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Elevating Construction Equipment Fleet Management
To a New Level: An Evaluation of Use of Telematics Technology

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Abstract
Construction industry has not kept up pace in the adoption and use of new technologies in general and for fleet management of construction equipment in particular. As a result, the efficiency, productivity and profitability in relation to construction equipment use has suffered. Fleet management in the U.S.A, to some extent, still relies on traditional and labor intensive methods of data gathering and evaluation, thus depriving the management from acting on current and reliable data in a timely manner.

Use of the "telematics" technology has the capability to enhance constructions equipment-fleet management to a whole new level. This paper focuses on a recent collaborative research undertaking to find more about the details of this technology and its impact so far on equipment-fleet management. The purpose of the research was to evaluate the use of this technology in construction companies, determine its user acceptance, and assess the differences it was making in fleet management. The difference was to be assessed in terms of how this new technology had changed spatial equipment tracking, equipment utilization, equipment maintenance scheduling, operations analysis, job costing, and jobsite/project management related to construction equipment. Presented herein are the details of the technology, the methodology of the research undertaking, the results of the evaluation, and the conclusions thereof, for the purpose of disseminating such information for the benefit of the construction management educators and the construction industry.

Keywords
Telematics, Equipment Telematics, Fleet Management, Construction Equipment

1. Introduction - The Technology

The term "telematics" combines "telecommunications" and "informatics." Literally defined, telematics is the integration of GIS, wireless communications, computational systems, vehicle monitoring systems, and location devices (Wikipedia.com,2008, Webopedia,com,2008, Whatis.com, 2008). More specifically it is the science of sending, receiving and storing information via telecommunication devices (Accenture studies, 2003, 2005; Osman, 2003; Riaz, 2003). The etymology of *telematics* is from the Greek "tele" ('far away') and ~Matos (a derivative of the Greek machinari, or contrivance, usually taken in this context to mean 'of its own accord') which combine in the term "telematics" to offer a means of describing the process of long-distance transmission of computer-based information (Foy, 2008).

More recently, telematics have been applied specifically to the use of Global Positioning System technology integrated with computers and mobile communications technology in equipment fleet management systems with the goal of efficiently conveying information over vast networks (Jones, 2003). The widespread availability of broadband cellular data networks has been a major factor in the growth of the equipment fleet telematics (Aeris.net, 2008). These networks provide reliable wireless data communications with broad coverage at a reasonable cost. GPS, AVL, MRM, WiFi, and RFID are just a few acronyms representing telematics systems and technologies (Riaz et al, 2003). The growing list is only one indication of the expanding use and variety of applications that telematics technology offers (Goel, 2007).

Equipment telematics systems are used by equipment manufacturers and equipment users/owners for different purposes. Manufacturers use it increasingly to provide remote diagnostics in terms of identification of mechanical or electronic problems, or in general proper functioning of the equipment. A full 80 percent of OEMs (original equipment manufacturers) and dealers see telematics as a source of competitive advantage and anticipate benefits from it like enhanced customer relationships and increased parts and services revenue among others (D.J.Driscoll & Assoc., 2008).

Equipment owners/users, on the other hand, use it to obtain data about if equipment is being used efficiently, productively, and responsibly at a job site to generate revenue for the owner or users of equipment. For owners/users, telematics addresses the most critical challenges facing construction and rental equipment companies: namely, increasing equipment utilization, reducing maintenance costs and increasing operational efficiency (Arnevil et al, 2005). The latter use is what this paper will be focused on. In this latter use, telematic equipment fleet management systems collect, wirelessly transmit, and manage critical operational data thus enabling the construction equipment owners and managers keep on top of things, evaluate the details of the use, as well as, track the equipment.

Historically, the construction equipment industry has taken a conservative approach to using new technologies, but we are now seeing penetration and adoption of these technologies from product manufacturers to end users. Equipment telematics will be a key technology that changes the business model of users and allows them to focus on service and growing revenues (Kapur, 2001). Still, the costs are still high and companies will have difficulty in adopting this new technology unless the costs decrease. Due to its novelty, sellers of the technology lack the necessary skills to promote the technology adequately and leverage the powerful management capability it offers. End users want telematics to work across equipment brands, but no standards for communication have been set in the industry. As these barriers are addressed, the adoption of telematics by the construction industry will increase even more and the benefits realized will promote it even further. For many fleet operators, telematics is a very promising technology (OEM, 2008).

