HARVESTING TECHNOLOGY WATCH

HTW-007
April 2011

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 – New developments in RFID technology for better product tracking and improved sensors enabling teleoperation of machinery.
- Technology Outside Forestry – Focussing on a retrofit anti-rollover truck system and an exhaust gas energy recovery device.
- Ex-FFR Files – A review of the FFR programme in protecting and enhancing the environment through forestry.
- Global View – Providing a review of forestry in the German province of Baden-Württemberg.

Dzhamal Amishev, Scion

NEW LOGGING TECHNOLOGY

Traceability Solutions for Forest Products Using RFID Technology

Product tracking provides tangible benefits to an operation's bottom line through the ability to trace the product through the supply chain, providing important feedback, with the opportunity for early interception of issues, to improve on-time, in-spec product delivery, increase yield and reduce product downgrade.

Several research organisations around the world have worked on improving traceability of forest products through the supply chain from "forest to end-user". One of the European Union funded projects, "The Indisputable Key" (http://www.indisputablekey.com/), aimed at developing a better traceability system for forest products, and part of it involved the development of a forestry-specific Radio Frequency Identification (RFID) system.

Traceability is based on automatic individual identification of logs. The logs are marked with RFID transponders using an applicator, either an automatic device or a manual tool. The unique ID code of the transponder is read with RFID readers in the harvester and at the saw mill. The associated data for the log is stored in a database.

The forest RFID system comprises:

- A specially designed wedge-shaped RFID transponder made from biodegradable artificial wood material that is compatible with pulping;
- A device that can be integrated into the harvester's head and which can automatically embed transponders into the bases of logs;
- An RFID reader with good readability rates and tolerant to vibrations that can be integrated into the harvester's control and data recording systems;
- The correct association of a log's read ID and its measurement data for over 95% of logs.

Figure 1. Traceability solution for logs from the forest to sawmill using RFID.

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The wedge-shaped transponder is applied into the log end so that it is protected by wood for high survival in the log during transportation. The transponder reading range is 2-3 metres from moist wood at the European UHF RFID frequency band (865-868 MHz).

A prototype of an automatic applicator consisting of a transponder magazine and an applicator arm with an application tool was developed for log harvesters. A feeding mechanism transfers the transponder into the application tool in the arm, the arm is lowered and the log is moved against the arm so that the transponder is pressed into the log end. The log is then moved back and the transponder ID-code is read with an RFID reader antenna in the applicator arm. A simple tool for manual marking of logs by hitting the transponder into the log end was also developed.

A prototype of a RFID reader which is robust, shock and vibration tolerant has been developed for use in the harvester. RFID readers in robust metal casings with the antennas on the outer surface were used in the log sorting and sawing at saw mills. The integrated reader assembly utilises commercial RFID readers and is easily installed over the log conveyor, as it requires only electric power and a network connection. In readability tests with logs marked with the transponders almost 100 % readability of fully functional transponders was observed.

Another new development in this area, although not originally targeting the forest industry, could improve this technology even further: “hidden nano RFID tags”.

This newly developed RFID technology comprises an inexpensive, printable transmitter that can be invisibly embedded in packaging, offering the possibility of a scanner that could read all the items at once by a walk past a load of products, total them up and charge the customer’s account while adjusting the seller’s inventory.

Researchers from Rice University in Houston, Texas, working in collaboration with a team led by Gyou-jin Cho at Sunchon National University in Korea, developed the new technology which is based on a carbon-nanotube-infused ink for ink-jet printers first developed by Professor James Tour in the Rice lab. The ink is used to make thin-film transistors, a key element in RFID tags that can be printed on paper or plastic.

