HARVESTING TECHNICAL NOTE

HTN09-09
2017

Production Trials of the CutoverCam

Summary

Providing the cable hauler operator in steep terrain harvesting operations with a view of the break out site (where felled tree stems are extracted) has the potential to improve the safety, productivity and efficiency of hauler operations. Where manual breaking out is used, enabling the hauler operator to see exactly where the breaker-outs are positioned and when it is clear to commence inhaul increases the margin for safety. In grapple yarding operations, providing a clear view of the cutover and the next load of tree stems to be extracted eliminates the need for a manual 'spotter' and potentially reduces the grapple yarding cycle time. Production field trials of the CutoverCam hauler vision system used during grapple yarding were undertaken at G White Logging Ltd's operation in the Bay of Plenty. The objective of the study was to determine whether the camera system had a positive effect on the time spent locating the grapple on to a tree stem compared to the hauler operator doing this by direct line of sight. Results showed that using the CutoverCam took no longer time to grapple a tree stem compared to looking directly out the hauler cab window. Where there was no direct line-of-sight the CutoverCam eliminated the need for a manual 'spotter'. The harvesting crew had used grapple-based cameras in the past and much preferred using the CutoverCam.

Spencer Hill, Logpro Limited

INTRODUCTION

The primary goal of the Forest Growers Research (FGR) Steepland Harvesting Programme is to reduce the cost of harvesting on steep country by introducing modern technology. The secondary goal is to remove workers from the hazardous tasks of manual tree felling, breaking out and unhooking.

The Steepland Harvesting Programme favoured grapple extraction over using manual breaker outs, as this had the potential to achieve both objectives through increased productivity and safety.

At the start of the programme in 2010 it was estimated that there were less than 20 grapples in cable logging operations, or only 6% of operations (Visser 2013). The difficulty of grapple yarding with the often limited visibility of the break out site, and long extraction distances, were limiting factors to the wider use of grapples. The lack of access for felling machines to bunch wood on steep slopes also meant that grapple operations often were able to extract only one tree per cycle, further limiting their productive potential.

The favoured method for locating the grapple on to the tree was (and still is in the majority of grapple yarding operations) for the hauler operator to look directly out the hauler cab window at the break out site. However visibility of the break out site is often limited for a number of reasons:

- terrain
- siting of the hauler back on the landing
- cab location
- window size and protective structures
- environmental and climatic conditions (such as glare, shade, rain, fog etc.)
- operating conditions (such as yarding distance, tree size and ground vegetation).

Where there is no visibility of the break out site, a manual 'spotter' is required to view the break out site and relay instructions via radio to the hauler operator to direct the grapple on to the tree stems. This is a difficult and often frustrating task, for both the hauler operator and the 'spotter', given the need for clear and rapid instructions, and the delay in response from the grapple yarder. Improving the hauler operator's view would eliminate the need for the manual 'spotter', reduce frustration, and potentially improve grapple extraction productivity.

BACKGROUND

MacMillan Bloedel, a Canadian forestry company active in research and development in the 1980s, tested a cutover camera system in 1983 (MacMillan Bloedel 1983). A video camera (with display in the yarder cab) was located in the cutover to enable the grapple yarding of a gully not visible to the operator.

From its establishment in 2007, FGR was aware that Dakota Micro Inc. in the U.S. manufactured the Agcam line of industrial video camera systems with remote operation via a 2.4 GHz wireless RT system (AGCAM). This camera system was used by Eagle Carriage and Machine Inc. of La Grande, Oregon when they manufactured their hydraulically operated grapple carriages, the Yoder Claw and Mega Claw Line Grapples (Eagle Carriage and Machine Inc.).

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From the commencement of the FGR Steepland Harvesting Programme in 2010 a project has been active to develop a camera system (Figure 1) for mounting on grapples, on the hauler cab, on the mobile back line machine and in the cutover (Evanson and Parker 2011).

Figure 1. The first prototype comprised a hauler camera, a tail hold camera, a cutover camera (pictured) and a hauler cab display.

From 2010 FGR supported Trinder Engineering Ltd of Nelson to develop a rigging-based camera suitable for use with a mechanical grapple. A prototype system was trialled in conjunction with the introduction of the Alpine Grapple (Evanson 2013).