For a construction or equipment rental company, fleet management is the management of a company's equipment fleet. Fleet management includes a range of functions including equipment financing, equipment maintenance, equipment telematics (tracking and diagnostics), driver management, fuel management and health & safety management. Construction-equipment fleet management allows companies to remove or minimize the risks associated with equipment investments, improving efficiency, productivity and reducing their overall ownership costs through what it enables equipment owners to do as to be detailed below. These functions can either be dealt with by an in-house fleet management department or through an outsourced fleet management provider (Shoup, 2002; Teglia, 2001).

Equipment fleet management using telematics answers the following sets of questions and provides the requisite capabilities to address these issues:

- What's happening right now at your jobsite?
- Does the accuracy of your job cost estimates sometimes make your bids inaccurate?

- How can you get accurate jobsite data without tying up people with tasks and paperwork?
- How can you insure equipment maintenance is done exactly when it is due?
- Do you have the best-available tools for decision-making?
- Which equipment is under-utilized?
- Which repair activity takes the most time?
- Which equipment has the most "down time"?
- How many loads were moved last month?
- What's your biggest headache in equipment use?
- How good is your equipment productivity?
- How out of line are your equipment maintenance costs?
- How effective is the compliance management?
- How effective is management of equipment fuel use?
- Have you received all the tax credits you're entitled to in terms of pollution control etc?

2. The Company

Eathwave Technologies Inc. has been in business since 2000 as a user of telematics technology to provide real time data to construction equipment owners, i.e. construction companies and equipment renters, through its Fleetwatcher system (Earthwavetech.com). Equipment, fuel, service/repairs and labor account for the majority of the costs in construction work involving heavy equipment. The fact that in construction work these costly assets (equipment) and expenses (labor) are remote and mobile, make them much more difficult to accurately monitor, measure, and manage.

Fleetwatcher, which was built specifically for the heavy equipment industry uses a device contractors attach to their vehicles that collects and transmits usage data through a GSM wireless data network to Earthwave's internet-based application. The Fleetwatcher application provides the contractor with an easy-to-use, online software reporting interface that allows them to view and manage all the data collected from their equipment. Earthwave Technologies' proprietary hardware and software collects data on location/tracking, frequency of equipment use, amount of time spent working, amount of time spent idling and engine starts. Contractors use the information to determine job progress, labor hours accounting, equipment productivity, preventative maintenance needs and misappropriation of machinery. By eliminating the manual systems that track equipment use and activity with "technology", Fleetwatcher provides the people dealing with equipment-use in the organization with the accurate and timely facts that empowers them to manage these high priced assets and related expenses to enhance profitability (Hinds, 2008; Hinds, 2008).

Each Fleetwatcher unit tracks and transmits how much that equipment "runs" every day, how much it "works" every day, equipment location and load counts on certain equipment. The Fleetwatcher unit wirelessly transmits this infomation to a website for ease of access and ease of use. This information, which is housed on Earthwave's website, is then processed and delivered in the specific data and format requested by users. The Fleetwatcher sofware modules (Project Management, Equipment Utilization, Maintenance and GPS Location Modules) turns that data into timely, useful management information that can help your people in the field, in the shop and in the office do their job more effectively, efficiently and ultimately more profitably (Youtube.com, 2008).

These reports (available online or in MS Excel format) can be shared with the whole management or operational team of the equipment owners. With over 20 reports and hundreds of filtering options available, the users have all the information they need to manage everything from a quality preventative maintenance program to equipment costs and operator performance. If desired Fleetwatcher can be automatically integrated with the equipment companies' accounting and job cost systems thus bringing everything needed for operation and management together for a more comprehensive view. Customized GPS technology inherent in Fleetwatcher tracks multiple data points, including: cycle times; productivity and down times;

equipment utilization and underutilization; exact location of each piece of equipment; project status; budgets; shop costs; rental expenses; trends and behaviors. There is no need for guess work or endless phone calls to track down a piece of equipment.

Realizing that data is useless if it doesn't help provide real solutions to end users, Fleetwatcher provides data in reports and formats that allow end users manage their business from a number of different perspectives as detailed below:

1. Productivity
- Identify and eliminate workflow inefficiencies
- Improve job forecasting and budgeting as a result of knowing how equipment is used
- Eliminate the manual process of collecting hourly readings without losing the data
- Determine project status on multiple projects
- Identify and evaluate trends and behaviors

2. Utilization
- Maximize assets by making informed decisions regarding those assets
- Identify underutilized equipment to liquidate
- Reduce rental expenses
- Improve employee and equipment uptime by monitoring status

3. Idle Reduction
- Improve profitability
- Save on equipment depreciation and maintenance costs
- Save money on fuel
- Save the environment

4. Preventative Maintenance
- Get timely and accurate information with automated reports of engine hours and mileage
- Extend equipment life, Improve life expectancy of equipment
- Avoid unplanned downtimes that can be costly
- Reduce the need to rent gear as backup

