HARVESTING TECHNOLOGY WATCH

Number HTW-009
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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 – New developments and improvements in small scale cable yarding using the Telecarrier excavator-based yarding system.
- Technology Outside Forestry – Focussing on liquid body armour and an intelligent t-shirt with potential for manual tree fallers.
- Ex-FFR Files – A review of a project in the FFR radiata management theme to count trees for forest inventory purposes.
- Global View – Providing a review of forestry research at the Finnish Forest Research Institute.

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NEW LOGGING TECHNOLOGY

Telecarrier cable yarding system from Teleforest Inc.

A Canadian company, Teleforest Inc., has produced an innovative cable yarding system with a self-propelled carriage that runs on a standing skyline suspended between two excavators (Figure 1).

Figure 1: The Telecarrier cable logging system.

Unlike most cable yarding systems, which are complex and require a considerable length of time to set up and relocate, the Telecarrier system has simplified the set up to increase productive time. The skyline is suspended between two excavators that do not require anchoring. This reduces setup time and less manpower is required.

Each excavator has a tower mounted at the end of its boom. Tower heights vary depending on base machine size. The excavator boom holds the tower on the ground at an angle of 18 degrees from vertical, angled towards the excavator, which provides the required stability. The skyline winch drum (6000 kg) is mounted at the rear of the excavator and runs the skyline through the top of the tower over to the other excavator. Each skyline drum holds between 300 and 500 metres of cable (Table 1).

Table 1: Excavator size and effect on skyline length and tower height.

Excavator size (tonnes)	20	30	40
Skyline length (m)	300	400	500
Tower height (m)	9	12	15

The self-propelled carriage is controlled by radio remote. The carriage is powered by a 50 kW (71hp) Deutz engine and is equipped with a hydrostatic braking mechanism. The carriage, which weighs 1320 kg, travels at up to 6 m/s (21 km/hr) on the skyline. It has 75 m of dropline and has a lifting capacity of 2700 kg. It uses approximately 4 litres of fuel per hour depending on the application.

The system can be used in a number of applications. When yarding horizontally or downhill, the carriage self-propels (Figure 2).

Figure 2: Telecarrier self-propelled carriage.

There is an option for a main winch drum (TL-6000 kg) mounted in front of the skyline drum. This enables uphill timber extraction (Figure 3). It can be used in conjunction with a fixed tail hold where excavator access is limited. When not skyline yarding, the excavators can be used in a shovel logging application or as loaders.

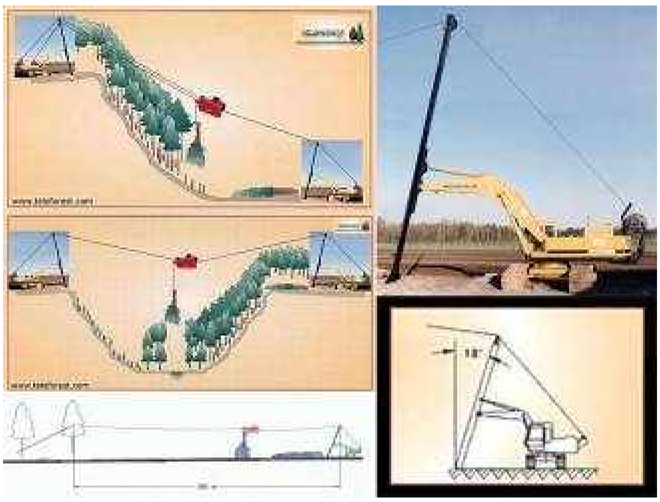

Figure 3: Versatility of use of the Telecarrier cable logging system.

Teleforest Inc. revealed that they prefer to use second-hand excavators to keep the cost down. Because of the function the base machines perform within the system – primarily serving as tower stabilisers – they are not moving much (except when line-shifting), and so new excavators are not required. The manufacturers gave an estimated cost of US$100,000 for two second-hand 40-tonne excavators. They quoted a price on this product (including the winches, modifications, towers, rigging, carriage and two weeks training on site) of US$330,000 resulting in a total price of US$430,000. Transportation costs to New Zealand would be additional.