In parallel, at about the same time, DC Equipment Ltd. of Nelson developed the Falcon Grapple Camera system for their Falcon Forestry Claw grapple which was first commercialised in 2012. The Falcon Grapple Camera was developed to provide a hauler operator with visibility of the grappling site to improve the time taken to position the grapple on the tree stem, thus increasing overall productivity.

Once a camera system is used (whether it be a grapple camera or CutoverCam) hauler operators are often not keen to revert to using a 'spotter'. The popularity of camera systems has increased over the last five years. DC Equipment Ltd are now the main supplier of grapple cameras in New Zealand and Canada. Falcon grapple cameras have been installed and operated in over 90 hauler crews in New Zealand and overseas. Subsequently in 2016, Electrical and Machinery Services Ltd (E.M.S.) of Rotorua launched Hawkeye, a grapple carriage with a built-in grapple camera. T-MAR Industries Ltd of Campbell River, British Columbia also market a grapple yarder camera.

CUTOVERCAM DEVELOPMENT

Over the past five years, Forest Growers Research Ltd (FGR) has developed the advanced hauler vision system, consisting of a camera mounted in the cutover that wirelessly streams live video back to a monitor mounted in the hauler cab. Software to control the camera to pan from side-to-side, tilt up and down and zoom in, and other safety functions (such as warnings of latency or loss of live stream video) were developed to provide hauler operators with a more useful system than simple standalone cameras available on the market at the time.

The FGR project resulted in the development of the CutoverCam, a camera mounted in the cutover to allow the hauler operator to see the whole hauler profile, to pan-tilt-zoom (PTZ) to see where to place the grapple and to see what tree stems to grapple next (Figure 2).

Figure 2: Second prototype CutoverCam

An economic analysis of the cutover-based camera concept showed the system would be beneficial if it resulted in a small reduction in average grapple time

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(7 seconds per cycle) compared to using a 'spotter' (Evanson and Parker, 2011).

An additional benefit of the CutoverCam was keeping a close eye on manual breaker-outs (the workers who attach the wire rope strops to felled tree stems ready for extraction to the log landing). It was foreseen that the CutoverCam would improve safety of manual breaking out, a function that grapple cameras cannot perform.

A study to test the reduction in grapple time when using a CutoverCam was carried out in 2012 (Evanson and Milliken 2012). The results of that trial showed there was no significant difference between using the camera compared to using a 'spotter'. Interestingly, a crew using the CutoverCam viewed the system favourably and feedback from the hauler operator was positive.

The CutoverCam has evolved over time. The early development has been reported in earlier FFR reports (Evanson and Parker 2011, Evanson and Milliken 2012, Evanson 2013).

The commercial model CutoverCam (Figure 3) was launched in 2017 at the HarvestTECH 2017 Conference in Rotorua.

Figure 3: CutoverCam commercial model

The latest model is a vast improvement of the first prototypes. The camera is smaller yet still has power tilt, pan and zoom and has higher definition. The camera also has some computing power so can do some initial data management (compressing files) which allows a reduction in the amount of data sent over the wireless link. All the wiring is now internal, as is the battery pack. It is now a one-piece unit and as such is much easier to install. It is also much lighter than earlier prototypes (3.5kg vs 15kg).

The control panel is much improved as well, with an industrial joystick and touch screen which makes it quick and easy to pre-set the camera to automatically point to different spots, (Figure 4).

Figure 4: CutoverCam control panel featuring an industrial joystick and touch screen controls

OBJECTIVE

The objective of this study was to investigate the usefulness of the CutoverCam compared to the grapple extraction productivity the hauler operator could achieve by controlling the grapple using direct line-of-sight.

This report summarises the results of a trial to measure the grappling time by direct line-of-sight (when the operator is looking out the window of the hauler) out to a distance of 280m, compared to the grappling time using a CutoverCam. The additional benefit of improving safety of the break out area was not a focus of this study.

METHOD

A continuous time trial was used to test the hypothesis that there was no difference between looking out the hauler cab window and using a CutoverCam for grapple yarding. The trial was undertaken at the operation of G White Logging Ltd in the Bay of Plenty. A Madill 123 with a standard mechanical grapple was used for extraction.

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The camera was located on the back face aimed at the front face of the setting which was out of view to the hauler operator (Figure 5). The crew had previously used a grapple camera and the CutoverCam, but preferred the CutoverCam due to its versatility and lower maintenance requirements.

