



New Zealand Steep Terrain Harvesting Technologies with Potential Application in Western Canada

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Dzhamal Amishev

Researcher, Harvesting Operations

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REVIEWERS

Jean-François Gingras, Manager, Harvesting Systems

CONTACT

Dzhamal Amishev
Researcher, Harvesting Operations Program
604-222-5633
Dzhamal.amishev@fpinnovations.ca

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1. INTRODUCTION

This report presents several technologies developed for steep terrain harvesting in New Zealand. The information was collected from on-site visits conducted in early 2015 by the author. Many of the innovative technologies presented here were developed under the auspices of the steep terrain program designed to improve safety and productivity in forest harvesting operations under the FFR vision of “No worker on the slope, no hand on the chainsaw”.

Note that this report is solely intended to present innovative concepts developed in New Zealand for the information and benefit of FPI members. It does not constitute an endorsement of the quality, effectiveness or overall suitability of these equipment in Canadian conditions, nor does it constitute an endorsement over other comparable products that already exist in the marketplace. Most mainstream forestry equipment manufacturers produce machinery and accessories that are designed specifically to operate effectively on steep slopes, and the readers are invited to consult the web site or contact the dealers of these equipment for additional information.

Further information about steep slope harvesting in Canada can also be obtained by visiting FPInnovations Steep Slope Initiative web site at <http://steepslopeinitiative.fpinnovations.ca/>

2. CUTOVERCAM YARDER VISION SYSTEM

Background/Objective

Breaking-out/choker setting is one of the most dangerous logging activities, particularly in steep terrain where visibility between the hauler/yarder and the ground crew is limited. On extremely steep and rugged terrain, contractors face greater risk from moving trees, poor visibility and delayed response time in manual choker setting operations. Furthermore, there are human factors such as fatigue and eye strain from trying to focus over long distances, and glare overloading the eyes' ability to adapt to bright and shady patches in the cutover. This technology has been developed as part of the Future Forests Research (FFR) Steep Slope Harvesting program to help reduce workplace injuries for crew members in the break out zone as well as streamline harvesting operations.



The CutoverCAM set up on a cutover slope overlooking choker setters in a steep gully in New Zealand; the screen is set up in the yarder cab for greater visibility for the yarder operator

Technical details

- The CutoverCam uses wireless IP camera technology to stream video of ground operations to the hauler operator.
- Joystick control of pan, tilt and 18x optical zoom.
- Wireless repeater allows camera to be positioned out of line-of-sight of the yarder.
- On-screen warning if the video stream is interrupted.
- Mirror function provides a more natural view when the camera is pointed back towards the hauler.
- Low latency video link.
- Light-weight construction that breaks apart to fit in a pa
- Designed for quick assembly.
- High energy-density Lithium-ion batteries.



Potential Benefits

- Improved safety
 - Allows the yarder operator to visually check the locations of the choker-setters.
 - Enables instant response to events in break-out (choker-setting) zone.
 - Instead of relying on audio signals like radio and the Talkie Tooter, the operator can see everything directly and respond instantly.

- Increased harvesting productivity
 - Lower maintenance costs due to improved longevity of ropes, chokers and the yarder by avoiding hang-ups during in-haul.
 - Reduced cycle times through stump avoidance and improved positioning of the rigging.
 - Less stem breakage due to dig-ins.
- Greater job satisfaction
 - Clear visibility of the choker-setting zone allows greater engagement between yarder operator and ground crew.
 - Instills a gaming-like environment appealing to younger operators.
- Environmentally sustainable
 - Reduced soil disturbance through stump and dig-in avoidance and improved positioning of the rigging.
 - Potentially lower fuel consumption.

Development stage/Availability

The system is commercially available internationally. Currently in New Zealand there are 3 skyline logging crews that have purchased it and use it on a daily basis. A fourth one has been installed in early April 2015. One of the biggest forest management companies is encouraging all its crews to acquire one with various incentives. Current quoted price is NZ\$18,850 plus installation, training and GST.

Contact Information

- Phone: +64 7 349 4189
- Mobile: +64 21 210 3350
- Email: info@cutoversystems.com
- Website: www.cutoversystems.com

3. FFE GRAPPLE CAMERA

Background/Objective

The Falcon Forestry Equipment (FFE) grapple camera has been developed to assist in the extraction process where a swing yarder and grapple configuration is used. This technology has been developed by logging contractor and DC Equipment company director Dale Ewers as part of his vision to create a safer workplace for his employees and forestry workers worldwide.



