HARVESTING TECHNOLOGY WATCH

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Summary

TECHNOLOGY WATCH is a biannual report outlining research and technology developments that are occurring outside the FFR Harvesting Theme. The report is divided into the following sections:

- New Logging Technology – Showcasing new logging equipment and technology being developed around the world
- Technology Outside Forestry – Technology being utilised in other industries that could be applied in logging
- Ex-FFR Files – A review of interesting research projects carried out in other FFR research themes
- Global View – What's new in logging from around the world.

In this issue, the focus is on transportation and logistics, with a couple of relatively new technologies reviewed: an integrated forestry transport management system and the use of hybrid technology in forestry equipment. In Technology Outside Forestry two different driver fatigue monitoring devices are presented. Understanding and managing the weed risk to plantation forestry is the focus of one part of the FFR Radiata Management theme. Global View provides a brief overview of forestry research at Oregon State University in the U.S.

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NEW LOGGING TECHNOLOGY

Using an Integrated Forestry Transport System to Maximise Wood Transportation Capacity

Transportation is an important cost, representing from 15% to 50% of the total wood value depending on the transport distance to the processing facility. One of the greatest opportunities to reduce transport cost is through technologies to increase loaded running and payload, and to reduce fuel costs. Given that operational costs of log transport are high, it is important to organise log and chip transport efficiently so the trucks are not standing idle or travelling unloaded any more than necessary.

Historically, forest products transportation costs have been weighed down by a number of common issues: inconsistent operations with low efficiency (hub-and-spoke routes), long operating hours (early start times, routing issues), increasing energy costs and unconsolidated industry effort to perform large-scale transportation optimisation.

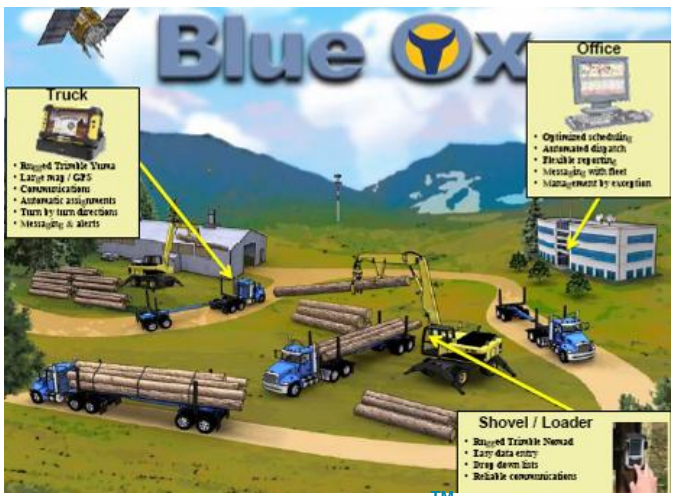

Figure 1. Schematic figure of Blue Ox™ components.

Trimble Forestry Automation has come up with a potential solution to this problem – an integrated forestry transportation management system named "Blue Ox™" (Fig. 1). It is an integrated communication system that links loaders and trucks with customer mills, coordinated with the company's office, using data servers, GPS, and a reliable integrated network, that can utilise cellular, satellite or radio communications to keep everyone in the loop.

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In the loader, the Trimble Nomad® rugged handheld computer (Fig. 2) allows real-time load information to be entered into a central system directly from a remote forest location via satellite modem connectivity. The system informs the loader operator of truck ETA and which load is to go on which trucks. In the truck, the Blue Ox™ system makes assignments and transmits other information to individual drivers via Trimble's Yuma® Tablet PC, which is mounted in the cab (Fig.2) of each truck in the fleet.

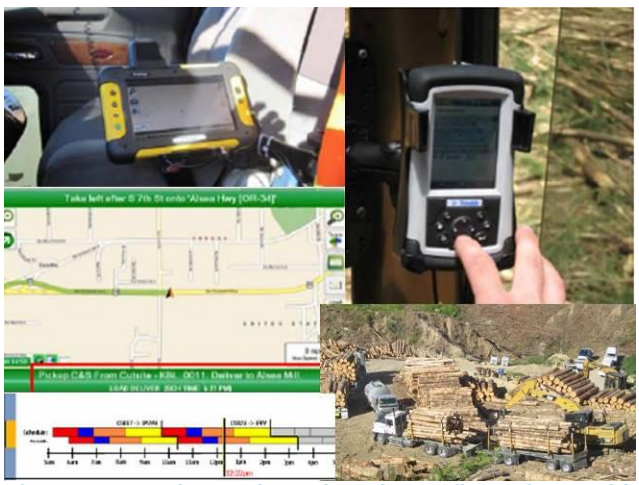

Figure 2. Loader and truck unit configurations with example display screenshots.

