FUTURE FORESTS RESEARCH

HARVESTING TECHNOLOGY WATCH

Number: 3, October 2009

2009 COFE: Council on Forest Engineering

Summary

TECHNOLOGY WATCH is a biannual report outlining research and technology developments that are occurring outside the FFR Harvesting Theme. In this third issue, we report the 2009 COFE conference held in Kings Beach (Lake Tahoe) California, 15 - 19 June 2009. The report covers the following sessions of the conference:

- Forest Operations
- The Human Factor
- Biomass and Fuel Reduction
- Roads, Trails and Transport
- Maximising Value

The theme of the 2009 COFE conference was "Environmentally Sound Forest Operations" and, consistent with the conference theme, strong emphasis was on environmental impacts of harvesting, together with biomass harvesting. Given the focus of FFR harvesting research, a number of presentations of interest to New Zealand harvesting stakeholders are reported: a turn-back yarding system with two carriages; use of radio-controlled chokers in Austria; finding the 'optimum' tree size for a Waratah harvester; use of synthetic ropes as guy-lines in standing skyline systems; hazards of thrown objects in harvesting operations; integrating biomass recovery operations into log harvesting; road engineering practices in New Zealand; and applications for terrestrial LiDAR.

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Introduction

The Council on Forest Engineering (COFE) is an international professional organisation interested in improving the field of forest engineering. The main objectives of COFE are: to foster the development of forest engineering; to promote the best methods of managing and operating forests; to serve the forestry profession on matters of policy in the area of forest engineering; and to disseminate technical information on forest engineering subjects: (http://www.cofe.org/)

The 32nd Annual Meeting of the Council on Forest Engineering (COFE) was held in Kings Beach (Lake Tahoe) California, 15-19 June 2009. The theme of the conference was "Environmentally Sound Forest Operations" and comprised about 40 conference presentations, divided into the following sessions:

- Forest Operations
- The Human Factor
- Biomass & Fuel Reduction
- Environmental Impacts
- Roads, Trails & Transport
- Maximising Value
- Production & Cost Analysis

Consistent with the conference theme, emphasis was given to environmentally sound harvesting, together with a topic gaining in importance - biomass harvesting. Observations during the one-day field trip also highlighted the importance of these issues in the western U.S. and especially in California.

Also presented was research work conducted in a number of other countries: Australia, Austria, Belgium, Canada, Chile, Japan, Malaysia, New Zealand, South Korea and from several states across the U.S. As the focus of the meeting coincides with the strategic goals of Future Forests Research (sustainability, quality and productivity), some value can be gained from a summary of the presentations, some of which could find application in New Zealand, or at least provide "food for thought" for forest harvesting professionals here.

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Forest Operations

The following four presentations from the "Forest Operations" session would be of most interest to New Zealand harvesting professionals, and are highlighted as having potential application in New Zealand:

1. Turn-back Yarding System

Figure 1: A developing model: carriages for turn-back yarding system

Aruga et al., (2009) developed a new cable system, called the turn-back yarding system, as a means of reducing harvesting costs. The new system has two carriages, each equipped with chokers (Figure 1).

At the beginning of a cycle, one carriage is at the log site while the other is at the landing. Once logs are hooked on, the two carriages move towards each other until they meet and the loaded strops are exchanged for empty. The two carriages move back, with the load of logs being yarded to the landing, and the carriage with the empty strops moving back to the choker-setting site. While still in the developmental stage, a working prototype has been constructed and trialled. This yarding system reduces haul distance by half, and could reduce inhaul and outhaul time per load by as much as 40% (or "by about half" according to the authors).

2. Radio-controlled Chokers in Austria

Stampfer et al., (2009) completed a study in Austria on the Wanderfalke yarder using Giritzer "Ludwig" radio-controlled chokers (Figure 2).

Figure 2: Radio controlled choker system "Ludwig"

The study design alternated extraction corridors with and without the use of radio-controlled chokers within the same setting. A standard choker for this system weighed 0.34 kg and cost 11 euros each. The radio-controlled chokers weighed 1.6 kg and cost 9,000 euros for the set of four. Workload was measured by continuously monitoring the heart rate of the workers. Results showed a 9% increase in productivity plus safety gains during the unhooking phase. However there was also an increased workload for the choker-setter, due to the additional weight of the chokers. This was reflected in the comments from the crew; the yarder operator appreciated not having to get off the yarder to unhook the turn, but the choker-setter was not impressed with the extra weight and workload.

3. Optimum Tree Size for mechanised Felling

Visser et al., (2009a) tested the common concept, known as the 'piece-size law' (Figure 3), stating that for felling machines, with increasing piece size, productivity increases at a decreasing rate. That is, as the tree size gets larger, the machine starts to struggle, and the productivity decreases.