FFE Grapple camera attached to a grapple block; the grapple camera kit, including batteries, transmitters, aerials, etc.

Technical details

- The FFE Grapple Camera can be mounted to the block or to the grapple assembly itself.
- GPS detail displayed on screen.
 - Distance from grapple to yarder.
 - Altitude change from landing.
 - Battery voltage status.
 - Accurate longitude/latitude readings for operational zones and emergency situations.
- Batteries - Two lithium batteries with a run time of 12 hours each are supplied with the unit. Batteries can be charged on site with the 24v charger connected to the yarder.
- Transmitter/Receiver.
 - 9 channel 2.4 ghz unit that can transmit up to 900 m (line of sight).
 - 20 m of protected cable and wire rope is supplied to run from the aerial/receiver (top of tower) to the cab.
- Camera and transmitter are mounted to a Ropemaster 515 rider block but can be mounted to any block or carriage.
- Can also be fitted to other carriages such as Bowman or Acme, as more of a safety feature where the camera is targeting the choker-setting zone and giving a live feed to the yarder operator of the location of his choker-setters.



FFE Grapple camera example setup inside “the box”; screenshot of the display that is transmitted to the cab screen.

Potential Benefits

- Improved safety
 - Allows the yarder operator to visually check the locations of the logs and whether any crew members are in proximity.
 - No need for spotters close to the extraction zone because of improved visibility.
- Increased harvesting productivity
 - Yarder operator has the ability to continue the extraction process through adverse terrain and/or weather conditions.
 - Reduced cycle times through faster payload accumulation.
 - Reduced cycle times through stump avoidance and improved positioning of the rigging.
- Environmentally sustainable
 - Reduced soil disturbance through stump and dig-in avoidance and improved positioning of the rigging.
 - Potentially lower fuel consumption.

Development stage/Availability

The system is commercially available internationally. Pricing information and support can be obtained from the contact information below.

Contact Information

- Phone: +64 3 544 7438
- Mobile: +64 27 232 4089
- Email: shaun@logger.co.nz
- Website: <http://dcequipment.co.nz/>

4. HARVESTNAV ON-BOARD STABILITY PREDICTION SYSTEM

Background/Objective

With the increasing push for mechanization on steeper slopes, the industry needs new tools to manage machine operator safety that will identify hazards and provide feedback on operator behaviour. The objective of this tool is to make use of LiDAR data to provide operators of harvesting machines with real-time information about the current terrain and upcoming route terrain that the machine is operating on. This tool has been developed as part of the Future Forests Research (FFR) steep Slope Harvesting program to predict hazardous situations which might not be visible to the machine operator.



The current HarvestNAV user interface and the tablet installed in a harvester's cab.

Technical details

- Developed for a Windows 8 touch environment and designed to operate on a modern Windows tablet. The application is linked to a geographical information systems library. The central panel of the application is a map panel that can have any number of spatial layers loaded onto it. The application requires a digital elevation model and slope layer, other vector layers such as roads, stand boundaries, and riparian boundaries are optional. By using diverse symbology of the different layers the amount of spatial data that is visible to the operator can be maximized.
- Obtains the current location of the machine using either the device's on-board GPS, which many tablets now include, or an external GPS. The location of the machine is displayed on the map as a circle – the size of the circle indicates the GPS accuracy, the track of the machine is also plotted on the map panel of the application. The location is also displayed in textual form in the bottom left hand corner. The terrain slope for any given point is read from the underlying slope map. The pitch and roll of the machine is measured using the tablet's internal accelerometers.
- The software starts automatically with the machine start and picks up from the last point machine was on.
- Points of interest and notes may be saved by the operator while working, , thresholds for slopes and distances can be changed, and specific observations for a harvest area can be included as notes/recommendations.

- System requirements:
 - Operating system: Windows 7, 8, 8.1
 - RAM Memory: 2GB or better
 - Location Sensors: Tablet or Laptop device featuring built-in true standalone GPS receiver such as the Broadcom BCM47511 GLONASS chip linked to the Windows Location Service OR an external GPS receiver connected via USB or serial port to the host device. This external GPS device should be capable of real-time tracking.
 - Inclinometer Sensors: Gyroscope.

