Calculating Utilization Rates for Rubber Tired Grapple Skidders in the Southern United States

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ABSTRACT - Utilization rate is an important factor in calculating machine rates for forest harvesting machines. Machine rates allow an evaluation of harvesting system costs and facilitate comparisons between different systems and machines. There are many factors that affect utilization rate. These include mechanical delays, non-mechanical delays, operational lost time, and personnel time. As a result utilization rate can be highly variable and difficult to accurately estimate without detailed information. This paper reports on an ongoing study to measure the utilization rates for forest harvesting machines in the southern US, specifically rubber tired grapple skidders. Electronic service recorders were mounted on four grapple skidders on a harvesting operation in east central Alabama. To date, 44 working days have been monitored for three of the skidders and 19 for the fourth machine. The average utilization rate ranged from 76.5 percent to 64.8 percent.

INTRODUCTION

Accurate machine productive time has a variety of uses for machine owners, managers and researchers. The data can be used to account for and charge for machine use. Maintenance and service scheduling and documenting can be kept more accurately.

Service recorders are the traditional means of measuring productive machine hours. There are several drawbacks to service recorders. They generally can only record for 24 to 48 hours and the charts must be changed manually. Data interpretation is also time consuming and can be tedious. Until recently there were very few commercially available alternatives. The Yellow Activity Monitoring System (YAMS) (Thompson, in press) is a commercially available electronic service recorder and software package that replaces the traditional service recorder.

YAMS has made possible the opportunity to monitor multiple machines for long periods of time with minimal labor. For research purposes, YAMS allows long term data capture that can be used to gain a better understanding and measure of machine usage and utilization rate.

Utilization rate is the ratio of Productive Machine Hours (PMH) to Scheduled Machine Hours (SMH) (Rolston, 1972). Utilization rate is used in the calculation of machine rates. Machine rate is a cost analysis method used to calculate a machine's average cost over it's lifetime (Matthews, 1942). Harvesting contractors and forest managers can use machine rates to more accurately compare machines and systems and address issues affecting their productivity. For a machine rate to be reliable it must be based on accurate data. Machine utilization rate is a value inherent to all machines, but one that is rarely calculated or reported. This paper reports on an ongoing study to measure the long term utilization rate for forest harvesting machines. The intent of the study is to monitor a wide range of forest machines working in different forest types and conditions. This paper is focused on current results for rubber tired grapple skidders.

MATERIALS AND METHODS

The Yellow Activity Monitoring System (YAMS) consists of a activity recorder, data gatherer and a data storage and analysis software package. The activity recorder can be permanently or temporarily mounted in any machine. It stores machine vibrations electronically and can hold 114 hours of machine activity. The intensity and frequency of the vibrations are recorded and the sensitivity can be adjusted to filter out "noise". The data gatherer is used to download machine data from the activity recorders in the field. The data gatherer has the capacity to download as many as 16 activity recorders while in the field. The YAMS software allows the storage and analysis of data for multiple machines. Reports can be printed for single or multiple machines over short or long periods of time. The software allows scheduled hours to be set for each machine and automatically calculates a wide range of machine statistics.

For this study four YAMS activity recorders were mounted on four rubber-tired grapple skidders working on an in-woods chipping operation in east central Alabama. The machines were a Caterpillar 518, Timberjack 450C,

Timberjack 460, and a Timberjack 660. The three Timberjack machines were the primary skidding machines, while the Caterpillar was used mainly for short skids, and cleaning the landing area.

The activity recorders should be mounted vertically on a wall of the machine and are downloaded via the bottom of the recorder. This limits the number of available places for mounting the recorders in the cabs of modern skidders. Double sided tape was first used to mount the recorders and later we switched to Velcro to allow for more mounting options (for example on carpeted interior walls). Based on information provided by the contractor scheduled hours were set for 8 am to 5 pm daily for each machine Monday through Friday.

RESULTS AND DISCUSSION

Data Collection

Data collection began in the second week of January 2001 and is ongoing at the writing of this paper. The data from the recorders was downloaded weekly and entered into the YAMS software. The data gatherer proved to be very easy to use and convenient for downloading in the field. Downloading time per machine was very quick, averaging less than a minute for a week's data. Each machine's data was downloaded as they approached or left the landing. Total time to download all machines was generally less than 30 minutes.

The activity recorders proved to be reliable overall. Some instances of lost data did occur due to battery problems. If an error occurred with an activity recorder it could not be diagnosed until the data had been downloaded back at the office. Other sources of lost data occurred as a result of mounting problems. For example, one activity recorder fell from it's mounting and the operator placed it in a cushioned compartment to keep it from getting damaged thus stopping the recorder was vibrating.