The driver is informed of starting time for the first load of the next day, the route to pick-up and to destination is displayed, and audible turn-by-turn directions are provided. After unloading, scale ticket and load ID are entered and the driver is informed of the next load.

The system generates several scheduled and on-demand reports: settlement, productivity, efficiency and safety reports. Implementing the Blue Ox™ system could enable increased production and loaded efficiency, reduced loading time and bottlenecks and administration costs through automated optimised dispatching and overall increased supply chain control. In one case study in the US, the Blue Ox™ system achieved 19% more loads, almost one more load per truck-day, and an increase of 11.5% in travel loaded ratio. Cultural acceptance has been the main implementation hurdle identified in the study.

Hybrid Technology Forestry Equipment

In the face of increased fuel costs and the threat of global warming, efforts to reduce fuel use in all operations are of major significance. One emerging technology that appears to offer opportunities for heavy vehicles working in a start-stop application is the development of diesel/electric hybrids with regenerative braking capabilities.

A unique hybrid solution being explored in Australia was reported in an earlier Technology Watch (Amishev, 2009). This offers most of the benefits of other hybrid solutions but at a much lower cost by converting existing diesel vehicles.

Pike Research forecasts that worldwide sales of medium-duty (MD) and heavy-duty (HD) hybrid, plug-in hybrid and battery electric trucks will grow at a compound annual growth rate (CAGR) of over 60%, with sales of almost 300,000 vehicles during the period from 2010 to 2015.

In looking at the forest industry there are three applications that show promise in using the new hybrid technology, including normal haul trucks, forwarders/skidders and shunt vehicles.

Volvo has apparently recognised this potential and is investing in the development of energy efficient and environmentally sound forestry machinery. Volvo Technology Transfer AB invested in El-forest AB, a company established in 2006 by the inventors of the El-forest forwarder, based in Örnsköldsvik, Sweden. The investment is part of the Volvo Group's efforts to strengthen its role as a leading supplier to the forestry industry.

The El-forest forwarder (Fig. 3) is the world's first forestry machine that uses hybrid-electric technology. The largest model (F15) premiered at Elmia Wood in 2009 and is now available for sale. Holmen Skog, one of Sweden's largest

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forest owners, has undertaken a series of operator tests of the F14 model in April 2010.

The hybrid forwarder uses a series hybrid architecture, with the generator set powered by a small diesel engine. The forwarder is moved by 23 kW traction motors in each wheel. Fuel consumption can be cut by up to 50% compared to conventional forwarders.

The El-forest machine is smaller (9.5 tonnes) than its conventional counterparts (14 tonnes). Despite its lighter weight, it is still able to handle the same load capacity (12 tonnes) as a conventional forwarder.

In addition, it has significantly less impact on the external environment through a patented innovative frame construction that enables all wheels, which are individually electrically powered, to follow the same wheel-track with adapted speed. According to Volvo, it has attracted major attention from the large forestry machine customers in the Nordic countries as well as from customers in other forest countries worldwide.

Figure 3. The Volvo Hybrid El-forest forwarder.

Volvo Construction Equipment (Volvo CE) unveiled a pre-production prototype of its L220F Hybrid wheel loader (Fig. 4) at the CONEXPO-CON/AGG exhibition, 11-15 March 2008 in Las Vegas. The L220F Hybrid offers more power, better performance and a 10% reduction in fuel consumption, according to Volvo.

While much of the technology remains confidential, subject to patents pending, the heart of the hybrid system is an ISG—Integrated Starter Generator. Fitted between the engine and the transmission, the ISG is coupled to an advanced battery.