The Telecarrier may be a viable option for small woodlot harvesting in New Zealand. This could be suitable for remotely located stands with poor or non-existent infrastructure where the use of conventional cable logging systems would be costly and economically infeasible.

References:
http://www.teleforest.com/

TECHNOLOGY OUTSIDE FORESTRY

This section is aimed at new technology for manual tree fallers in the logging operation that could address issues such as hazards of falling branches and debris, chainsaw injuries and working at some distance from other workers. These include body armour and an “intelligent” t-shirt to monitor vital signs.

Liquid armour that hardens on impact

BAE Systems, a British multinational defence, security and aerospace company, has a project to create future body armour offering soldiers greater ballistics protection and ease of movement.

Existing Kevlar armour is stiff and can impede movement and cause discomfort so the scientists and engineers at BAE have developed a liquid which hardens when struck. The technology has been dubbed “liquid armour” by its developers

It harnesses the unique properties of shear thickening fluid (STF) which behaves like a solid when it encounters mechanical stress or shear. In other words, it moves like a liquid until an object strikes or agitates it forcefully. Then it hardens in a few milliseconds.

Shear-thickening fluid is a colloid, made of tiny particles freely suspended in a liquid. The energy of a sudden impact overwhelms the repulsive forces between the particles, and they stick together, forming masses called hydroclusters. When the energy from the impact dissipates, the particles begin to repel one another again. The hydroclusters fall apart, and the apparently solid substance reverts to a liquid.

Figure 4: Body armour from BAE Systems.

These properties can be used to enhance the existing energy absorbing properties of material structures like Kevlar (Figure 4). To make liquid body armour using STF, researchers saturate the Kevlar with the STF so the Kevlar strands hold the particle-filled fluid in place. When an object strikes or stabs the Kevlar, the fluid immediately hardens, making the Kevlar stronger. The hardening process happens in mere milliseconds, and the armour becomes flexible again afterwards.

When liquid armour is struck by a bullet the force is spread over a wider area. In cross-section, it can be seen that the depth of penetration is also less than in traditional Kevlar (Fig. 5). Stewart Penney, Head of Business Development for Design and Materials Technologies at BAE Systems says “…with ‘liquid armour’, you would feel significant resistance as the elements in the fluid lock together. So when the material is impacted at speed, it hardens very quickly and absorbs the impact energy.”

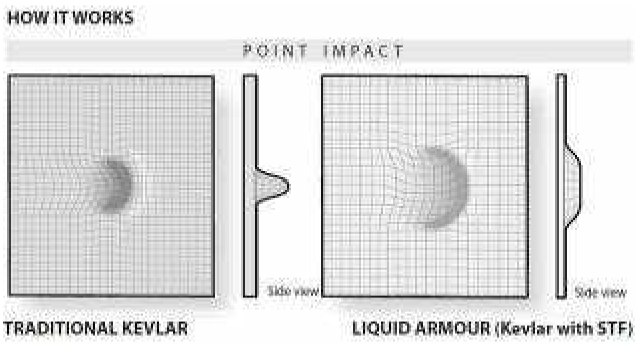

Figure 5: Schematic view of the way the liquid body armour works.

The liquid armour is designed to offer increased protection with reduced mass, wider area cover, greater manoeuvrability and easy integration with other systems. BAE says the STF integrated into standard Kevlar body armour offers superior freedom of motion and a reduction in overall thickness of up to 45 per cent. Trials conducted at BAE Systems’ Advanced Technology Centre in Filton in Bristol have shown the liquid armour allows thinner than standard armour to withstand equivalent levels of forces. An early prototype of the technology has been demonstrated to the UK Ministry of Defence. In future the team at BAE Systems hope to create applications of the technology beyond the military. Penney said: “In addition to increasing the ballistic performance of combat body armour there is potential for developing a version that could be of interest to police forces and ambulance crews.”

