Productivity Improvements through Professional Training in Appalachian Cable Logging Operations

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ABSTRACT – The Appalachian mountain region lends itself ideally to cable logging operations. However, very few new cable logging contractors that have started over the last two decades have been successful in sustaining their operation. The absence of advanced planning, contract management, lack of skilled labor and labor turnover issues has led to inefficient operations that cannot survive financially.

A productivity study was carried out on one new Thunderbird TY 45 operation to document the effect of professional training on the production efficiency. The productivity of the operation after a month of self-learning was established at 18.8 tons per productive machine hour at an average piece size of 1.25 tons and 120 meter extraction distance. The crew then received one full week of professional training from two experienced Pacific Northwest riggers. Two weeks after the training the average productivity increased to 23.7 tons per productive machine hour. The main factors were a reduction in carriage out and in times, as well as increased average turn volume. Considerable improvements in line shifts, landing organization and safety were also observed. For this case study, the expense of professional training will be paid off in four working weeks.

INTRODUCTION

In the late 1970's and early 1980's a large amount of information was published regarding cable logging in the southern Appalachians (Gochennour *et al.*, 1978; Iff and Coy, 1979; Rossie, 1983; Ledoux, 1985; Sherar *et al.,* 1986). A number of these systems were studies to establish typical productivity levels (LeDoux, 1995). Environmental factors and logistical difficulty in reaching second growth timber on steep terrain using ground based logging methods was the primary driver for heightened interest (Gochenour *et al.,* 1978).

Fisher *et al*. (1980) identified four reasons for promoting the potential effectiveness of small or medium cable yarders in this region:

- Slopes are predominately convex and smaller cable systems with a reach of 1000 feet or less would minimize the problems associated with convex slopes.

- More than 75 percent of the forestland is owned by private individuals and has a limited tract size. Small cable systems are highly mobile and can easily be moved into small tracts. In addition, these machines can usually be moved on state highways without special permits for height, weight, and width.

- Smaller cable systems have a lower initial capital cost and can be better matched to small and low value timber than bigger machines.

- The transportation of small cable systems does not require the wide roads necessary for the transport of their large western counterparts. Road building and maintenance cost may be reduced and less forestland removed from production.

These reasons still hold true but since then there has been considerably less activity in terms of cable logging operations in the region. It is estimated that 70 medium sized yarders could work on a sustainable basis to harvest the 140 MMBF that would be available each year in the Appalachian region (Baker *et al.*, 2001). Currently only about five crews work, and not all of those on a full time basis.

Ground-based skidder operations are still the most common extraction option because of the lower logging price and steady production. Where timber volume and value permits, helicopters are used on the steeper slopes. While the local timber companies still actively manage ground-based operations, the helicopter operations are considered a ‘turn-key’ solution. This means the helicopter crew carries out all aspects of the operation from planning to felling to extraction. Only the loading out of the timber is usually sub-contracted to a local crew.

Increasing helicopter operation costs, due to high energy and maintenance expenses, has lead to a need to promote cable-yarding operations as a profitable alternative. The need for correct management to find utility in this system on a long-term basis in this region is not only being driven by economic factors, but by environmental concerns as well. Pre-harvest planning, harvest layout and truck scheduling play a less critical role in ground-based operations versus cable logging operations. Contract logging and operational management expertise in cable-yarding systems in the region is very poor relative to the Pacific Northwest.

The need to quantify the productivity improvements that can be made through training over time is important. An experienced operator can account for a 30 to 40 percent increase in productivity (Stampfer, 1999: Parker *et al.,* 1996: Stampfer *et al*., in press).

The objective of this case study is to document the improved productivity resulting from professional training and establish a payback period for the training costs incurred.

METHODOLOGY

Yarding Operation

Wes Hood Logging, of Norton, Virginia, purchased a Thunderbird TY45 yarder (Figure 1) and commenced operations in July 2001. The yarder system uses an Eagle motorized slack-pulling carriage and a skidder to clear the chute. The logs are bucked and loaded out by a Barko 160A trailer-mounted loader.

