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. This report is divided into four sections:

- New Logging Technology – New developments and improvements in small scale cable yarding equipment.
- Technology Outside Forestry – Developments in exoskeleton robots and a technique for converting used motor oil into fuel.
- Ex-FFR Files – A project in the FFR Radiata theme to develop a new technique for measuring stiffness in tree seedlings.
- Global View – Research from the Trees and Timber Institute of the National Research Council of Italy.

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NEW LOGGING TECHNOLOGY

Herzog Grizzly 400-Cable Yarder

The excavator-based Grizzly 400 Yarder from the Swiss manufacturer Herzog Forsttechnik (Figure 1) has been described as "the best response to the economically difficult situation of timber extraction in steep terrain forests". It has now manufactured in Switzerland.

Figure 1. Herzog Grizzly 400 Cable Yarder.

The Grizzly 400 Yarder optimally combines the European cable crane system technology with American derived yarder system. Crawler excavators are widely used in North America and Australasia, where once there were no trees as anchors. The mast is attached to the excavator as a counterweight and tensioned to provide the support for the guy lines. In addition, the excavator engine power is used to drive the entire excavator cable crane. This Swiss-made cable crane technology allows the user to achieve a very high yarding performance in both clearfell and closed canopy thinning stands.

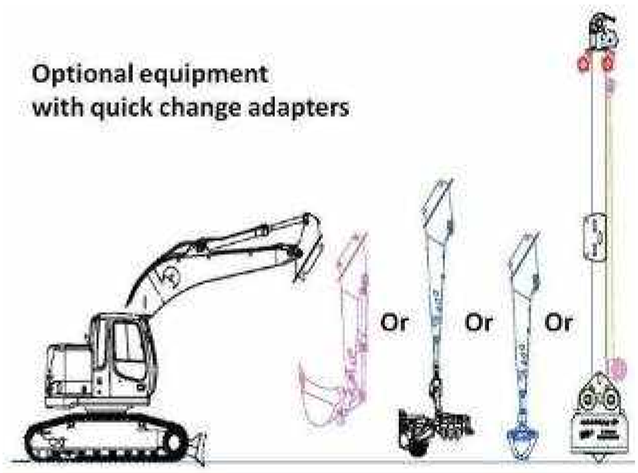

Figure 2. Optional quick change adapters.

The fixed tension monitor in conjunction with the self-locking, remote-controlled carriage and rope winch makes radio-control of the machine possible. It is also optionally equipped with quick

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change adapters allowing the excavator to be used in other parts of the system as well – loading grapple, processing head or earthworks bucket (Fig. 2). According to the manufacturers, interchanging the different attachments would take no more than 3-4 hours to complete.

Figure 3. Grizzly 400 in transport position on a trailer.

Due to its compact size and versatility, transportation is easy and inexpensive, allowing for better utilisation at more operations (Fig. 3). Woodlot harvesting and small scale forestry would be some of the situations where this technology can reduce costs and increase economic feasibility and attractiveness. The yarder is able to position itself on small landings or even roadside locations, reducing costs for roading and landing construction.

The Grizzly 400 yarder is suitable for yarding up to 400 metres. An optional three rope setup allows horizontal yarding up to 400 m and downhill yarding up to 200 m.

It is equipped with:

- 9.8-m-high structural steel pipe mast and a 2-m extension option at the bottom (Fig. 4),
- 400 m of 18-mm swaged skyline (Clamping force up to 11 tons),
- 450 m of 11-mm swaged mainline (39 kN average tension during inhaul, maximum safe traction 48 kN),
- 800 m of 7-mm tail rope (15 kN average traction during outhaul), and
- four hydraulically driven guy line drums, with 50 m of 20-mm guy lines.

Depending on the weight of the carriage, in optimal deflection this yarder is able to inhaul up to 4 tonnes of payload. During inhaul, when the rope is winding it is hydraulically pre-tensioned at the top of the tower for optimum winding and tension monitoring.

Figure 4. The Grizzly 400 yarder yarding uphill using its full 11.8 m tower height with the 2 m bottom extension.