Up to 40% of a wheel loader's time can be spent with the engine idling. The ISG allows the diesel engine to be turned off when stationary and then almost instantly restarted by rapidly spinning the engine up to optimum working speed using the high power battery. The ISG can also overcome the problem of low torque at low engine speeds by automatically offering a massive electric torque boost — the ISG's 50 kW electric motor offers torque of up to 700 Nm (516 lb-ft) from standstill.

The combination of these two attributes of the ISG means that the diesel engine will remain off for long periods when it would otherwise be idling, and that the operator does not need to over-rev the engine in order to get sufficient torque to work, as peak torque will be offered at lower engine speeds.

Figure 4. The Volvo L220F Hybrid wheel loader.

The battery is replenished automatically without reducing productivity, with the ISG acting as a dynamo/alternator. While the ISG is the heart of the system, there are other energy saving

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innovations in the L220F Hybrid, such an electrically powered climate control system (rather than being powered directly by the engine). The Volvo L220F Hybrid will be Volvo's - and probably the industry's - first commercially available hybrid wheel loader.

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TECHNOLOGY OUTSIDE FORESTRY

Harvest sites are more often than not located a substantial distance away from population centres. For forestry workers, that usually means a significant amount of time spent in driving just to get to the worksite. Harvesting crew members and managers alike have raised concerns about lengthy travel to work which, coupled with a long workday, leads to several issues, one of the most important being worker fatigue. It results in poor overall operator performance and lower value recovery as well as decreased safety awareness and hazard identification both while working and travelling. For that reason, a couple of pieces of technology, developed for drivers in general, are presented below as potential accident prevention solutions.

EyeAlert Driver Fatigue Monitor

Driving when you are in tired is one of the most dangerous pastimes imaginable. With an accumulated sleep deficit, driving is potentially exposing to risk not just your own life but those of your fellow road users as well. For years there has been talk of research yielding such devices for the marketplace.

The DD850 Driver Fatigue Monitor (Fig. 5) from EyeAlert is a fatigue/sleep deprivation warning device.

Figure 5. The DD850 Driver Fatigue Monitor.

When the ambient light drops below 50 lux the DD850 infrared camera/sensors begin to monitor the driver's eye closure rate and duration, and if the driver begins exhibiting unsafe patterns, it sounds an alarm. The cost of this device is US$849. The DD850 is small, portable and has just become available worldwide.

Earpiece Driver Alarm

For those who would rather not use coffee to stay awake, Takanoha & Co. has developed an ingeniously clever earpiece alarm (Fig. 6).

Figure 6. The Nap Vieeb Plus II earpiece alarm.

Its latest model, the Nap Vieeb Plus II, is designed to sense when you fall asleep and then trigger an alarm that wakes you up again.

How does the device know when you're falling asleep? It measures the angle at which your head is positioned, and once it drops below a specified angle (which can be preset using a dial on the earpiece) it delivers either an audible alarm or a vibration to wake you up. It weighs in at only 15 grams, and is attached to the ear with a special silicon rubber loop. Clearly the Nap Vieeb Plus II would be a great gadget for a wide range of users.

According to The Nikkei Marketing Journal, the company's president Kozo Samizo created the Nap Vieeb Plus II, having himself dozed off at the wheel resulting in an accident. The cost is approximately NZ $40, but the web site is in Japanese! There is however some English contact information on the web store page that might be of use for inquirers.

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EX-FFR FILES

Understanding and Managing Weed Risk

Projects in FFR's Weeds Management theme are focusing on building more knowledge in order to better understand and manage weed risk. Two key research issues are being investigated:

1. Prediction of the potential distribution of significant weed species that have limited geographic ranges. The hypothesis being tested is that biosecurity measures to restrict weed spread from the current range are more cost-effective than allowing them to spread and then managing them in their new environment. This work requires new data on weed distribution and the application of existing and new models to predict potential distributions, and the cost-effectiveness of different management options.

2. Optimising weed management strategies through understanding weed population dynamics and how these are influenced by alternative management practices. Data from observations and statistically designed experiments using model weed systems will enable new models to be formulated in which the critical weed life processes are described mathematically. This approach has been taken because models provide the capability required to "look beyond the present" and make informed estimates of the probable outcomes, and hence sustainability (or otherwise) of alternative weed management strategies.