No initial rigging training was provided, although the contractor had previously attended a two-day introductory cable-planning course at Virginia Tech. He received support from the compny receiving the logs and from Hank Sloan, Forest Engineer for the USDA Forest Service, Roanoke, Virginia.

An initial productivity study was carried out on the operation during the last week of August, 2001. Two months late, in October 2001, two experienced riggers came out from the Pacific Northwest. Ross Hojem of Chehalis, Washington, was out for 5 days and Robert Armstrong was out for 8 days to train the crew. The productivity of the system was captured again with a follow-up study in the third week of October.

Figure 1: Wes Hood Logging: Thunderbird TY45 yarder with Barko 160A loader.

The operation had moved to a different site for the post-training study (Figure 2). The slope, amount of deflection, and stand characteristics were similar between the pre-training and post-training sites, although a change in average pieces size of 1.2 to 1.35 tons was noted.

Figure 2: Photo showing typical southern Appalachian site conditions.

The crew remained the same between the two individual studies with the exception of the fallers.

Productivity
A basic elemental time study was carried out using Husky FG/FS handheld computers running Siwork3 software.

The following time elements were recorded for each yarder cycle (in 100^{th} of a minute):

- outhaul - the time required for the empty carriage to travel from the landing to the choker-setter
- hook - the time required for the slack to be pulled from the carriage, the choker-setter to hook the turn and the turn to reach the carriage
- inhaul - the time required for the loaded carriage to travel back to the landing
- unhook - the time to lower the turn on the landing, release the chokers and return them up to the carriage
- delay - all time not in one of the categories above

The following physical parameters were also recorded:

- Distance - yarding distance (meters)
- AvePieceVol – average piece volume based on large end diameter (LED) and length estimate of each stem in the turn
- Piecenum - number of trees per turn

Finally, a block factor was introduced to separate the pre- and post training data sets:

- Train, equal to 0 before training and 1 after training.

Total cycle time and total turn volume was combined to calculate delay free productivity. The delay time, which accounted for 42% of the total work time during the studies, was not used for the evaluation.

The actual stem volume of at least 35 trees were also measured on the landing at each study site to obtain a regression between the LED and length and actual volume. During the actual productivity study the LED was measured using calipers and the length was estimated, or measured if it did not impede productivity or compromise safety.

PRODUCTIVITY RESULTS

A total of 55 cycles were captured prior to training and 35 cycles after training. To identify the specific area in which improvements were made, the time elements were modeled individually.

Carriage out
Carriage out time is expected to be strongly correlated to extraction distance. The variability in the pre-training data set is due to the inexperience of the yarder operator. Analyzed separately, the r^2 of the pre-training data set is 0.19 while the after training data set r^2 = 0.69. The overall model for the carriage out phase of the operation has an r^2 = 0.42.

$$\text{Carriage out} = 96 + 0.225 * \text{Distance} - 52.3 * \text{Train}$$

This indicates that the training of the operator saved on average just over half a minute off each carriage out phase of the cycle. This is not necessarily just an increase in line speed but also a reduction in the amount of adjustment when the carriage reaches the target area.

Hook-up

No significant difference was found in the time taken to hook up the turn before and after training. However, the average turn volume increased significantly from 1.4 tons to 2.2 tons, with an increase in average number of pieces of 1.3 to 1.7. This increase in average turn volume played a significant role in the overall increase in productivity.

Carriage in

As with the carriage out phase, the overall carriage in model had a low r^2 value (= 0.44) due to the higher variability in the first data set. The following model was developed:

$$\text{Carriage in} = 51 + 0.331 * \text{distance} + 51 * \text{piecenum} + 120 * \text{avepiecesize}^{0.6} - 130 * \text{Train}$$

The model indicates that the inhaul phase was reduced by 1.3 minutes on average, and that both average piece size and number of pieces influenced the overall time.

Overall Productivity Model

The following overall productivity model was developed for the total data set.

$$\text{Productivity (tons/PMH)} = -15 - 0.052 * \text{distance} + 8.9 * \text{piecenum} + 23.9 * \text{avepiecesize}^{0.6} + 4.9 * \text{Train}$$

The r^2 for the model = 0.70, p-value for Train = 0.062 while the p-value for all other variables <0.002.