Potential Benefits

- Improved health and safety
 - The HarvestNav application is a method of minimizing potential risks associated with unknown terrain. HarvestNav provides extra visual cues to the operator.
 - The application works like a black box recorder in a plane. The information could be used to review the cause of any incident.
- Environmental
 - By providing the operator information about potential environmental hazards and/or sensitive areas, operators can avoid these areas.
 - The track of the machine is stored as a shape file which can be used to determine where the machine has travelled in the event of an incident.
- Increased productivity
 - The information recorded by the HarvestNav application could be used to investigate how productivity could be improved (by studying distance travelled, routes chosen by the operator, etc.)

Development stage/Availability

The system is commercially available internationally. Currently in New Zealand there are about a dozen machines that use it on a daily basis. The newest HarvestNAV Version 1.5 is freely available for download; a key can be acquired from Hamish Marshall at Interpine.

Contact Information

- Phone: +64 7 350 3209
- Mobile: +64 21 677 720
- Email: hamish.marshall@interpine.co.nz
- Website: <http://www.interpine.co.nz/SitePages/HarvestNav.aspx>

5. DRONE-ASSISTED YARDER SETUP

Background/Objective

The mobilization/setup of a yarder before the actual extraction of wood commences is a labour- and time-consuming endeavour. It's even more so when the yarding corridor goes over broken terrain, rock bluffs, thick undergrowth, etc. Pulling the strawline through such a terrain can be exhausting as well as hazardous for the employees performing the task. Often a helicopter is used for this task when conditions are too hazardous for workers to manually complete the task thus further increasing the costs.. A New Zealand logging contractor (Bill Winmill from Gillion Logging Ltd) has developed a process for running a strawline using an octocopter drone.

Technical details

- Uses a synthetic rope, Dyneema (polyethylene).
 - Dyneema 10 mm rope weighs 4.6 kg/100 m with a breaking strength of 10 tonnes
 - Dyneema stores little energy, so does not whiplash when it breaks
 - Easy to splice, so lengths can be easily repaired
 - Susceptible to abrasion so easily damaged by sharp objects
 - Strength is reduced by 1/3 when joined using a knot
 - Approximately twice the price of steel
- Uses 1,500 m of 3 mm Dynamica rope on a truck-mounted winch with an S1000 octocopter drone.
- Deneema rope setup is done before the yarder is shifted to the location and then just connected to the yarder strawline and setup/mobilization is complete.



Current S1000 octocopter with attachments.



Bill Winmill's winch and rope at his workshop; mounted on a pick-up truck in operation spooling rope for the drone.

Potential Benefits

- Improved health and safety
 - workers would be removed from hazardous situations virtually eliminating all possibilities of operational injuries during yarder relocations.
- Increased productivity
 - Most of the mobilization setup is complete before the yarder is relocated, so productive time for the yarder is increased.
 - By reducing production delays and reducing relocating costs through eliminating use of helicopter or time- and labour-intensive manual looping, the whole operation would be more cost-effective.
- Environmentally sustainable
 - Gives opportunities for better positioning of the rigging not constrained by how traversable the terrain is.
 - Potentially lower fuel consumption in the case of avoided helicopter use.

Development stage/Availability

The concept has been fully developed and operational for some time at Bill Winmill's operations. It is not developed with the view of commercial distribution, but rather for own business operational improvement. Details on availability and pricing of components can be acquired from the contact information below.