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Four different mechanised felling operations were studied in New Zealand radiata pine plantations. Using non-linear equations it was possible to identify an 'optimum' piece size for maximum productivity.

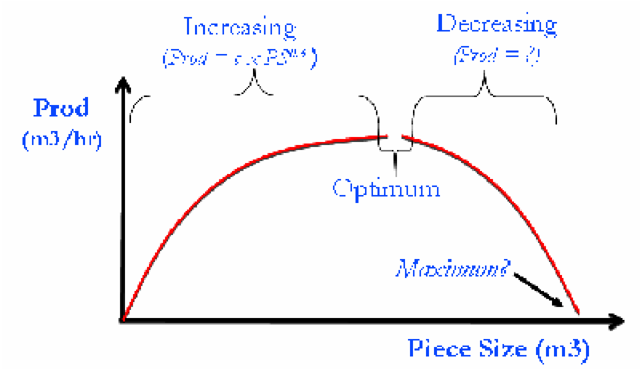

Figure 3: Basic relationship between piece size and productivity

In two of the studies, the data collection, through lack of large enough trees, did not extend far enough beyond the optimum. In two further studies enough data was collected in large piece size (up to 5.2m^3) to clearly show the declining productivity phase. This 'sweet-spot' piece size for each machine was found to be considerably smaller than the maximum (2.2 m^3 or 48 cm DBH for the Waratah 622, and 2.8m^3 or 55 cm DBH for the Waratah 624, vs. maximum diameter of 65 cm and 76 cm respectively). Unexpectedly, productivity tended to decrease gradually, not drop off suddenly beyond the optimum. Using more complex statistical functions when correlating piece size to productivity would help identifying this 'sweet-spot'.

4. Synthetic Ropes in Logging

Pertlik (2009) stated that the use of synthetic ropes as guy-lines may change previous design routines that estimate or calculate the forces in a standing skyline. The flexibility of synthetic ropes may work as a shock absorber and reduce the maximum forces in the skyline. A test bench to stress cables with oscillating forces was described. Consideration of the elongation effects to the top of the tower of a cable yarder demonstrated the absorbing effect of the guy-lines in general. The difference in the modulus of elasticity was boosting this effect and should be reflected in the design rules. He concluded that use of synthetic ropes creates an opportunity to simplify the design procedure for standing skyline systems and also contributes to safer operations.

The Human Factor

Hazard Analysis of Felling Machines

Garland and Rummer (2009) presented research on the mechanisms and hazards related to thrown objects in mechanised harvesting operations. Some of these are clear (e.g. thrown cutting teeth) while others are less obvious and need explanation (chain shot, thrown spears and stubs). The authors suggested resolutions to the problems lie with improved guarding, protecting operators and others, and changing operating practices. The effectiveness of a specific no-entry force field around the machine was questioned. Safety standards in the U.S. at state and national levels, and at international levels have addressed these issues. The authors discussed implications for anyone working in the vicinity of cutting machines.

Biomass & Fuel Reduction

Integrated Biomass Recovery

Visser et al., (2009b) noted that biomass recovery from existing timber harvesting operations is recognised in many countries as an important component of any bio energy programme. There are however very few biomass recovery operations in New Zealand, despite the large volume of residues generated by harvesting operations in plantation forests (Figure 4). The authors have commenced a research project in New Zealand to assess what may comprise an optimal residue recovery system.

The integration of biomass recovery into the harvesting operation was considered key, and the paper considered what strategy could be

employed to successfully achieve this in New Zealand.

Figure 4. Typical yarder landing showing the biomass discarded ‘over the side’

Productivity and cost estimates for three favourable options were provided. The cost of post-harvest residue recovery from the landing using a tub grinder, as well as the use of off-road trucks to transport residues to a secondary landing for comminution, was estimated at $34/tonne. Whereas the post-harvest option provided for easier logistics, the concurrent recovery option yielded greater quantity as well as higher quality biomass. Using a bundler to accumulate slash and then comminute at the power plant, increased the cost to $44/tonne. Limitations and future research considerations were also discussed.

Roads, Trails & Transport

Forest Road Pavement Design

Fairbrother et al., (2009) identified that, in New Zealand, current road engineering practices varied widely between forest owners. Forest road construction owed more to the experience of roading supervisors than to formal design methods, qualifications and training. The majority of surveyed forest owners used a single ‘improved’ aggregate layer to complete their forest road, as opposed to a multi-layered approach used for most public roads. This paper focused on reviewing the aggregate grading standards available for forest road design, and noted there was considerable variation between standards (Figure 5).