The whole operation is remotely controlled with automatic return to previous position. The carriage is a radio-controlled mechanical slack-pulling carriage equipped with a skyline and mainline lock. The position of the carriage can be fixed during inhaul as well. There is additional optional equipment with spooling for the 3-cable-use (horizontal and downhill yarding).

Standing Skyline Yarding Systems Larix Lamako

The yarding systems Larix are manufactured by the Research Station of Forest Mechanization in Křtiny in the Czech Republic. Standing skyline yarding systems, Lamako are designed for timber transport downhill and uphill, as well as on flat terrain. The whole unit of the skyline system is suspended on the back and front three-point linkages of the agricultural tractor – both axes of the tractor are well loaded and the complete unit is very mobile, on road and in difficult terrain.

The yarding system is mechanically driven and uses the agricultural tractor transmission and mechanical clutches and brakes of the drums are controlled by the pneumatic control system. It is equipped with:

- a 8.0-m tower,
- 550 m of 16-mm skyline (45kN of pulling force),
- 550 m of 10-mm mainline (inhaul power – 27kN),
- 1100 m of 10-mm haul back line (outhaul power – 14kN) and
- 1200 m of 10-mm polypropylene straw line.

Similar loads as with the Grizzly 400 should be achieved according to these technical specifications.

Figure 5. Carriage Sherpa U 3T (MM-Forsttechnik, 2009) and Larix Lamako yarder.

The skyline system is equipped with a radio-controlled mechanical slack-pulling carriage equipped with a skyline and mainline lock (Sherpa U 3T, Koller Uska 1.5) (Fig. 5). The clamps are operated by remote control. When the skyline is clamped, the mainline clamp opens automatically and vice versa. The remote control has the advantages that the carriage can be fixed at any position of the skyline, and that the load can be held at any height above ground. This kind of operation enables a very efficient but gentle loading of timber on different stands. Carriages used with this system have the haul back line drum capacity for necessary lateral yarding distance. The mainline is mechanically pulled slack to the logs by using the power of the haul back line winch as the skyline clamp is active. The logs are yarded laterally to the carriage, using the power of the yarder mainline winch and active skyline clamps. As the loaded carriage is hauled in the mainline clamp is active (Fig. 6).

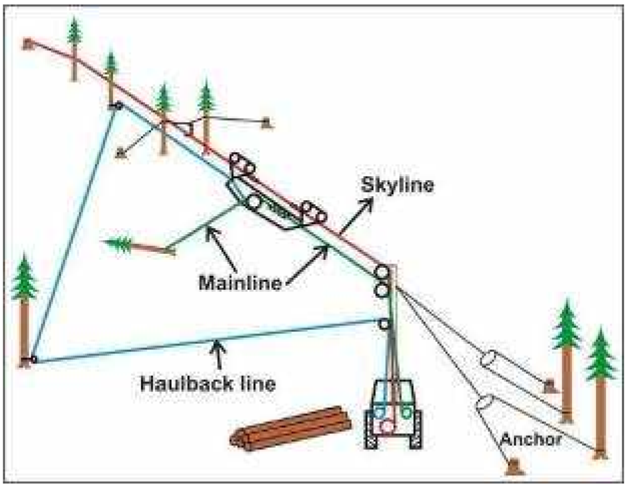

Figure 6. Scheme of the standing skyline yarding system LARIX LAMAKO.

Larix Lamako is operated by remote control, both from the landing and the forest (when setting chokers). After the yarding cycle is finished, the landing operator sends the carriage to the forest operator. If the forest operator does

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not accept control, the carriage can return automatically to the pre-programmed location. As the line is pulled in (to the landing) and the carriage approaches the landing, control is transferred to the landing operator again. The memory pre-programmed location also works in this direction. The in- and out-haul functions of the drums are synchronized by computer, so the operators use only simple orders to control the yarder.

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TECHNOLOGY OUTSIDE FORESTRY

Service Rescue Exoskeleton Robots

In our first issue of the Logging Technology Watch (Sept. 2008) we wrote about advances in exoskeleton technology in the US military. A slightly different perspective on the topic is given by Japanese robotics engineers – service rescue robots.