Contact Information

- Phone: +64 27 432 5403
- Email: billwinmill@xtra.co.nz

6. “CHPS” CABLE HARVEST PLANNING SOFTWARE

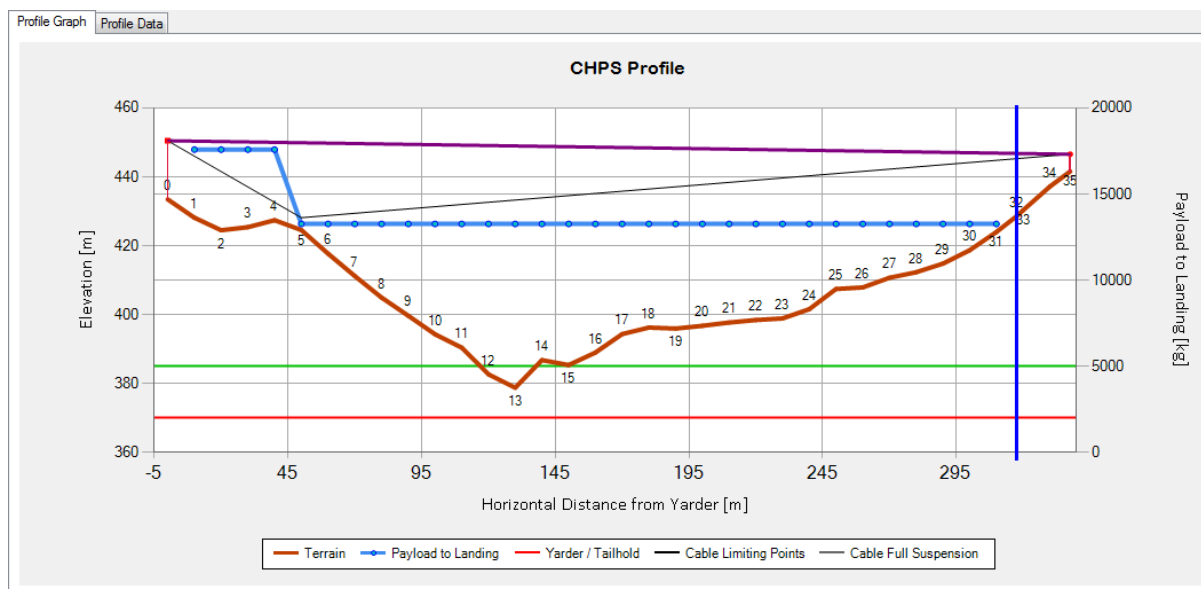
Background/Objective

CHPS (Cable Harvest Planning Solution) is a dedicated forestry planning tool for analysing terrain and calculating payloads for cable yarding applications. It is an extension integrated into Esri® ArcGIS™ for Desktop software, so it leverages the benefits afforded by this GIS platform.

Technical details

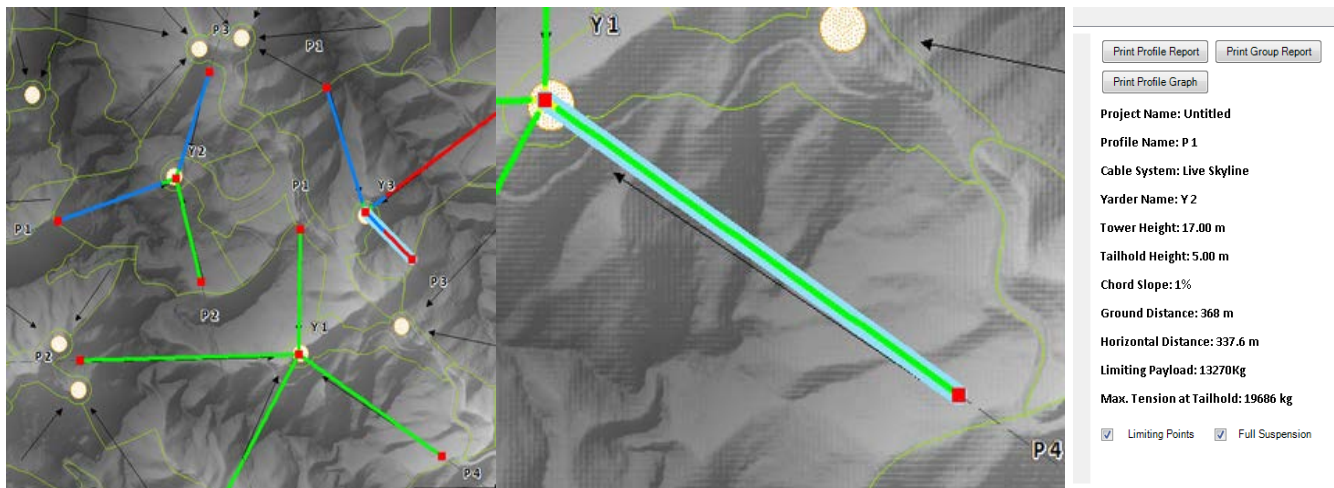
The current CHPS Version 1.5 features:

- High speed and ease of use.
- Efficient planning using multiple yarder locations and slope profiles.
- Auto-placement of profiles around yarder locations, including solving for feasible profiles.
- Manual placement or relocation of yarders and tailholds.
- Modelling of running, live, and standing skyline, plus high-lead and multi-span system types.



