

TEL
1
\$552

SAE Technical Paper Series

UNIVERSITY OF WASHINGTON

MAR 26 1987

LIBRARIES

861249

Truck/Mobile Equipment Performance Monitoring Management Information Systems (MIS)

LeRoy G. Hagenbuch

Philippi-Hagenbuch

ENGRG. LIBRARY
UNIV. OF WASH.

International Off-Highway & Powerplant
Congress and Exposition
Milwaukee, Wisconsin
September 8-11, 1986

The appearance of the code at the bottom of the first page of this paper indicates SAE's consent that copies of the paper may be made for personal or internal use, or for the personal or internal use of specific clients. This consent is given on the condition, however, that the copier pay the stated per article copy fee through the Copyright Clearance Center, Inc., Operations Center, P.O. Box 765, Schenectady, N.Y. 12301, for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law. This consent does not extend to other kinds of copying such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

Papers published prior to 1978 may also be copied at a per paper fee of \$2.50 under the above stated conditions.

SAE routinely stocks printed papers for a period of three years following date of publication. Direct your orders to SAE Order Department.

To obtain quantity reprint rates, permission to reprint a technical paper or permission to use copyrighted SAE publications in other works, contact the SAE Publications Division.



*All SAE papers are abstracted and indexed
in the SAE Global Mobility Database*

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

ISSN 0148-7191

Copyright © 1986 Society of Automotive Engineers, Inc.

This paper is subject to revision. Statements and opinions advanced in papers or discussion are the author's and are his responsibility, not SAE's; however, the paper has been edited by SAE for uniform styling and format. Discussion will be entered with the manuscript file.

Persons wishing to submit papers to be considered for presentation or publication through SAE should send the manuscript or a 300 word abstract of a proposed manuscript to: Secretary, Engineering Activity Board, SAE.

Truck/Mobile Equipment Performance Monitoring Management Information Systems (MIS)

LeRoy G. Hagenbuch

Philippi-Hagenbuch

ABSTRACT

Truck/Mobile Equipment Performance Monitoring is a vital part of every mining operation. Performance Monitoring identifies current performance baselines for use in analyzing, refining, and improving equipment performance levels. Further, to be meaningful, equipment monitoring requires real time data collection. Equipment Performance Monitoring is the key to building a Management Information System leading to Computer Integrated Mining.

Can management be of a higher quality than the data upon which it is based? Is there a relationship between the effectiveness of management and the integrity of the information it uses to formulate its decisions?

You bet your bottom dollar there is!

Without doubt, where "management" is maximized, information "integrity" has been maximized. But how is this accomplished? All successful, complex organizations now have a Management Information System (MIS) to gather, compile, and distribute the information that described organizational affairs. Corporate success is then based on MIS success: the complete, accurate, and timely flow of appropriate, definitive information."**

*GIGO Garbage In Garbage Out

*Babel The Tower of Babel

Corporate Integration

YOUR CHOICE!

TRUCK/MOBILE EQUIPMENT PERFORMANCE MONITORING

MANAGEMENT INFORMATION SYSTEMS (MIS)

Typical truck/equipment performance monitoring/management systems take into account many factors.

Appropriately one might ask, why implement a truck/equipment monitoring/management system?

THE NEED:

"You Choose:

GIGO

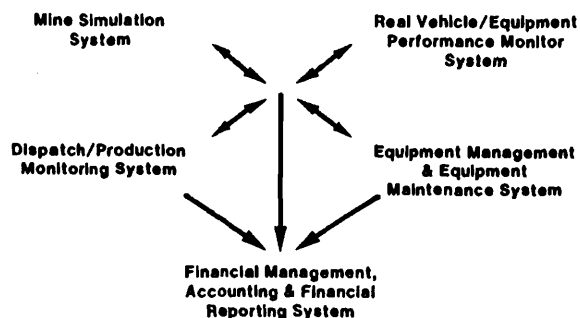
Babel

Corporate Integration

** Harry Burke, "Field of View," Automatic I.D. News, May 1986, pp. 28-31.

Whether equipment owners choose to admit it or not, truck/mobile equipment monitoring does exist in every operation. (Fig 1) It is just that in some operations it is more formalized than others.

Computer Integrated Mining The OBDAS System Approach



Truck/mobile equipment monitoring is there whether equipment owners choose to legitimize-formalize it or not.

This being the case, accepting and recognizing that truck/mobile equipment monitoring is going to occur one way or another, how does one implement good-valid truck/mobile equipment monitoring?

THE CONCEPT:

The what, when, and where of equipment monitoring. What is being monitored, when are the results available, and where is the information/output obtained.

The what of equipment monitoring:

Equipment monitoring primarily takes two forms: vital signs monitoring and performance monitoring. Consider a runner running a race, his vital signs are his blood pressure, pulse, temperature, rate of respiration, etc., while his performance is his time at the quarter mile, half mile, and finish line.

Vital signs monitoring monitors components, i.e. what is happening to the items being monitored?

Performance monitoring (normally) monitors the whole, i.e. what the item being monitored does?

Typically, truck/mobile equipment items that can be vital signs monitored are:

1. Engine Criticals
 - a. Oil Pressure
 - b. Water Temperature
 - c. Exhaust Temperature
 - d. Etc.
2. Hydraulic System Criticals
 - a. Hydraulic Pressure
 - b. Hydraulic Oil Temperature
 - c. Etc.
3. Drive Train Criticals
 - a. Wheel/Motor Current Draw
 - b. Wheel/Motor Temperature
 - c. Etc.