Robotics seems to be becoming more popular in the forestry equipment manufacturing world, and whenever robots are discussed it seems the name TMSUK comes up. The small Japanese robotics company has collaborated with some of the biggest names in electronics to produce commercial robots in the last few years, and their concepts always seem to be innovative and imaginative, not to mention very useful.

TMSUK is best known for its security robots Banryu and Artemis, a semi-humanoid security guard for hospitals and office buildings. So when Japan's National Research Institute of Fire and Disaster defined its strategy on next generation response to earthquakes and fires, they decided they needed a robot for high risk situations and TMSUK got the call.

Figure 7. The T-52 Enryu rescue robot from Japan's TMSUK robotics manufacturer.

Built for business, the strapping 3.5 metre Enryu will be used to enter burning buildings, lift heavy objects and rescue people. The 'super robot' is codenamed the T-52 Enryu and certainly has excellent capabilities with its weight of 5 tons and ability to lift a ton of weight with its "arms" alone.

The arms have the full range of movement available to the human arm. Enryu can be operated remotely, thanks to seven 6.8-megapixel CCD lenses mounted on its head, torso and arms, enabling the remote driver to see from several angles. It can also be operated from inside, making it an exoskeleton and enabling far greater dexterity and hence capability. The driver wears a fireproof suit and is encased in a protection capsule (and will surely have the dream job of the next generation of adolescents).

Production began in 2004 and the company sees a large part of its future building robots which can go where human beings cannot, such as burning buildings or on the battlefield. The company is also conducting feasibility studies on the potential market for super-strong robots and

exoskeletons in the construction and agricultural industries.

Figure 8. The T-52 Enryu and T-53 rescue robots from Japan's TMSUK robotics manufacturer.

The latest in their line of rescue robots, however, is the Enryu T-53 (lit. "Support Dragon"). This little number is half the size of its older brother the T-52 so that it can move faster in emergency situations (Fig. 8). Its arms are more precise when moving towards a target, but aren't quite as powerful. Still, the T-53 is quite capable of moving heavy objects like rubble at the site of an earthquake with a load bearing of 100 kg per arm. It can also be used to move dangerous objects like barrels of toxic waste, controlled remotely via the cameras on its head and arms, or directly (so long as the operator wears some protection). The arms are controlled via joysticks or with true mechatronics-style controls that mimic the operator's arm movements.

The T-53 is the first robot licensed to travel on public roads, since it has headlights and brake lights. It is being marketed not only as a rescue robot, but for construction and waste disposal industries as well. Its claw-like hands are interchangeable with existing construction equipment parts allowing it to do a variety of jobs.

Microwaves Utilised to Convert Used Motor Oil into Fuel

Over 8 billion US gallons (30.3 billion litres) of used motor oil are produced every year by the world's cars and trucks (Fig. 9). While some of that is re-refined into new oil or burned in furnaces for heat, neither of those processes is entirely environmentally innocuous. Researchers from the University of Cambridge announced the development of a process that uses microwaves to convert waste oil into vehicle fuel.

Figure 9. Scientists from the University of Cambridge have developed a system that uses microwaves to convert waste oil into vehicle fuel.

Scientists have already been using a process known as pyrolysis for recycling oil. It involves heating the oil to a high temperature in the absence of oxygen, and causes the oil to break down into a mixture of gases, liquids, and solids. While the gases and liquids can be converted to fuel, the Cambridge scientists state that traditional pyrolysis doesn't heat the oil very evenly, making the fuel conversion process difficult and impractical.

They added a microwave-absorbent material to samples of waste oil, before subjecting it to pyrolysis by heating it with microwaves. The addition of the material caused the oil to heat more evenly; almost 90 percent of it was converted into a mixture of conventional gasoline and diesel.

Study leader Howard Chase believes that their unique brand of pyrolysis shows great potential for being scaled up to the commercial level.

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EX-FFR FILES

A Novel Technique for Non-Damaging Measurement of Stiffness in Tree Seedlings

A project in the FFR Radiata Theme has focused on developing a technique which can measure the sound speed in seedlings rapidly without damaging them or influencing their future development (Emms *et al*., (in review)). Potentially, standing tree acoustic tools are valuable since they are non-destructive and allow genetic material to remain for breeding future generations. The techniques need to be non-damaging to young seedlings so that the seedlings' development can be monitored over time.