A population dynamics approach (rather than the traditional within-generation mortality approach) has been chosen because weeds are necessarily managed at the population level, and populations invariably exhibit changes over time that affect how they must be managed in different environments.

The focus of this research is at three different scales of weed management decision making; national, regional and local levels. To enable weed management decisions at the national scale, FFR will develop models of the potential distributions of key species currently limited in their geographical extent and impact in NZ. Since weed management decisions are frequently also necessary at the regional scale, the spatial dynamics of "model-system" weeds including *Buddleja* spp. will be determined. At the local population scale, earlier projects will be continued to understand the rates of increase of populations of key weed species.

FUTURE FORESTS RESEARCH

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GLOBAL VIEW

Forestry in Oregon State University (USA)

The College of Forestry at OSU has been educating forestry professionals for over a century and has earned a reputation as a world-class centre of teaching and learning in forestry and related resource management. Its forestry academic programme is ranked number one in the United States. The Department of Forest Engineering, Resources & Management (FERM) comprises a unique group of specialists in forest management, engineering, biometrics, hydrology, forest health and silviculture, working to support decisions for sustainable forests.

The FERM faculty pursues a wide range of basic and applied research projects on topics that include:

- understanding watershed processes in forested ecosystems;
- logging and transportation system management and supply chain efficiency;
- modelling of tree and stand development; forest data sampling and monitoring methods;
- planning models in all forms of active management; and
- measurement, mapping, and data management technologies.

In addition, several decision-support software programs for designing forest operations and computer-based forest growth models that are widely used by practitioners have been developed in the department.

Recently completed research projects carried out by FERM graduate students under the guidance of faculty members include:

- Ph.D. level work (Toman, 2008) had the goal of reducing sediment production from the pavement of forest roads by investigating turbid runoff during wet-weather road use. This research explored the opportunity costs associated with upgrading forest roads for environmental performance, determined a method to design an unbound aggregate pavement to reduce sediment production, and tested alternatives for road pavements that were designed specifically to minimize turbid runoff during wet weather hauling.

- A Ph.D. research project (Hamann, 2009) examined optimizing the primary forest products supply chain by presenting methods of helping forest ecosystem managers to develop operational sampling, monitoring, and production plans for a set of specific quantifiable ecosystem services. These were formulated as a series of general multi-objective optimization problems, and solved using a heuristic solution technique to determine the best trade-off among the different and potentially competing objectives, with the intention that the decision maker(s) will select and implement a single plan.

- One M.S. researcher (Lengerich, 2009) focused on evaluation of a prototype Near InfraRed (NIR) system for Douglas-fir wood density estimation. The rationale behind this study was to evaluate NIR under conditions that are similar to field harvesting operations to estimate log density.

- A Ph.D. dissertation (Thompson, 2009) addressed how transportation planners and road managers can provide and maintain a road system that provides efficient access to the forest while limiting adverse effects those roads can have on water and soil resources. The study developed a decision support tool for improved economic and environmental efficiency in the management of forest road networks. In particular, techniques were developed to

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facilitate trade-off analysis and help landowners identify optimal erosion control policies.

- One M.S. project (Kibler, 2008) assessed the effects of forest harvesting management practices on stream temperatures of small non-fish-bearing headwater streams, and investigated the physical processes that control stream temperature patterns. Results indicated that maximum daily stream temperatures did not increase after harvesting, but that minimum and mean daily temperatures decreased significantly after harvesting. Mean over story canopy closure in the harvested streams decreased by 84% as a result of the harvest, but as the logging slash provided considerable cover, total canopy closure decreased by only 20%. It is possible that the logging slash effectively attenuated solar radiation and prevented extreme temperature increases in the harvested streams.

- A Ph.D. student (Kiyvyra, 2009) assessed the sustainability of management practices for planted forests in New Zealand. Key soil processes which regulate soil function (such as nitrogen mineralisation, decomposition, and soil water dynamics) were measured during the final year of growth on highly stocked plots at ten sites across New Zealand. The impacts of soil disturbance, fertilization, and tree species selection (*Pinus radiata* D.Don vs. *Cupressus lusitanica* Mill.) on those soil processes were investigated. A quantitative forest soil quality index (FSQI) that is applicable across the complex environmental gradient in New Zealand was developed.

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