Table 1 details the start and end points for the cycle time elements and other data recorded during the study. The grapple time was the key element for this study, so particular care was taken to ensure the grapple element times were accurately measured. If the end of 'outhaul' and start of 'grapple' or the end of 'grapple' and start of 'inhaul' were not accurately recorded the cycle time was discarded.

Table 1: Study information collected

Data	Element start	Element end
Outhaul	**Grapple moves away from hauler**	**Grapple stops moving out**
Grapple	**Grapple stops moving out**	**Break out (tree begins to move)**
Inhaul	**Break out (tree begins to move)**	**Tree stops moving forward at landing**
Drop	**Tree stops moving forward at landing**	**Grapple moves away from hauler**
Distance	**(m)**	
Pieces	**(number)**	
Diameter	**(cm)**	
Delays	**Reason**	

There were five distinctly different grappling techniques:

1. Grappling from unbunched trees by operator viewing out hauler cab window (line-of-sight)
2. Grappling from bunched trees by operator viewing out hauler cab window (line-of-sight)
3. Grappling from unbunched trees by operator looking at CutoverCam monitor in the hauler cab (camera)
4. Grappling from bunched trees by operator looking at CutoverCam monitor in the hauler cab (camera)
5. Grappling from unbunched trees by operator directed by a 'spotter'.

Figure 5: Grapple setting showing camera location aimed at front face out of view

RESULTS

The results for the average grappling time are shown in Table 2.

Table 2: Average time to grapple a tree using five different grapple techniques

Technique	Sample size	Average grapple time (sec)	Std. dev (sec)
1.Line-of-sight (unbunched)	**88**	**23.49**	**5.05**
2.Line-of-sight (bunched)	**35**	**31.81**	**7.36**
3.Camera (unbunched)	**101**	**24.49**	**3.18**
4.Camera (bunched)	**18**	**31.42**	**7.54**
5.'Spotter' (unbunched)	**32**	**20.67**	**4.46**

The average time taken to grapple unbunched trees by direct line-of-sight was 23.5 seconds compared to 24.5 seconds while using the camera, but due to the variation in grappling times this difference was not statistically significant. There was also no significant difference between direct line-of-sight and using the CutoverCam when grappling from bunches (31.8 sec vs. 31.4 sec).

More time was taken to grapple from bunched trees. Using line-of-sight, the grappling time averaged 31.8 sec compared to 23.5 sec from unbunched trees. This difference was statistically significant.

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A similar result was found using the CutoverCam. Using the camera to extract from bunches took 31.4 sec to grapple vs. 24.5 from unbunched trees. Again this difference was significant. However the average number of trees extracted per cycle from bunches was double that of unbunched, and this difference was significant. The number trees per cycle increased from 1.4 to 2.8 when bunching with the grapple.

The total average delay free cycle time was 97 seconds per cycle (37.1 cycles per hour), excluding the cycles where the operator would bunch the trees with the hauler grapple prior to extracting them to the landing. Using the average of 1.4 trees per cycle resulted in average productivity of 52 trees per productive machine hour.

The average total cycle time to bunch and extract was 227 seconds per cycle (15.9 cycles per hour). The average number of trees per cycle when bunching with the grapple was 2.8, resulting in hourly productivity of 44.4 trees per productive machine hour.

During the trial, cycles were collected where a very experienced 'spotter' was used to direct the grappling process. The results showed that grapple time using a 'spotter' was slightly faster in unbunched trees than using the CutoverCam (20.7 sec vs. 24.5 sec). This difference was statistically significant. Using a 'spotter' however was not the option of choice for the hauler operator. The crew simply did not want to revert to using a 'spotter' during this trial. Statements from the crew were that it would slow them up too much and they would risk missing their customer orders. In the crew's experience, using a 'spotter' was much slower than direct line-of-sight.

DISCUSSION

While using the CutoverCam the hauler operator made good use of its features, using the pan, tilt and zoom often to improve the view of the grappling process. Prior to beginning a new corridor, the operator would pan along the hauler profile and carefully look at how the trees were lying and plan his extraction route. Often the operator would zoom in to get a closer view of the grapple at the time of grappling the tree. Given the camera control is a standalone joystick, an improvement could be made to amalgamate the camera controls into the hauler control lever (regen lever). This would allow the operator to use the camera without taking his hands off the hauler controls.