Real Financial Returns: Fleetwatcher provides many benefits all of which lead to the bottom line related to equipment use by informing equipment owners of exactly what equipment and people are truly doing at all times. The purpose is to provide the right data so that right decisions can be made. The benefits can be summarized as follows:

1. Better Asset Management:
- Improve transportation logistics
- Gain real-time insight into current fleet utilization
- Find exact equipment locations at any time
- Streamline preventative maintenance
- Stop unauthorized usage
- Reduce the risk of loss due to theft or unauthorized use

2. Greater Productivity and Efficiency
- Increase operator and driver productivity
- Decrease reliance on manual processes
- Gain real-time access to production information like start times, cycle counts, and real idle time
- Reduce fuel cost by actively managing engine idle time

3. Better Control over Costs
- Reduce rental costs
- Greatly reduce fuel costs
- Improve equipment costing process by comparison of operator timesheets vs. actual equipment usage
- Increase value of equipment

4. Real-time engine idle tracking impacts more than the bottom line
- Greatly reduce unnecessary idle time
- Stop accelerated depreciation of your equipment
- Reduce preventative maintenance cycles
- Gain insight into the true costs of unproductive engine idling
- Reduce greenhouse gases and pollution

3. Research Methodology - Scope of Research

The research was of a collaborative nature between the private company Earthwave Technologies Inc. and the Construction Engineering Management Technology Program of IUPUI (Indiana University-Purdue University Indianapolis). This research work was motivated by the desire to find out:

- What was motivating the companies who bought the technology to do so.

- What were the main ways the companies were using the technology among the following functions: 1. Equipment tracking; 2. Equipment utilization; 3. Equipment maintenance tracking; 4. Job costing; 5. Operations analysis; and 6. Jobsite and Project Management

- What kinds of changes the technology was conducive to in fleet management practices.

- Were the companies using the technology able to take advantage of all of its capabilities and if not why not.

- As one of the principal intended outcomes of using the Fleetwatcher technology, were the companies able to reduce useless idling and see any monetary returns as a result.

- How effective the technology was in helping the companies carry out preventative maintenance on time without unduly hindering equipment operations.

- How effective the technology was in tracking equipment and whether the outcomes were notable.

- Overall, was the investment in the Fleetwatcher technology worthwhile in terms of the quantitative (monetary) and qualitative returns realized.

- How the technology could be improved to make it address fleet management needs of companies more effectively, efficiently, and profitably.

The companies were so chosen that they had used the Fleetwatcher Technology for a length of time adequate for them to be able to make meaningful assessment of the advantages and disadvantages associated with such use. The companies were chosen so that they owned or rented equipment, had managed both over-the-road and off-road equipment, and exhibited union or non-union characteristics. Despite the limited size of five companies not necessarily constituting a statistically representative sample, statistical inferences were made in percentage terms to exhibit the nature of the responses.

The research was conducted by means of a survey instrument developed with additions and modifications to existing company literature and documents, as well as, some new material, all reshaped to extract responses without undue demands on the part of people responding to the survey. A student intern was placed with Earthwave to administer the surveys and compile the results and data from the surveys. The surveys were administered through either meetings with company people face-to-face in a meeting, posing the questions, and noting and taping the answers or by sending of the survey and compiling the responses trough electronic means. The Survey Instrument was sent to the companies beforehand every time.

4. Research Results

The introduction of new technology by Earthwave to a new company inherently and unfortunately suffers from the reality that if the technology is accepted and bought, and, if it is used properly and it succeeds, it may very clearly indicate to the fact that the equipment fleet was probably being managed quite inefficiently and unprofitably before using the Earthwave technology. Realizing this, there is probably little incentive, if any, on the part of a lot of people involved in the decision-making process/stage to be enthused about this adoption at the beginning or ensuring its success after the purchase. It is thus recommended that Earthwave approach family-owned companies more aggressively than other types of companies and always approach from the top rather than at the fleet management level. In line with above, the fact that some sections of the survey were responded to by people who may have had some sort of a stake in the outcomes may possibly mean that they may not have been totally unbiased in their responses and the results may need to be looked at with that premise in mind.

Earthwave markets its "Fleetwatcher System" first and foremost in terms of its capability to track useless idling. The responses from the user companies confirm the user companies' awareness and appreciation for this. Overall, however, this point did not come out as one that carried a huge importance or impact during the purchasing decision-making and/or after the purchase. Part of this may be due to the fact that admitting to significant losses due to useless idling before acquiring the technology would not have looked good at this point. Another reason may be that the companies are really not able to monetarily quantify the savings from this capability of Fleetwatcher despite Earthwave's efforts in this respect and more enlightenment of the companies may be needed.