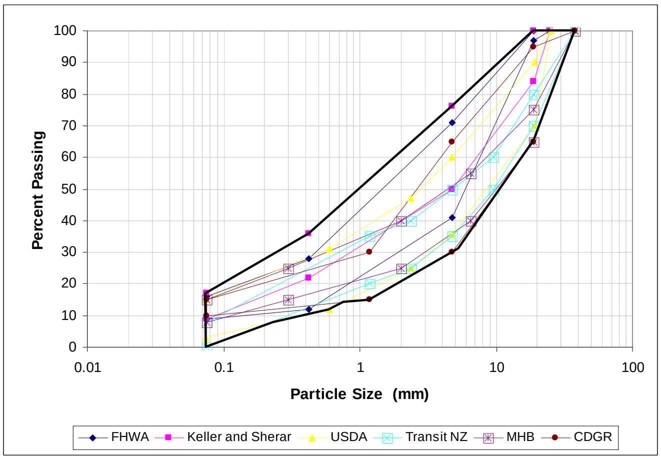

Figure 5. Aggregate grading envelopes for selected surface course standards

A series of eight aggregates actually used for East Cape forest road construction were analysed by sieve test and compared to the standards. It found that the aggregates had widely varied gradation and were dissimilar to the gradation envelopes of the reviewed standards (Figure 6).

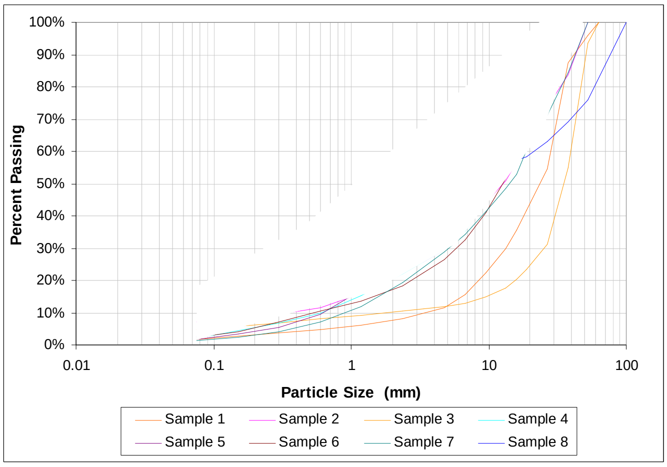

Figure 6. Results from sieve analysis of eight East Cape forest road aggregates (“standards envelope” shaded in grey colour)

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Maximising Value

Terrestrial LiDAR Applications

Acuna et al., (2009) scanned 18 plots in three radiata pine stands of different tree sizes using terrestrial LiDAR systems. Tree locations were automatically detected using commercially available software. Stem profiles were measured using three methods: (1) from LiDAR scans, (2) by the harvester and (3) manually after felling. Stems were optimally bucked based on log specifications and prices for Australian log markets. Tree values and log product yields were estimated for the terrestrial LiDAR derived data and compared with estimates based on the harvester and manual stem profiles. Harvester data should only be used for comparison with scanner (or manual) measurements if the harvesters were properly configured and calibrated, and appropriate bark thickness equations were used. Plot preparation and tree characteristics affected the accuracy of automated stem detection and stem profile measurements.

Balance of the COFE 2009 Programme

The other “Human Factor” session presentations dealt with identifying loggers’ reactions and priorities in an increasingly fragmented landscape in South Carolina, as well as challenges in developing managerial behaviours for small logging entrepreneurs in Quebec, Canada.

Other papers in the “Biomass & Fuel Reduction” session included estimating available forest biomass; a decision support system to optimise fuel treatments; systems ranging from a stand-alone slash bundling unit to combining bundling with in-woods grinding to stump harvesting and use of masticators for fuel reduction; production estimates for biomass harvesting systems; and the impacts of biomass harvesting on forest resource sustainability.

The “Environmental Impacts” session ranged from papers on soil damage and compaction from skidding and its effect on tree growth and soil strength, to best management practices and estimates of carbon emissions.

Other papers on designated skid-trail networks and the application of hook-lift trucks and roll-off containers were discussed in the “Roads, Trails & Transport” session.

The “Maximising Value” session included: the vision of FPInnovations in Canada towards maximising value from the forest; presentations on log-making in New Zealand; product sorting impacts on cost and productivity in Georgia; financial feasibility and potential of log sort-yards in Montana; and using newer technologies such as acoustics and near infrared (NIR) for improved value recovery.

Four cost analysis models were presented in the last session on “Production & Cost Analysis”: ChargeOut for machine cost analysis; a stump to mill logging cost programme (STOMP); Western Biomass – a production and cost prediction model for integrated biomass harvesting; and a Fuel Reduction Cost Simulator (FRCS).

All of the above papers are available in electronic format. If any FFR members want further details on any of these conference papers, please contact Dzhamal Amishev at Scion (Dzhamal.Amishev@scionresearch.com).

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