Cho and his team are developing the electronics as well as the roll-to-roll printing process that, he said, will bring the cost of printing the tags down to one cent per piece. He expects the technology to mature in five years

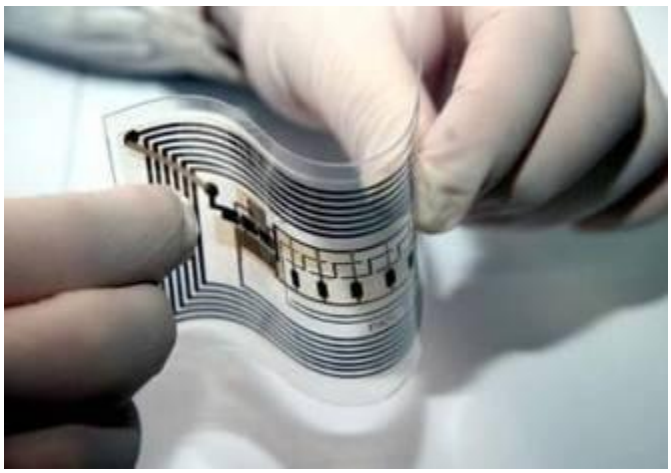

Figure 2. Nano RFID tag on a plastic roll.

RFID tags are almost everywhere already. They are being used to identify and track everything from farm animals to shipping containers, and passports to library books. But to date RFID tags have been largely silicon-based. Paper or plastic tags printed as part of a package would cut costs dramatically and the roll-to-roll technique, which uses an engraving (gravure) process rather than inkjet printers, could replace the barcodes that currently appear on just about everything we buy.

The researchers say the RFIDs are practical because they are passive. The tags power up when hit by radio waves at the right frequency and return the information they contain. "If there's no power source, there's no lifetime limit. When they receive the RF signal, they emit," Tour said.

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There are several hurdles to commercialisation. First, the device must be reduced to the size of a bar code, about a third the size of the current device. Second, its range must increase since currently the emitter has to be pretty close to the tags.

The practical distance to have it ring up all the items in a shopping cart is one metre. But the ultimate would be to signal and get immediate response back from every item in your store – or log landing – what's in the log stacks, the grades, lengths, their dates, everything. "At 300 metres, you're set – you have real-time information on every item in a warehouse. If something falls behind a shelf, or if a product is about to expire, you know about it."

There are some obvious applications for such technologies in harvesting. Potentially, such transponders in every log could allow very rapid stock updates on the skid, meaning contractors could provide more frequent updates to forest owners on inventory, and also save crew time. Information on all logs in a load could be read as the truck or train passed under or through a scanner, This would be useful to track export volumes and for automatic control of incoming products (Kaul, 2010).

Autonomous Navigation – "No operator in my machine?"

Manual tree felling is one of the most dangerous and physically demanding roles in harvesting, especially on steep terrain. One of the objectives of FFR's harvesting theme is to increase mechanisation of felling and eliminate this dangerous role. This also potentially allows the felled stems or logs to be better accumulated and presented for attachment to the hauler's ropes. Looking further out, this research aims at developing a remote controlled (or teleoperated) machine for steep country harvesting. Certainly, new technologies are emerging to enable this transition, and one of them is LiDAR.

Mainstream autonomous navigation is a step closer with this breakthrough LIDAR technology. Velodyne has produced the HDL-32E LiDAR Sensor. It is smaller, lighter and more cost effective than previous products. Its application lies in autonomous navigation and 3D mapping.

This model measures only 15 x 8.6 cm and weighs 1.4 kg. It has up to 32 lasers aligned over a 40 Vertical Field of View (from +10 to -30 degrees) and generates 800,000 distance points per second. It rotates 360 degrees and can measure and provide information from 5 cm to 100 m away, with an accuracy of approximately 2cm. The 3D cloud that results will allow autonomous vehicle applications and mobile mapping applications of a much greater extent than is currently available using conventional LiDAR sensors.

Figure 3. Velodyne's HDL-32E LiDAR Sensor.

When mounted onto a harvesting machine, not only will automated navigation become more of a commercial reality, but mapping and inventory assessments could be carried out as the machine works.