A striking observation was that despite the capability of Fleetwatcher, in our opinion, to move the companies to a totally new and enhanced platform in terms of fleet management, some companies were still somehow clinging to their previous ways of doing things like manual hour-meter readings, equipment related site visits, and the like. One explanation for this may be the inherent resistance of human beings to change. The other explanation may be that Fleetwatcher is being looked at, probably by some people involved with fleet management, as something that they have to put up with. A third possibility, and one about which Earthwave probably has the most control over, is lack of appreciation on the part of people who are supposed to be using Fleetwatcher as to what the capabilities of this technology they are equipped with are.

Along the same line, it is to be noted that, even the companies that understood and were using Fleetwatcher in a serious way, were not sure they had recouped the investment they had made, even though they were hopeful that they would. What this is telling us is that, for example, being able to do maintenance on time and thus preventing a costly overhaul as a result, is probably not something that they look at as something affecting the bottom line since they are not able to quantify it or it is not being recognized at all. For example, people typically do not look at the insurance premiums they are paying for their different belongings as something that is saving them money. Obviously Fleetwatcher is affecting the bottom line in every capability it brings into the picture

This again brings forth the need for education of the companies for being able to monetarily quantify outcomes, and, more importantly, train them in uses of Fleetwatcher in ways that directly affect the bottom line. Training companies to calculate savings from preventing useless idling is only one of these. Encouraging of using of Fleetwatcher to track productivity and tie it to the construction schedule, or, helping them in seeing some savings qualitatively if they are not necessarily able to see them in monetary terms may be the others There are probably several other savings which are going unnoticed since they are difficult to quantify in dollar terms. An example is useless site visits. Even though use of Fleetwatcher has most probably reduced the number of visits to the project site, this is not necessarily seen as a monetary saving of cost of management time and direct cost of trips themselves.

The conclusion from above is that a concerted effort on the part of Earthwave to provide extensive training may need to be planned and implemented. It is to be noted that despite what training Earthwave is providing at the beginning, training needs to be a more ongoing undertaking with a certain frequency for a certain duration of time to be agreed upon with the user company. The reasons are turnover in companies and that as companies get more experienced with and more appreciative of Fleetwatcher, they would want it to penetrate more extensively into the fleet management culture over time. A response that supports the above conclusion is that companies were buying Fleetwatcher as a leap of faith rather than as a result of very informed and definitive understanding of its capabilities.

Another observation was that if a company had a software-based way of doing things before Fleetwatcher purchase (such as maintenance-tracking using software) they did not necessarily get rid of this and put Fleetwatcher in place. Even though they started using Fleetwatcher in some other functions, the functions that were already being undertaken by some computer software were seemingly immune, that is, familiarity ruled the day. This prevented Fleetwatcher from taking over the fleet management culture more exhaustively. It is not clear how this can be overcome. Further education will definitely help or time may possibly take care of this in the long run by itself unless a more active approach is considered.

Our feeling overall was that companies were trying to figure out how Fleetwatcher can be used in different functions on their own, rather than, being aware of these from the beginning and trying to focus on the implementation aspects. It is of course also possible that they are aware but are having difficulty or resistance in implementation.

Note that despite Fleetwatcher use, even for a company using it for over 5 years, there were visits to the project site "to see things first hand". This tendency for not being able to let go of traditional ways needs to be researched further as to why and how it can be overcome. There was nothing much to go on to research this any further from the survey responses.

None of the companies surveyed are aware of the fact that they may be entitled to the reductions in insurance premiums due to Fleetwatcher use or unaware of any reductions that may have been realized in terms of the person responding to the survey. Similarly, none of the companies seem to be aware of the fact that they may be able to take advantage of some state/federal grants due to reduction of pollution from their equipment fleets due to minimization of useless idling. We are aware of Earthwave aggressively trying to get the point across for savings due to prevention of useless idling but not necessarily of other possible indirect savings.

Our overarching conclusion, looking at all the responses holistically, is that, companies which were properly organized and had somewhat streamlined their fleet management practices before Fleetwatcher, through a computerized means or otherwise, are/were happy with and running with Fleetwatcher. Others, possibly thinking that Fleetwatcher would bring the discipline and culture for proper fleet management that did not exist to begin with and hoping that Fleetwatcher would be a panacea for their long-term and ongoing problems may need to work at it. Even though it reasonably should have been the case, it is not

possible to trustfully conclude from the survey responses that all companies were able to make use of Fleetwatcher as much as they would have been normally expected to do so.

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