Numerous other items are also capable of being monitored, in fact, for every component on a vehicle there are corresponding vital signs that can be monitored.

Equipment performance monitoring, (nominally) equipment performance as a whole versus individual components; what the equipment does and when the equipment is a truck, some items considered are:

1. Equipment Loading, Amount Being Hauled
2. Equipment Use/Abuse (is the equipment being operated in a proper manner in accordance with mine parameters and manufacturer's guidelines)
3. Equipment Tracking
4. Equipment Cycle Times
5. Equipment Utilization

The Equipment Monitoring Chain. First monitor vital signs/performance signs then process the data obtained so that action initiation can take place reacting to the results of the monitoring process, i.e. monitor, process the results, and initiate action accordingly.

Truck/mobile equipment monitoring system building blocks are hardware and software.

Truck/mobile equipment hardware breaks down into three categories:

Input Devices	Output Devices
- Analog	- Display
- Digital	- Digital (numeric)
	- Alpha/numeric
	- Video
Processor	- Printer
- Analog	- Data storage
- Digital	Devices
	- Real time data
	output devices

Truck/mobile equipment monitoring system software interrogates the input devices, directs the processing of the data obtained from the input devices, and consequently formulates and initiates data output.

Vital signs monitoring while normally guarding against premature component failures, fails to address equipment performance.

In today's competitive world, improved equipment performance/utilization is where the returns are at; with improved equipment performance flowing directly to an operation's bottomline profitability.

Equipment Performance is improvable as monitoring identifies current performance baselines for use in analyzing, refining, and improving equipment performance levels. After all if you don't know where you're at, how can you determine if you are maintaining status quo, improving, or worse, falling off, i.e. to go anyplace you have to know where you are at, with Equipment Performance Monitoring establishing both where you are at and where

THE IMPLEMENTATION:

The balance of this paper is directed to equipment performance monitoring and the implementation of truck performance monitoring; specifically in a mining environment and how this performance monitoring can lead to integrated Mine Management Information Systems and Computer Integrated Mining.

Basic Truck Performance Monitoring Hardware Items

- Load/weighing sensors
- Transmission/vehicle direction monitor F-N-R
- Dump switch
- Vehicle control number status/keypad
- Microprocessor with built in display and battery back-up clock

Load/weighing sensors and why weigh trucks? Trucks are weighed because it is central to truck performance monitoring. Trucking is material haulage. And, optimum truck utilization/performance is basic to efficient/profitable mining operation. The basic definition of work is: to move "X" amount of material from point A to point B over "Y" amount of time. (A basic trucking operation definition.)

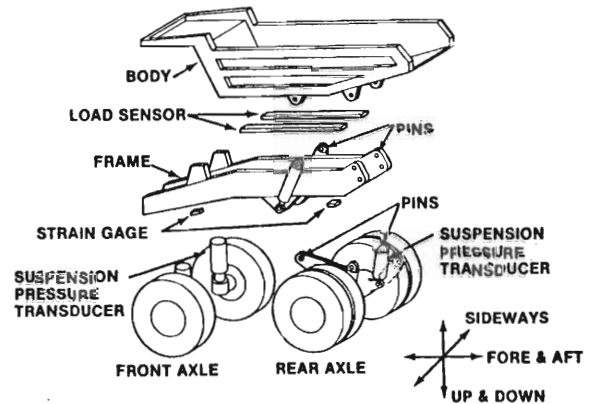
Further, with 170 ton capacity mining trucks costing \$750,000 to \$850,000, 35 ton trucks at \$225,00 to \$250,00, and 85 ton trucks at \$400,00 to \$500,00 it becomes very important, considering the owning operating cost of these trucks, to operate these mining trucks at optimum utilization within performance parameters. (Fig 2 & 3)



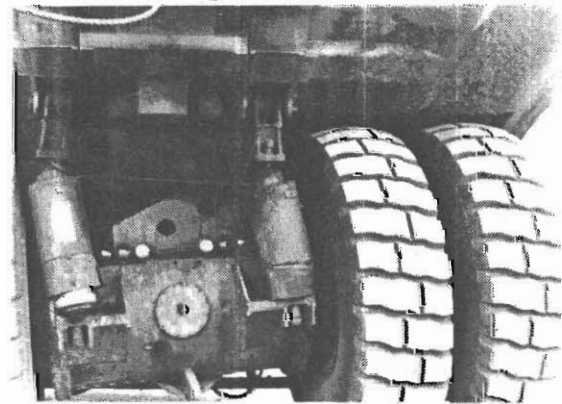
Providing the point is made for the need to weigh trucks, how can an on board truck weighing system be installed? Separating a truck into discrete components: 1) running gear, front axle and rear axle, 2) the truck frame, and 3) the truck body. These are the areas at which a truck can be weighed.

(Fig 4)

THE VARIOUS POINTS AT WHICH A TRUCK CAN BE WEIGHED



The running gear: it is possible to attach strain gauges to the running gear or in the running gear mounting pins, however, these strain gauges are very susceptible to damage and do require ongoing calibration. Further as the rear axle, in particular, oscillates its relative position to the truck frame changes throwing meaningful load weighing way out of wack. (Fig 5)



The area between the running gear and the frame: various devices can be utilized between the running gear and the truck frame. Nominally, pressure transducers in the running gear suspension cylinders, provided the truck has an air over oil type of suspension. However, with internal friction in the suspension cylinders and because of the fact that the rear axle moves sideways and fore to aft as it oscillates up and down, this method provides only a relative indication of load, i.e. somewhere in the area of +/- 20% of load. (Fig 6 & 7)

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.