The Profile window in CHPS.

- Calculation of key variables such as maximum and average payloads, rigging length requirements and average and maximum haul distances.
- Use of environmental constraints to monitor special areas.
- Flexibility to configure local settings and equipment (yarders, carriages and cables).
- Comprehensive reporting (maps, excel and PDF).
- The use of contours and DEMs for terrain data.
- Add-in capability of GPS survey points to augment existing terrain data.
- Comprehensive Online Help.
- Support for ArcGIS 10.1, 10.2, and 10.3.



CHPS Profiles on the Map and a selected profile and yarder (on the right)

Potential Benefits

- Improved health and safety
 - With improved planning and equipment utilisation the operations will run smoother and with less interruptions and frustrations thus creating a more pleasant and safer working environment for the whole crew.
- Increased productivity
 - Production delays as well as disagreements between contractors and harvest planners will be reduced. The effect of changing machines or tailhold locations on payload can be seen and legible maps which can then be shared with the contractor can be produced.
 - Improved harvest planning will ensure the right equipment is used for the right setting.
- Environmentally sustainable
 - Optimizing yarder and landing locations will reduce the amount of earthworks and soil disturbance.
 - Improved profile settings will reduce the unnecessary movement of tailhold machines.

Development stage/Availability

The system is commercially available and can be downloaded for a 30-day trial. Pricing information and support can be acquired from the contact information below.

Contact Information

- Phone: +64 9 570 3875
- Email: sales@cableharvesting.com
- Website: <http://www.cableharvesting.com/index.html>

7. TELE-OPERATION KIT FOR JOHN DEERE 909 DIRECTIONAL FELLER

Background/Objective

Future Forests Research (FFR) in New Zealand has aimed at achieving remote control of felling machines on steep slopes to allow mechanical felling without putting the operator in jeopardy in extreme locations. Originally, the vision was to develop a remotely-operated machine with the cab removed, making it smaller, lighter and more stable on steeper ground, but it was decided to adapt an existing machine first.

Nelson-based contractor Ross Wood wanted the ability to operate his John Deere 909K levelling directional feller from the cab as well as having the remote option when his operator felt he was in unsafe conditions and could exit the machine and continue working with it. The prototype has been running successfully in the Nelson region of New Zealand.

Technical details

- Developed with similar hand controls to those in the cab of the directional feller, a wireless system is used to interface with the machine's computer control. Engineers worked with John Deere and CablePrice to ensure the system did not compromise the operation of the machine and any of its systems.
- Designed to meet the New Zealand standard for remote-controlled mining equipment NZS4240.



The newest controls that closely resemble the ones in a John Deere 909 cab and antenna for live video streaming from the cab (left); video stream and a screenshot of controls shown on remote screen (right).

- Next stage is to incorporate video and audio feedback. Once achieved, the operator will be able to operate the machine remotely, out of line-of-sight.
- Has been used operationally for nearly six months now and according to Ross Wood it is just as productive as a conventional in-cab operator harvesting. Optimal location of the remotely positioned operator is being investigated in regards to improved visibility and working conditions evaluation.
- In combination with a traction-assist system the directional feller has been able to mechanically fall trees in areas previously considered inaccessible.



The John Deere 909 self-levelling directional feller

Potential Benefits

- Improved health and safety
 - Mechanized tree falling provides a safer working environment for tree fallers and improved ergonomics.
 - Removing manual labour from steep slopes reduces exposure to hazards significantly.
- Increased productivity
 - Mechanized tree falling as well as bunching for yarder/skidder/forwarder extraction has been shown to significantly increase steep slope harvesting productivity.
 - By completely removing the person with remote control virtually any slope can be negotiated for mechanized harvesting.
- Environmentally sustainable
 - Once the technology is developed and commercialized the weight and design of the machines can be changed substantially to improve traction and maneuverability thus reducing soil disturbance and erosion.