Although no specific tests have been reported on its performance to cuts, depending on its

affordability, such invention would a very suitable protection for future forestry workers due to the nature of the job.

References:
http://www.baesystems.com/index.htm
http://www.gizmag.com/liquid-armor/15771/

The 'Intelligent T-shirt' to remotely monitor vital signs

One of the latest examples of clothing made from "smart fabrics" is in the field of medicine where the "intelligent T-shirt" can monitor patients' vital signs.

This garment is designed by scientists at Spain's Universidad Carlos III de Madrid (UC3M). It can remotely monitor a person's temperature, heart rate, activity level, body position and location.

The prototype shirt (Figure 6) incorporates electrodes that detect bioelectric power, such as that created by the beating of the heart – an electrocardiogram can be obtained using these electrodes to record the level of physical activity. It features a removable device that includes a thermometer and an accelerometer which measure the patient's body temperature, along with their position (whether they're standing or reclining).

Figure 6: UC3M designed "Intelligent T-shirt".

The UC3M research team believe that the shirt could be used to remotely monitor people's health. Alarms built into the T-shirt could notify other workers when the wearer's heart rate exceeds a given limit, or when their body temperature drops significantly below normal (37^0C, or 98.6^0F).

Another device which researchers could build into the shirt is a GPS receiver, which can establish the wearer's location within the forest to track location and movement.

Given its capabilities, this development could be suitable for harvesting and forestry workers working in remote locations away from the main operation site. Manual tree fallers often work alone and could be injured without anyone noticing. Information about their vital signs and location could be transmitted in real time to the hauler operator, for example, and hazardous situations could be identified earlier and required help provided in a timely manner.

References:
http://www.gizmag.com/intelligent-t-shirt-monitors-vital-signs/19903/

EX-FFR FILES

Tree Counting with Virtual Plots

Throughout 2011, a project in FFR's Radiata Management theme has focused on developing a technique for tree counting for operational inventory purposes.

The theory is that given an accurate estimate of the total number of trees, then a more cost effective individual-tree sampling method could be used as an alternative to the conventional bounded plot-based inventory for assessing total volume by log grade.

Remote sensing imagery is used to obtain the tree count. Previous research in this area lead to the development of TimberLine, a forest inventory system which used a semi-automated image processing system called TIMBRS[1] to establish a total tree count (Figure 7), combined with ground-based individual tree measurements. Despite some promising initial results using TIMBRS, many subsequent tree counts had unacceptably wide ranging error variances due to subjectivity in balancing tree omission and commission errors.

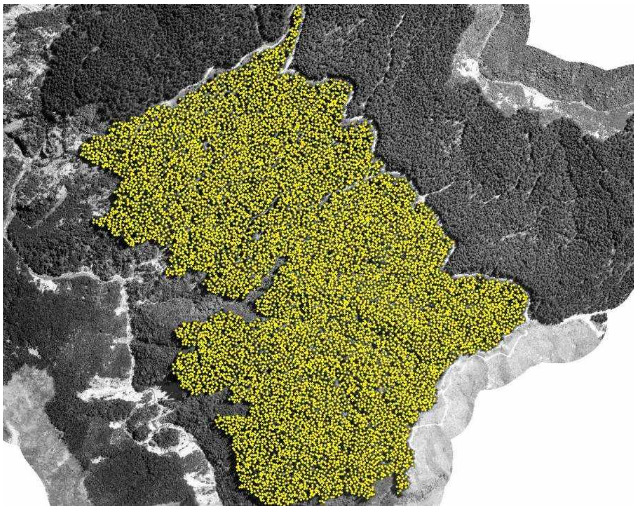

Figure 7. A TIMBRS tree count with tree map locations for a 70 hectare stand in Esk forest.