With steep terrain, however, knowing the change in position of the machine would be crucial for its operation. Motion tracking sensors could provide this essential information and because of their small size, even the change in position of different components of the machine (such as the boom, felling head, tracks, etc.) could be monitored.

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Epson Toyocom Corporation has produced what it claims is the world's smallest 6-axis motion sensor. The use of motion sensors is growing dramatically, with the components found in all sorts of devices including cell phones, digital cameras, and of course game controllers such as the Nintendo Wii Remote or the Sony PlayStation Move. Epson Toyocom's AH-6100LR combines two different sensors in a single small package, incorporating both a 3-axis accelerometer and a 3-axis gyro-sensor.

The sensor is a quartz crystal-based micro electro mechanical systems device (QMEMS). Quartz crystals are known for their excellent frequency stability and precision, and Epson Toyocom says these characteristics give its sensors their accuracy and sensitivity.

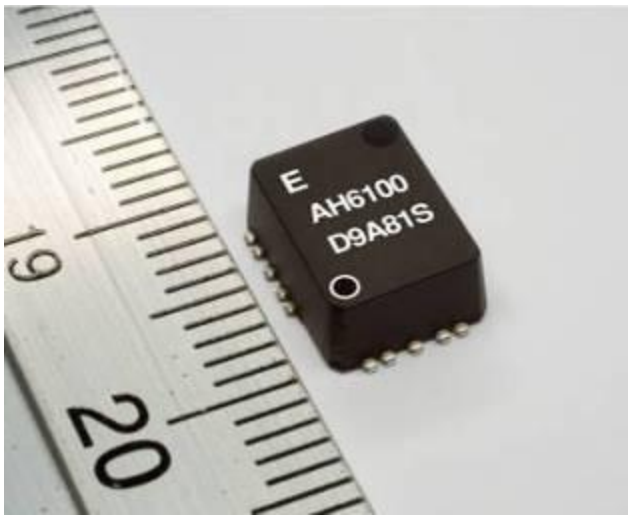

Figure 5. The Epson Toyocom AH-6100LR six-axis quartz MEMS motion sensor.

Epson Toyocom also manufactures a line of highly accurate gyro-sensors that are used in applications such as camera shake correction (image stabilization) and navigation systems. The AH-6100LR incorporates this technology for high-integrity motion tracing and motion tracking use. Tracking a person, or other object requires a sensor with a wide dynamic range of control to detect a wide range of motion at both low and high speeds. Epson Toyocom says the AH-6100LR's wide dynamic range of 81 to 83dB (200Hz output bandwidth) enables highly precise control through accurate tracing, and helps improve motion recognition. With motion sensors showing up in many devices (e.g. iPhone), the market for these devices is definitely growing, and the demand for improved capabilities is increasing as well. The AH-6100LR 6-axis sensor measures just 10 x 8 x 3.8 mm, uses only 6.1mA of power, and is shock resistant to 5000 g.

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TECHNOLOGY OUTSIDE FORESTRY

Log transport, as with any other goods transport, is an expensive operation. With increasing fuel price, transportation is set to become an even larger portion of the total cost for forestry products. Transportation is already an important cost, representing from 15% up 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 reduce fuel costs. Fuel efficiency improvements are important and are being tackled on a number of fronts and by various industries. Two new technologies, developed for the transport industry, are presented below as potential solutions for forest industry issues.

Retrofittable Anti-rollover Truck System

The Log transport Safety Council has spent a lot of time and effort to reduce log truck rollovers. Studies have shown that over 6 percent of the heavy truck fatalities and incapacitating injuries on U.S roads alone are a result of rollover accidents. Modern trucks fitted with ESP

(Electronic Stability Program) have a greater chance of avoiding the problem, but a new retrofittable early warning truck roll-over device provides added safety for older vehicles.

Figure 6. Retrofittable anti-rollover truck system.