Development stage/Availability

The tele-operation system is still a concept under development and the first commercially available prototype is still estimated to be at least a couple of years away. The first prototype unit is now with the contractor Ross Wood where it continues to be tested operationally. Further updates are available from the contact person listed below.

Contact Information

- Keith Raymond, Harvesting Program Leader, Future Forest Research
- Phone: +64 7 921 7239
- Email: keith.raymond@ffr.co.nz
- Website: www.ffr.co.nz

8. “LOGSAFE” SAFETY COMMUNICATION AND MANAGEMENT SYSTEM

Background/Objective

Developed by the Mobile Systems company in New Zealand, “Logsafe” is a new safety communication & management system designed to support the choker setting and falling crew. This patented system is developed specifically for loggers, combining GPS tracking, radio communication, data measurement and mapping software, with the functionality of a touch screen computer in the yarder cab.

Technical details

- A screen is fitted into the yarder cab.
- Compatible with any cable logging system and suitable for use in all contour conditions, with either tower or swing yarders.
- Captures difficult to measure data, such as drag cycles per day, log count, faller check in, downtime and breakdowns
- Increased Accountability - View the actual safe retreat performance records of each choker setter, and compare against required standards.
- Analysis tools and daily satellite reporting functionality tools are currently under development.



Yarder operator can keep an eye on choker setters via the screen in the cab.

Potential Benefits

- Safe Retreat Management - View the location of breaker outs live on computer screen & receive notification of entry's into the no-go zone. The safe retreat position is clear - if the handset is beeping choker setters know to retreat back further, and entries into the no-go zone are recorded.
- Reduced over-walking (fatigue) and under-walking (hazard exposure) of retreat distances. Choker setters can have input with setting safe retreat distances. This can increase communications and awareness levels, and help produce more ownership of retreat performance.
- Faller Monitoring - Locate the position and welfare of fallers anytime. Fallers' location is displayed on screen, updated every 80 seconds - or request the exact real time position and GPS coordinates at the touch of a button. Useful when the faller is working alone in demanding country, or working out of sight hundreds of metres from the crew. If the handset is on an angle of less than 45 degrees for over 120 seconds, the handset will start to beep. If the faller does not move to a vertical position within 30 seconds, the Emergency Alert process above will automatically activate.
- Performance Data - Capture extraction performance information to help manage your business.

Development stage/Availability

The system is commercially available for purchase both in New Zealand and internationally. Pricing information and support can be acquired from the contact information below.

Contact Information

- Phone: +64 7 575 2966
- Mobile: +64 27 552 5256
- Email: sales@logsafegps.co.nz
- Website:

http://www.mobilesystems.co.nz/product_details/p/985/c/332/Logsafe_GPS_Monitoring_System

9. FORESTRY WORKERS SAFETY SYSTEMS

Background/Objective

With heavy equipment and materials, challenging terrain, and multiple moving heavy objects and steel wires, a steep slope logging site presents many high-risk situations. Many companies in New Zealand have developed systems to address some of these safety issues. Two of these are the Forestry Hawk and the Navman Wireless Lone Worker.



Forestry Hawk's proximity detecting device (left); employee transponder(right).

Technical details

Forestry Hawk

- Uses latest GPS Technology to ensure all crew is kept out of harm's way.
- Each employee is outfitted with a battery-powered transponder reporting position continuously.
- Proximity detecting computers inside machinery track location of all crew
- Report visually and audibly to equipment operators if any crew members move into their danger zone. Each unit can easily be adjusted for the size of the security perimeter and whether an intrusion triggers an alarm or shut down of the machinery.
- Works alongside existing safety protocols and requires no sophisticated training to operate.

Navman Wireless Lone Worker

- Two-way communication device that remotely connects person to person via mobile networks or the Iridium satellite communication network.
- Includes a small, lightweight transmitter carried at all times, which connects back to the vehicle utilising the Navman Wireless tracking unit and satellite communications device to send notifications, high priority alerts, automatic "man down" alerts and low priority check-in confirmations.

- The range is 500m with clear line of sight, but varies based on terrain. If the transmitter loses contact with the vehicle, the system automatically sends an out-of-range alert to the pendant to return to a safe operational range. After three unattended alerts the vehicle device will notify base that worker is out-of-range and could be at risk.
- Lone Worker sends a confirmation signal when a distress message has been received by the server.
- It detects a fall or sudden movement, which could indicate a trip, or a possible health issue – if no response is sent from the worker within ten seconds, an alert is sent to base for immediate attention.