To provide more insight into omission and commission error issues, image analysis tools were developed which lead to a new tree counting approach using 'virtual plots" (VP).

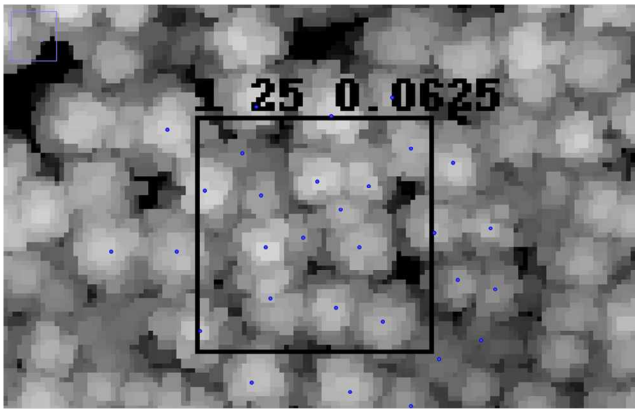

Figure 8. An operator virtual plot on a LiDAR derived image.

There are two types of virtual plots. The virtual plot operator (VPo) involves an operator manually clicking on trees (Figure 8). The VPo can be used to assess the tree spacing and stocking of a stand with estimates of these parameters used when generating an automated count. The virtual plot TIMBRS (VPt) simply sees virtual plots overlaid over the automated tree count.

Using the ratio of means between virtual plots and ground stocking plots, the automated tree count estimate can be adjusted. Recent results show this approach is not only flexible, but produces accurate and repeatable results between different operators, image types and stand conditions.

The current research focus is on developing a field inventory procedure that incorporates individual-tree sampling and ground stocking plots. In conjunction with current research using LiDAR to provide new image data, an industry case study incorporating the Virtual Plot tree counting approach and new inventory field procedures is planned for 2012.

References:

L. Holt, D. Pont, R. Brownlie, and C. Goulding, Scion, Rotorua.

GLOBAL VIEW

[1] Tree Identification Methodology Based on Remote Sensing (TIMBRS) is a system which uses a spatial clustering algorithm to identify and count tree crowns.

METLA – Finnish Forest Research Institute

Finland is the most heavily forested country in Europe, with 76 % of its area covered by forests (Figure 9).

Figure 9: A typical Norway spruce stand in Finland.

Metla, the Finnish Forest Research Institute, conducts research into the forest environment, and the forest industry aimed to enhance the sustainable use of forests and the economic competitiveness of the forestry sector. Its mission is to build the future of the forest sector by producing and disseminating information and know-how for the well-being of society.

Metla is one of the biggest forest research institutes in Europe, with 700 staff. In recent years its budget has been about 53 million Euros, funded 70% by the Finnish government through the Ministry of Agriculture and Forestry and 30% from private organisations, foundations and commissioned services. Metla operates a large number of permanent field experiments producing extensive measurement data. In addition to research and information on reserve management, Metla creates forecasts relating to the health status of forests, harvesting prospects, and the timber trade.

The research priorities are:

1. Forest-based enterprise and business activities:
   - Silvicultural methods
   - Properties of wood as a raw material,
   - Production efficiency applied in forest management and utilisation (Fig. 10)
   - Business economics.

Figure 10: Site preparation in a forested area in Finland.

2. Societal impact of forests:
   - Forest economy at the national economy level,
   - The profitability of forest economy and forest policy methods,
   - Environmental economy of forest-based services.

3. The structure and functioning of forest ecosystems:
   - Forest ecological yield and development dynamics,
   - Chemical flows in forests,
   - Interactions between genetic structures and forest use,
   - Biology of forest diseases and pests and methods to control and prevent them,
   - Mechanisms for biodiversity.

4. Information databanks on forestry and the forest environment:
   - Forest inventory methods,
   - Forestry planning methods,
   - Information technology,

- Forest carbon pools and fluxes.

References:

http://www.metla.fi/index-en.html