Bertocco Automotive Engineering of Italy and Shell Chemicals Europe, based in the Netherlands, have been awarded the EuroTra Safety and Innovation Award 2010 for their innovative early warning roll-over device. The system uses a sensor unit mounted between the rear axles of the trailer to measure the lateral acceleration of the trailer. Data are continuously sent through a wireless link to a receiver in the cab where the driver gets a visual and/or audible early warning if the vehicle is becoming unstable, giving extra time to react accordingly.

The system is low cost, and easily and quickly retrofitted to existing vehicles. Given that it provides immediate feedback to the driver on their driving behaviour, it also provides a valuable training aid.

"This simple but effective warning device for drivers is a result of years of work by a highly skilled team'" said Jack Eggels, General Manager for Global Land Logistics at Shell Chemicals. "We are delighted that EuroTra has recognised the hard work that went into developing this concept into a working device, which can further reduce the risk of tanker rollovers across Europe."

Exhaust Gas Energy Recovery System

A lot of energy is flushed out the exhaust pipe of the internal combustion engine, and a number of companies, most notably BMW and Toyota, and now Controlled Power Technologies (CPT) are working on harvesting that power through an exhaust gas energy recovery system.

Figure 7. CPT's Turbo-generator Integrated Gas Energy Recovery System (TIGERS).

The Turbo-generator Integrated Gas Energy Recovery System (TIGERS) is now being added to the UK Technology Strategy Board's "Vehicle Integrated Powertrain Energy Recovery" (VIPER) research project. The new VIPER project aims to show how a reduction in CO^2 emissions of 4.5 per cent can be achieved over a broad range of vehicles in part by optimizing the control of heat energy from conventional gasoline and diesel engines. The project is being led by Jaguar Land Rover with consortium members including Ford, IAV, BP, University of Nottingham and Imperial College London.

CPT estimates it will take five years to bring its research to market, and the Technology Strategy Board anticipates that VIPER technologies could be applied to the majority of new vehicles before the turn of the decade, though it will be interesting to see what percentage of the vehicles on our roads still

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contain an internal combustion engine a decade from now.

"The VIPER project builds on our exhaust gas energy recovery work already underway for the HyBoost programme," says CPT engineering director Guy Morris. "HyBoost also includes CPT's VTES electric supercharger. There's enormous synergy in the integration of these and other micro-hybrid technologies such as SpeedStart; the mild electrification of gasoline and diesel engines can produce highly efficient vehicles able to achieve significant fuel savings with CO^2 emissions of less than 95 g/km for the average family saloon."

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EX-FFR FILES

Protecting and Enhancing the Environment through Forestry

A project in the Environment and Social theme has focused on enabling New Zealand to realise the full value of its forests on the international market through trading in non-timber benefits and services, potentially worth hundreds of millions of dollars. This step represents a previously unconsidered opportunity for further green economic transformation for NZ.

The key theory is that well managed forests do not require a trade off between economic, social, cultural and environmental benefits, but deliver on all dimensions of sustainability. This hypothesis has been tested using a two pronged approach: (1) by creating new management practices for multiple value forests, (environmentally, economically and socially sustainable primary production), and (2) increasing the forest productivity and efficiency of plant and soil resources (production system productivity and efficiency).

The programme has addressed three main areas of research:
(1) Determine how soil resource use efficiency can be increased to improve plant health and productivity through new knowledge of plant, micro flora, forest soil invertebrate and soil interactions;
(2) Use both quantitative and qualitative methods, including risk assessment and sensitivity analysis, in partnership with stakeholders to gain consensus on acceptable and scientifically valid approaches to measuring societal values;
(3) Develop relevant indicators and measurement approaches for a wide range of environmental values that reflect New Zealand's unique forestry environment (e.g. steep land with high erosion risks, unique biodiversity, cultural history and values). Acceptable values will be reported in a spatial context so that quantitative information on ecosystem values such as carbon or biodiversity can be easily incorporated into new value chain models. The key science challenge is to improve purely economic value chain models so that they integrate new knowledge on a diverse range of indicators of sustainability.