Potential Benefits

Improved safety through accident prevention and early reaction to incidents is the primary benefit of these worker safety systems. Reduced fatigue and confident safe operation would be ensured by better awareness of other crew members' positions. Reduced injury rates and lost time improves the overall morale of the teams and the quality of the working environment.



Forestry Hawk's display configuration and warning system; Navman Wireless Lone Worker pendant and vehicle unit.

Development stage/Availability

The systems are commercially available for purchase both in New Zealand and internationally. Pricing information and support can be acquired from the contact information below.

Contact Information

Forestry Hawk

- Kurt Rees – National Sales manager
- Mobile: +64 21 144 6177
- Email: kurt@hawksafety.co.nz
- Website: www.forestryhawk.co.nz

Navman Wireless Lone Worker

- Phone: +64 9 481 0500
- Email: <http://navmanwireless.co.nz/about-us/contact-us/>
- Website: www.navmanwireless.co.nz

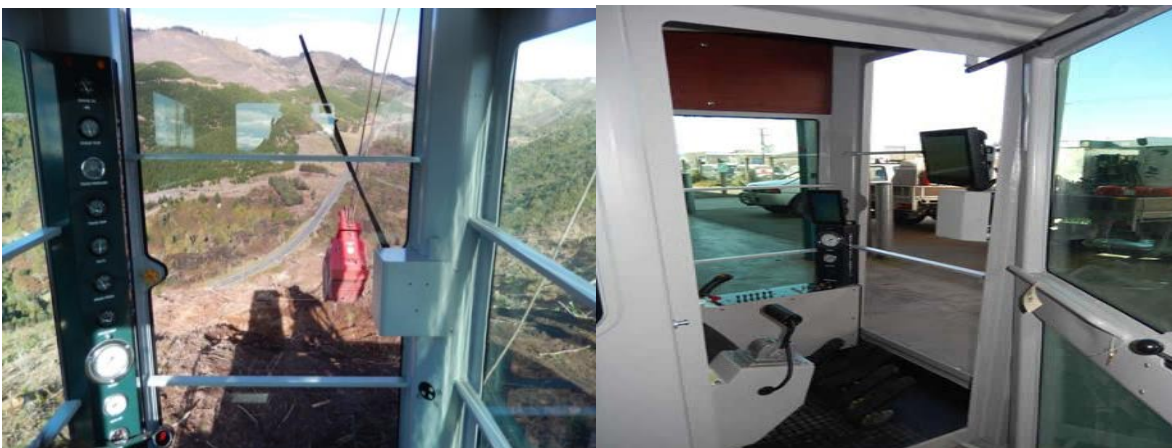
10. THE ACDAT YARDER CONTROL AND MANAGEMENT SYSTEM

Background/Objective

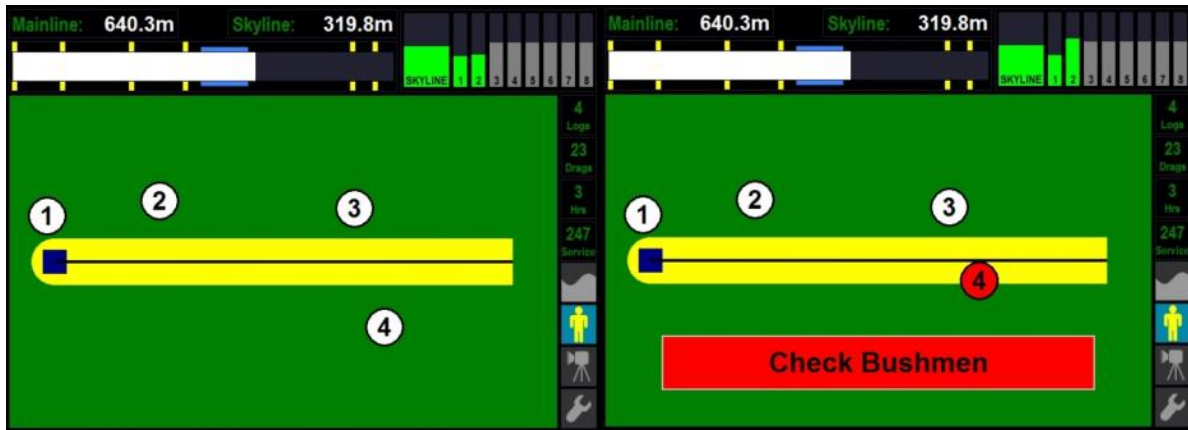
The ACDAT system is designed to provide operators of both tower and swing yarders relevant visual information in placement of the rigging to provide fast, smooth and safe production increases. The Acdat System will assist the operator by giving them live time relevant information needed to increase production levels safely. It will also give logging contractors the ability to record actual daily production figures and forest companies production figures and relevant costs in extracting particular areas.

