- Caterpillar Product Link
- John Deere Link
- Waratah TimberRite

Four suppliers and six users of OBMS forest machines were contacted for further information and comments on their use and benefits.

## Results

### Volvo MATRIS (Machine Tracking Information System)

MATRIS provides data for two products, Care Track Basic, and Care Track Advanced. The basic version means data are manually downloaded, usually during maintenance by the machine supplier, for example at 250 hours, 500 hours or monthly. Selected summaries of critical functions are sent to the machine s owner or agent. Care Track Advanced, with upload by satellite, is not yet available in New Zealand. MATRIS reporting is available on all Volvo machines following and including the B-series (with electronic fuel systems). Care Track Basic can be retro-fitted providing monitoring of 5 to 25 machine functions. It is not available for use with other makes of machine.

### Komatsu Komtrax

Komtrax comes in two versions, Komtrax Standard and Komtrax Plus. The plus product includes fuel consumption information and monitor messaging. Komtrax involves the transmission of GPS and machine operation data by satellite and is available on all Dash 8 series machines.

Selected summaries of critical functions are sent to the machine s owner or agent. Komtrax data are uploaded by satellite and data are processed in Sydney. Some summaries are available on a website on a daily basis, such as machine location, operating hours and idle time. About 12 machines are using Komtrax in New Zealand.

### Hitachi e-service

This product works through daily satellite upload of Machine Information Centre (MIC) data to a Hitachi server. A user can view and download basic MIC data while complete data are downloaded by the supplier during inspections. E-service is operational on 2006-year machines and can be retro-fitted on some Zaxis models delivered after 2000.

### Caterpillar Product Link

Product Link obtains data from two different modules, one that can be installed on any Cat machine (PL121), and a more advanced version, installed on machines with electronic engine management systems (PL321). Both use GPS systems and upload via satellite four times daily to a common website. PL121 systems provide operating hours and location; PL321 systems have a full range of machine use information.

Caterpillar service agents can monitor the locations and maintenance status of all machines equipped with Product Link. The OBMS equipment is owned and serviced by Goughs.

### Costs

On-board monitoring systems are integrated into most new excavators and loaders, and some other machines if they use electronic engine management systems. Some suppliers provide OBMS services free for the first year with a charge thereafter. Charges for use can vary from NZ$65 to $125 per month depending on the level of reporting. Access to reporting, detail, and cost depend on the individual machine supplier and the systems used.



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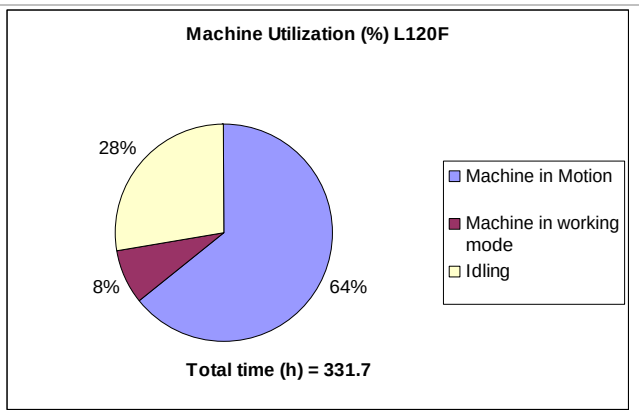
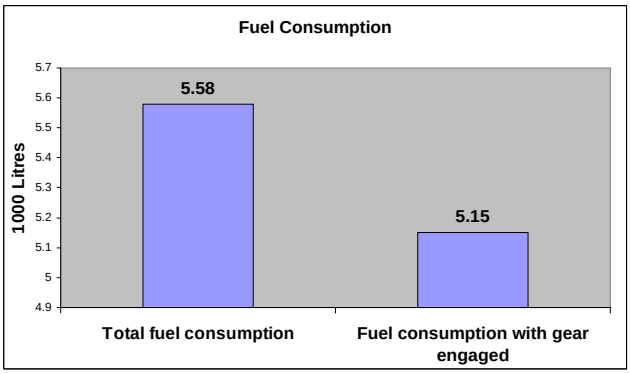
**Management information an example:**