A time-of-flight technique based on relatively low-frequency quasi-longitudinal waves, miniature accelerometer sensors, and the use of the cross-correlation of time-windowed waveforms was developed.

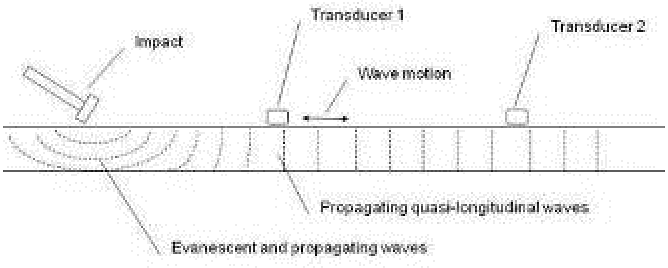

Figure 10. Basic concept for the seedling time-of-flight technique (Emms *et al*., (in review)).

This technique can measure the speed of sound in a section of a seedling non-destructively and non-intrusively.

The wavelengths and wave types of this time-of-flight technique are such that we expect the measured sound speed to be influenced by the axial stiffness and density of the stem.

This so-called 'cross-correlation time-of-flight' procedure was tested on nine 1- and 2-year-old *Pinus radiata* seedlings. Comparing the sound speed results of the method to a destructive resonance test showed that the results are essentially unbiased. Repeatability tests of this procedure on the seedlings yielded an average standard deviation of less than 2% for the sound speed over a distance of 100 mm. The effect of small branches on the sound speed results was minimal.

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GLOBAL VIEW

CNR-IVALSA
TREES AND TIMBER INSTITUTE

National Research Council of Italy – Trees and Timber Institute

The Trees and Timber Institute of the National Research Council was created in September 2002 by the merging of three previous institutes: the Institute for the Propagation of Tree Species (IPSL), the Institute of Wood Research (IRL) and the Institute of Wood Technology (ITL). It is the biggest Italian institute for research in the wood-forest sector.

There are 70 staff at IVALSA. Their laboratories are equipped with innovative and advanced testing machinery and perform activities of consultancy and certification.

IVALSA collaborates with many universities, and includes many postgraduate students in its research programmes. It also participates in many national and European research projects. The research activities are focused in five main areas:

- Characterisation, selection and propagation of tree species and biodiversity preservation.
- Protection of the agro-forest environment.
- Quality improvement of timber production including biomass production systems (Figure 11).
- Promotion of wood technology and engineering uses of timber.
- Protection of cultural heritage.

Figure 11. A processing landing site for a cable logging operation in Italy.

In the area of operational quality improvement, several research projects f interest to FFR have been undertaken in the last couple of years:

- Impact of traditional small-scale logging systems used in Mediterranean forestry. (Spinelli *et al*., 2010a)
- Safety and productivity in motor-manual and mechanised logging operations in the Italian Alps (Fabiano *et al*., 2010; Montorselli *et al*., 2010).
- Benchmarking and comparison of harvesting systems performance and new harvesting equipment in thinning operations (Spinelli *et al*., 2010b; Spinelli *et al*., 2010c).
- Comparison of harvester processor units in processing hardwood from coppiced forests (Suchomel *et al*., 2010).
- Productivity and costing of biomass harvesting and wood chipping (Spinelli and Magagnotti, 2010).

Some work is to be presented at the FORMEC 2011 meeting in October, 2011 in Graz, Austria:

- Performance of industrial firewood processors.
- Effect of feedstock type on chipping productivity, fuel consumption and quality output.
- Determining the annual usage, service and value retention of cut-to-length (CTL) technology.

Recently, two of the Institute's researchers – Raffaele Spinelli and Natascia Magagnotti – visited the School of Forestry at the University of Canterbury to conduct joint research projects with Dr. Rien Visser and his graduate students.

Some of the projects focused on the size of skid sites in New Zealand logging operations and their relation to the used harvesting system and the associated productivity factors (Visser *et al*., 2010a), biomass extraction and processing systems, the use of landing residues for biomass purposes and exploring different options for optimal productivity and cost (Visser *et al*., 2010b).

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