Technical details

- Color monitor displaying a topographical silhouette showing the relative ground contour for identifying features to be avoided by adjusting load height.
- Displays skyline tension, skyline distance, main line distance, ground profile, all guyline tensions, operating time, previous drag locations and number of drags with the ability to key in number of logs/stems per drag.
- Independent, battery-powered camera can be set up away from the machine to overlook the rigging. The system can automatically provide a camera view to the operator at set points during the drag.
- Records working hours and alerts operator for next service due.
- All data can be downloaded onto a memory stick or transmitted via wifi or satellite.
- “Man tracking” facility with a set of personal locator transmitters to be carried by choker setters. The yarder operator can set a safe distance from the skyline to the personal transmitters, advising when the choker setters have retreated to a safe distance.
- Separately, Active Equipment has developed a simplified AcDat system that can be installed into any machine with the “Man Tracking” feature to allow other operators to monitor people on the ground working around equipment (as per the systems discussed in the previous section).



“Active” yarders cab controls and displays layout



Example scenario screenshots of the “Man Tracking” and warning feature of ACDAT

Potential Benefits

- Improved health and safety – with greater visibility and easy-to-use controls on the yarders fatigue would be reduced and accidents minimised. The “Man Tracking” feature would help avoid accidents and near misses.
- Increased productivity – improved controls and maintenance would ensure smoother operation and improved yarding productivity.

Development stage/Availability

The AcDat system is commercially available, costs start at around NZ\$ 25,000 and can be retrofitted to any yarders.

Contact Information

- Phone: +64 7 343 9298
- Mobile: +64 27 333 6824
- Email: tony@activeequipment.co.nz
- Website: www.activeequipment.co.nz

11. PLC AIR CONTROL SYSTEM FOR YARDERS

Background/Objective

Most yarders in use in New Zealand use control systems based on air over hydraulic principles. These operating systems have remained largely unchanged for some 20 years or longer. In comparison, the operating systems of excavators and harvesters (processors) have moved to electric systems, with associated fine tuning of functions enabling precise movement, and they are tailored ergonomically to the task.

Nelson based “Brightwater Engineering” has been designing and manufacturing cable logging equipment for over 20 years. They have developed a PLC-based control system for yarders. The Brightwater PLC Air Control System delivers precision logging by providing the yarder operator increased speed and accuracy.



The design of the yarder cab and location of controls and the PLC system.

Technical details

- Allows operators to swap between Grapple, Carriage or Scabbing with the simple press of a button.
- Gives operators the ability to locate the next log with audible and visual indicators.
- Has line tension monitoring and individual drum control.
- Trouble shooting is made easy through using the visual test points screen and alarm function.



Potential Benefits

- Improved health and safety – with easy-to-use controls on the yarders fatigue would be reduced and accidents minimized.
- Increased productivity – improved controls and maintenance would ensure smoother operation and improved productivity.

Development stage/Availability

The system is commercially available for purchase both in New Zealand and internationally. Pricing information and support can be acquired from the contact information below.

Contact Information

- Phone: +64 3 543 5300
- Email: hayden.campbell@brightwater.co.nz
- Website: www.brightwater.co.nz



Head Office

Pointe-Claire

570, Saint-Jean Blvd
Pointe-Claire, QC
Canada H9R 3J9
T 514 630-4100

Vancouver

2665 East Mall
Vancouver, BC.
Canada V6T 1Z4
T 604 224-3221

Québec

319, rue Franquet
Québec, QC
Canada G1P 4R4
T 418 659-2647



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