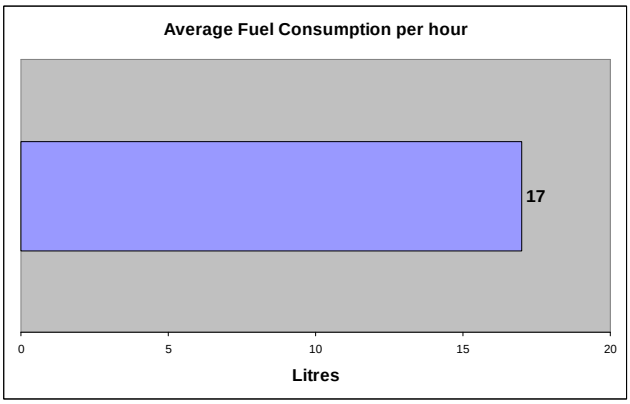
A management report for one of the monitoring systems (MATRIS) showed the following information for a wheeled loader in graph form, reporting over a period of 300 operating hours:

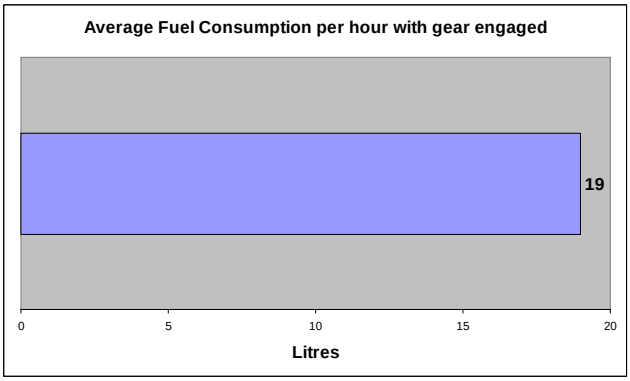
- Machine utilisation %
- Average fuel consumption per hour, per $m^3$ and with gear engaged
- Average speed and distance
- Speed distribution
- Engine coolant temperature, distribution % and hours
- Start at different engine coolant temperatures (%) and number
- Engine oil pressure distribution, hours and %
- Average number of starts per hour
- Cooling fan speed distribution, hours and %
- Engine speed distribution, hours and %
- Transmission oil temperature, hours and %
- Differential lock usage, hour
- Machine speed when shifting, Forward to Reverse, Reverse to Forward
- Usage of transmission cut-off
- Kick down usage
- APS selector usage, hours and %
- Brake engagement time, distribution, %
- Brake pressure, distribution, %
- AC compressor usage
- HVAC air temperature setting in auto control mode, distribution, hours
- HVAC air flow direction in manual mode, distribution, hours
- HVAC air blower speed in manual mode, distribution, hours
- HVAC Auto – Manual mode selection, distribution, hours
- Machine ambient temperature distribution, hour
- Hydraulic oil, temperature distribution, % and hours

Actual reporting of some machine functions and performance over a 2 month period:



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Suppliers, users, and owners of machines with OBMS were asked how they used the OBMS information.

Some suppliers commented that there were some barriers to the use of OBMS information including :

- Low levels of computer skills by contractors.
- Suitability of information for owners of large numbers of machines rather than smaller “players”.

Other user comments:

- They had no spare time to read reports, even though they recognised that there was useful information in them.
- OBMS information could be used for operator training but had to be timely. One-month summaries were not useful for this. A system with frequent satellite downloads was used for operator training feedback.
- One user was using the information to monitor the performance of a prototype machine he had developed.
- For some users, a key feature was monitoring fuel usage, as well as idle time and machine hours. This enabled machine utilisation to be improved. The monitoring system reported breakdowns and alerted the supplier and owner, enabling timely repairs.
- Of interest to civil construction machine users was the monitoring of the use (wear) of a ground-engaging tool (bucket) so that the teeth could be reversed.
- Some had not made use of the reporting system at all.

## Conclusions

On-board monitoring systems are capable of providing data/reports on a wide range of machine/engine performance parameters.

It is apparent that these data are very useful in tracking machine performance, scheduling maintenance and giving early warning of potential problems such as engine overheating.

Fuel consumption is a key indicator of machine usage and cost, and of great interest to a machine manager. Aspects of the reporting detail, such as too great a machine speed when shifting (forward to reverse) or excessive hydraulic oil temperatures may also indicate poor driving practice and flag the need for more training.

Most users also want to use the systems for operator training. Monitoring systems are independent of operator input and if several operators are using a machine, the only identification will be by shift time. Typically, data might be downloaded from the machine on a monthly basis by the supplier’s technicians, or the machine owner might have opted for a daily satellite download system. Systems allowing more frequent downloads and operator identification will enable OBMS reports to be used effectively for training.

## Reference

Surcel, M.D., and Michaelsen, J. (2009): Evaluation of accuracy and precision of truck engine electronic control modules to capture fuel data, Advantage, Vol.11, no.10, August 2009 FPInnovations FERIC, Pointe-Claire Quebec, Canada.



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