The research also aims to improve outcomes for Māori by enhancing productivity, resource quality, and market value from Māori land in a manner that incorporates Māori concepts and values. Māori have signalled a strong desire to participate in both decision making processes, and in the benefits arising from research. The key improvements for Māori will be through the development of 'Mana Whenua' indices applicable to sustainable management of Māori forest land.

The research will then incorporate these indicators into broader monitoring and reporting frameworks for sustainable forest management, and provide the basis for valuing specific forest benefits and services important to Māori.

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GLOBAL VIEW

ForstBW

Forestry in South-West Germany

The state of Baden-Württemberg is located in south-west Germany and borders France in the west and Switzerland in the south. The State Forest Company trading as ForstBW manages the state-owned forestry resource (329,000 ha) and provides forest management, planning, wood sales, harvesting and consulting services for municipal forests (536,000 ha) and privately owned forests (513,000 ha).

ForstBW was established in January 2009 and its head office is in Stuttgart. It has more than 4,000 employees working in 44 local branches, four harvesting service departments, three forest education and training centres and the head office.

ForstBW also runs its own forest research centre (FVA, www.fva-bw.de) nearby and is associated to the faculty of forestry at the University of Freiburg. The FVA is a European leader in research on the forest effects of climate change.

Forestry in Baden-Württemberg has a long history, beginning with Roman settlement 2,000 years ago. The ancient royal forest administration legislated strong forestry laws and invented a sustainable forestry regime which is still the framework of forest management in Germany today. ForstBW practises a “near to nature” multipurpose forest management and is certified to the standards of the Program For The Endorsement Of Forest Certification (PEFC). This involves long rotations (120 to 250 years) and the abandonment of clearfelling to manage the forests on a selective cutting regime in order to get stands with various tree species and a huge range of ages and highly valuable trees (target diameter from 60 to 90 cm DBH). The main tree species are spruce (36%), beech (24%), other European hardwoods (12%), fir (8%), and pine (8%). The company’s objective is to run a commercial forestry business (with annual yield for the state treasury), which complies with social requirements (recreation, employment, education, training) and protection demands in a densely populated and highly industrialised country. ForstBW’s mission is to achieve all these demands equally.

The annual cut is 2.35 Mm³ (7.3 m³ per hectare) ForstBW achieved an annual turnover in 2008 of 135 M€ and earned a profit of 14.8 M€.

Product Line	Unit	2006	2007	2008
Wood Production	Mm³	2,824	2,526	2,355
Wood Yield (Net Costs of Harvesting)	€/ha*	244	273	243
Other Yield	€/ha*	34	33	34
Costs of Administration	€/ha*	166*	152	152
Costs „Biological Production“	€/ha*	33	39	40
Costs „ Other Services“	€/ha*	65	66	68
Result of Operations	€/ha*	**14**	**49**	**17**

Although most of the harvesting (65%) is done motor-manually, ForstBW aims to increase the rate of semi- and fully mechanised harvesting operations. Due to mountainous country and the selective cutting regime this is a real challenge. ForstBW is a leader in mechanised steep slope harvesting using adapted harvesters and slope-forwarders. It runs two of their own mechanised harvesting systems and four cable logging systems. The mechanised harvesting system consists of an excavator-based harvester (Impex Königstiger with a Lako Impex-VV 786 harvester head) and a steep slope forwarder (Herzog Forcar FC200 8x8 with 12 tonne loading capacity and a traction-winch with 250 m of wire rope cable). The forwarder drive and traction winch are automatically synchronised, operator seat is with tilt and there are video cameras in the rear and inside the winch casing.

Contributed by Matthias Schmitt, Forest Officer, State Forest Company of Baden-Württemberg - ForstBW (visiting intern at FICA office in Rotorua from February to April 2010)

Reference: www.forstbw.de

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