Figure 3 shows the productivity function based on average piece size. For the average conditions in this study, distance = 120 meters and the average piece size = 1.2 tons, the productivity before training was 18.8 tons/PMH and this was increased to 23.7 tons through the training effect. A significant increase in average number of pieces per turn of 1.3 to 1.7 was also noted.

COST RECOVERY OF TRAINING

Using cost estimates it was possible to calculate the payback period for professional training. The overall cost for the week long training period was estimated to be $7500.

The overall improvement in productivity was calculated to be 4.9 tons/PMH. Assuming an average of 5 productive yarder hours in a work day, the contractor could increase his production by at least one truck load a day. At typical logging rates, and as an indicator only, it would take just four working weeks to recover the cost of training.

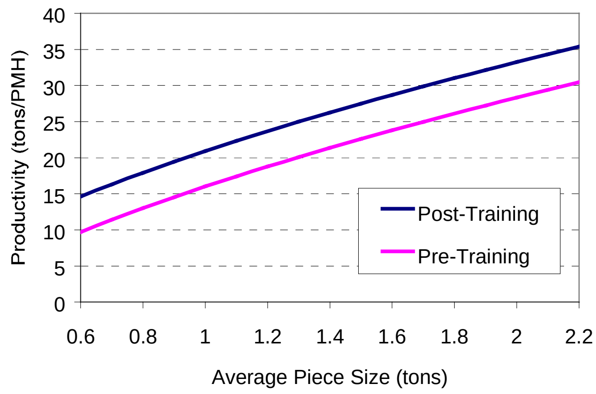

Figure 3: Productivity model based on average piece size for an extraction distance of 120 meters and 1.5 pieces per turn.

ON SITE OBSERVATIONS

The following list is intended to provide the reader with some overview of activities that were observed that either hinder the efficiency or professionalism of the operation. These issues can be considered typical for many of the new operations in the Appalachian region.

Pre-training Observations

- Poor directional felling resulting in excessive breakage and hook up time. The directive was given to fell the trees as quickly as possible.
- Need for infield merchandizing/log-making skills to optimize payload and improve value recovery.
- Excessive waste material on the landing was causing operational delays for both the yarder and the waiting truck.
- Control of the haulback and mainline needed improvement to avoid overshooting the target area and dynamic loading of the mainline.
- The extraction corridor needed to be cleared of all small (un-merchantable) trees. Trees left in the corridor impeded carriage movement.
- The use of a tail spar would improve ground clearance near the end of the skyline to reduce soil disturbance.
- Unhooking under the skyline before the carriage comes to a complete halt, or working under the skyline while the carriage is in motion, is a safety concern and caused a near miss incident.
- The loader position on the log deck should have been placed on the side where the truck comes in. This prevented the yarder from working during the time that the truck was being loaded (Figure 4).

Figure 4: Poor location of the loader resulting in operational delays when loading out the truck.

Post training Observations

- Directional felling and delimbing was of a higher quality that led to less hook-up time and less waste on the landing.
- Improved ability to operate the control levers in the yarder resulted in reduced carriage out time.
- Able to increase the payload through greater confidence in system capabilities.
- Ability to manipulate the haulback line to increase break-out options.
- Landing was kept clear of waste and the chute area was also improved so that the logs could be easily un-hooked.
- New techniques learned for line-shifts greatly reduced the operational delay time. Line shifts were being completed in 30 minutes.
- Poor advanced planning (logger given new tract less than one week before he was expected to start) meant the contractor had to spend 30 bulldozer hours pushing roads for this poorly accessible tract before he could pull his first load.

CONCLUSION

The promotion of cable yarding in the Appalachians relies on the ability of new logging contractors to be successful over a longer period of time. The lack of operations in the region in the last decade means that very few skilled operators are available to either work or train new crew members. The Pacific Northwest has a higher concentration of skilled trainers and while the initial cost appears prohibitive, this study shows that the training costs can be quickly recovered through increased productivity.

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