The time to grapple seemed to be related to how the grapple was hanging at the time of placing the grapple on the tree. An assessment of how the grapple was oriented to the angle of the tree that was about to be grappled was not made. However it was observed that waiting for the grapple to swing and sit in the right position could frequently take up to 5 seconds (5% of the average total cycle time).

A further observation was made that longer grapple times occurred when the grapple was not oriented to the tree and it took a few seconds for the grapple to slowly rotate into position. The grapple did not have a restraint to hold it in one direction so the operator was required to swing one grapple tine over the tree on occasion, which he did in most cases with ease.

ECONOMIC ANALYSIS OF INVESTMENT

The new model CutoverCam with pan/tilt/zoom costs $12,750 plus GST. Assuming an expected life of one year (with no resale value), the daily cost of the camera system ($55.43 per day) amounts to less than 1% of the annual cost of the average cable logging crew ($9,212 per day) based on 2016 FGR benchmarking data (Visser, 2017).

Assuming that a 'spotter' is required for at least half the time, when the grapple is extracting from the front face out of view (Figure 5) and the CutoverCam is used, with no improvement in grappling time using the camera, the cost savings would be about $110 per day. The payback period (cost of unit divided by the cost savings) for the CutoverCam system is about 6 months.

CONCLUSIONS

The preferred option during grapple yarding is for the hauler operator to look directly out the window. This is suitable when there is line-of-sight and visibility of the break out site is not limited by terrain or environmental or operating conditions.

The view of the grappling area on the CutoverCam monitor was high quality video and proved to be just as good as direct line-of-sight. The time taken by the hauler operator to grapple a tree using the CutoverCam was not significantly different from the time taken by direct line-of-sight out the hauler cab window.

Where there is no direct line-of-sight and a 'spotter' must be used, the CutoverCam offers an economic

alternative. The payback calculation indicated a payback period of about 6 months.

The CutoverCam also offers some real benefits over the more common grapple cameras, including;

1. The camera can be sited for best advantage on the cutover.
2. The CutoverCam can be panned and tilted to get a high-level view of the whole hauler profile about to be grappled and can be zoomed right in to enhance grappling.
3. The commercial model CutoverCam is a one-piece, robust but light weight unit which is not subject to the rigours of operation of a grapple camera.
4. The CutoverCam enables the hauler operator to keep a close eye on breaker-outs, in situations where the grapple is taken off, and manual breaking out is used.

The CutoverCam is versatile in terms of its application. Not only is it an excellent tool to maintain consistent grappling, especially when the grappling site is out of view of the operator, but also it can play a key role in keeping breaker-outs safe. The hauler operator can now see if the breaker-outs have retreated a safe distance before inhaul is commenced. With the CutoverCam monitor displaying a warning if the video stream is interrupted, the hauler operator can be assured that the view of operations is live. The CutoverCam can also be used for monitoring other aspects of the harvesting operation, such as tree felling.

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REFERENCES

AGCAM, Retrieved from: www.agcam.com.

Eagle Carriage & Machine Inc., Retrieved from: www.eaglecarriage.com.

Evanson, T and Parker, R. 2011. Advanced Hauler Vision System – A Feasibility Study. Harvesting Report H006, June 2011. Future Forests Research Limited, Rotorua, New Zealand

Evanson, T and Milliken, P. 2012: Hauler Vision System: Testing of Cutover Camera. Harvesting Technical Note HTN05-03, 2012. Future Forests Research Limited, Rotorua, New Zealand.

Evanson, T. 2013: Improved Grapple Control – The Alpine Grapple. Harvesting Technical Note HTN05-08, 2013. Future Forests Research Limited, Rotorua, New Zealand.

MacMillan Bloedel (1983): “MB's video yarding system increases productivity”. Logging and Sawmilling Journal 14 (2) (1983).

Visser, R. 2013: Survey of Cable Yarders Used in New Zealand. Harvesting Technical Note HTN06-03, 2013. Future Forests Research Limited, Rotorua, New Zealand.

Visser, R. 2017: Benchmarking Harvesting Cost and Productivity – 2016 Update. Harvesting Technical Note HTN09-08, 2017. Forest Growers Research Limited, Rotorua, New Zealand.

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