Data Analysis

Summary results are presented in Table 1. The Caterpillar 518 and the Timberjack 450C and 460 were monitored for 44 consecutive working days. The Timberjack 660 was monitored for 19 working days. Missed days on the Timberjack 660 were due to errors with the activity recorder. During the 44 day observation period the operation was shut down due to the weather on only two occasions. Mechanical availability was not calculated for the machines due to the lack of data on daily service time. Work missed for major mechanical delays is accounted for.

Table 1: Utilization rates (percent) and productive machine hours for four rubber tired grapple skidders working in an in-woods chipping operation in east central Alabama.

	Cat 518	*TJ 450C*	*TJ 460*	*TJ 660*
No. Days	44	44	44	19
Avg Util	65.61	64.75	76.52	70.65
Max Util	94.77	91.44	96.44	90.0
Min Util	0	0	0	0
Std dev	26.22	26.14	22.56	26.72
Avg. Hrs	6.71	6.58	8.11	7.81
Max Hrs	9.32	9.03	10.37	9.88
Min Hrs	0	0	0	0
Std dev	2.57	2.55	2.14	2.74

The Caterpillar 518 had an average utilization rate of 65.61 percent and averaged 6.71 hours per day. On 37 of the 44 monitored days (84 percent) the machine worked outside of the scheduled hours. The average time per day outside of scheduled hours was 0.66 hours with a maximum of 1.37 hrs. The machine missed two days due to mechanical delays.

The average daily utilization rate for the Timberjack 450C was 64.75 percent with an average daily working time of 6.58 hrs. On 36 of the 44 days (82 percent) of monitoring the machine worked outside of the scheduled hours of 8am to 5pm. The average time per day spent outside of scheduled hours was 0.59 hrs with a maximum of 1.06 hrs. The machine had no lost days due to mechanical delays, but did have two lost days due to personnel time (operator unavailability).

The Timberjack 460 had the highest calculated utilization rate of 76.52 percent. The average daily working time was 8.11 hrs with a maximum of 10.37 hrs. The machine worked outside of scheduled hours 40 out of the 44 days (91 percent) with an average time per day of 0.73 hrs and a maximum of 1.85 hrs. The machine had no lost days due to operator unavailability or mechanical delays.

Average daily utilization rate for the Timberjack 660 was 70.65 percent with 19 days of observation as compared to 44 for the three other machines. Average daily working time was 7.81 hrs with a maximum of 9.88 hrs. On 18 of the 19 monitored days (95 percent) the machine worked outside of the scheduled machine hours. The average daily working time outside of scheduled time was 1.34 hours with a maximum of 1.85 hrs. No days were lost due to operator unavailability or mechanical delays. The machine did experience some lost days due to mechanical delays, but they occurred during the time no activity was recorded due to errors with the activity recorder.

Brinker et al (1989) suggest utilization rates for grapple skidders of 60 and 65 percent based on machine power. The higher utilization rate of 65 percent was suggested for machines of lower power ratings 70 - 90 hp (52 – 67 kw) and the lower utilization rate of 60 percent was suggested for machines with power ratings of 91 hp (68 kw) or above. To date two of the observed machines in this study have averaged 10 and 16 percent higher average daily utilization rates than the maximum suggested 65 percent. The other two machines in the study averaged the maximum suggested utilization rate of 65 percent. All machines in the study have power rating above 68 kilowatts. The Caterpillar 518 has a power rating of 97 kw and the Timberjack 450C, 460, and 660 have power ratings of 130, 130, and 160 kw respectively. In this situation calculated utilization rates are higher for the more powerful and newer machines.

The scheduled hours were set from 8 am to 5pm based on information provided by the contractor. The data show that the machines worked outside of the scheduled hours a majority of the time with average times ranging from a minimum of 0.59 hrs to 1.34 hrs per day. The calculated utilization rate could be higher than that reported here if the scheduled hours were adjusted to fit the average work day.

CONCLUSIONS

The use of Yellow Activity Monitoring System electronic activity recorders allows the long-term collection and calculation of utilization rates for forest harvesting machines. Four rubber tired grapple skidders working on an in-woods chipping operation in east central Alabama were monitored. Calculated utilization rates ranged from 64.75 to 76.52 percent for the four machines. These rates are equal to or above the figures suggested in the literature for grapple skidders. Is this due to the nature of the operation? Would grapple skidders working in a predominantly sawlog harvesting operation have lower average utilization rates? Future plans call for machines working in these types of operations to be studied. This study is ongoing at the writing of this paper.

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