High resolution forwarding data and evaluation of operator differences by use of TimberLink data

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This study is a part of the PhD dissertation by Jussi Manner that will be defended 11th of December 2015 at SLU in Umeå, Sweden
The general problem in forwarder work studies

- Time studies can give detailed data about work element proportions, driven distances, number of crane cycles etc., but lack in representativity
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• This study is about to combine the two study methods with new technique!
Objective

• Present representative values on fuel and time consumption, speed and distances at load level for large forwarders in final felling
Material and methods

• The John Deere TimberLink automatic machine monitoring system was used. In this study also the newest TimberLink’s algorithm versions were used, which were not yet in commercial use (when preparing a paper and this presentation)
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• However, the volume on loads were not known!
Material and methods

Two brand new John Deere 1910E forwarders (21.8 tonnes, 19 ton load capacity). In total 9 experienced operators and 8800 -15 300 loads collected during two years of forwarding in final fellings with terrain conditions typical for mid-Sweden.
Forest road

Log piles at landing
Work elements in forwarding

Forest road

Log piles at landing
Forest road

Log piles at landing

Driving empty

Work elements in forwarding
Forest road

Loading and Loading drive

Driving empty

Work elements in forwarding

Log piles at landing

Forest road
Loading and Loading drive

Driving empty

Log piles at landing

Driving loaded

Work elements in forwarding

Forest road
Forest road

Log piles at landing

Driving empty

Driving loaded

Unloading and unloading drive

Loading and Loading drive

Work elements in forwarding

Forest road
Driving only

Crane work only

Simultaneous crane work and driving

Driving empty

Loading and Loading drive

Unloading and unloading drive

Work elements in forwarding

Other time

Driving loaded

Forest road

Log piles at landing
Definitions on driven distances in this presentation

Loading and Loading drive

Driving loaded

Driving empty

Unloading and unloading drive

Forest road

Log piles at landing
Definitions on driven distances in this presentation

"Total driven distance" Adding all distances for a load together
Definitions on driven distances in this presentation

“Total driven distance”
Adding all distances for a load together

“Extraction distance”
Driving loaded + Driving empty divided by two

Loading and Loading drive

Driving empty

Unloading and unloading drive

Log piles at landing

Forest road
Results

If just looking on some raw data plotted for each load, it is obvious that the variation is big, but also that are some connections between variables.
Results

Some average values for the whole dataset

The median total driven distance was 666 m/load

The median extraction distance was 174 m/load
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The median fuel consumption was 8.5 l/load, or 12.4 l/km during driving
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The median extraction distance was 174 m/load
The median forwarding time was 42.1 minutes/load
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The average speed was 3.3 km/h during Driving empty
2.8 km/h during Driving loaded
2.2 km/h during Loading drive
Results

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The average fuel consumption for all loads together on the two forwarder was:

17.3 – 23.1 l/hour during Driving loaded

19.0 – 20.3 l/hour during Driving empty

11.5 – 12.8 l/hour during Loading (including Loading drive)

10.8 – 11.7 l/hour during Unloading (including Unloading drive)
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11.5 – 12.8 l/hour during *Loading* (including *Loading drive*)

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Driving consumes about 70% more fuel per hour than loading and unloading
Results

Time consumption
Figure. The total and productive machine time (PM time) consumption per load as function of extraction distance (mean of Driving loaded and Driving unloaded distances).
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The difference is "Other time" meaning when nothing happens.
Figure. The proportion of time consumption for work elements as function of extraction distance (mean of *Driving loaded* and *Driving unloaded* distances).
Driving empty and Driving loaded together only make up to about 15% of total time consumption at the median extraction distance.

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Driving empty and Driving loaded together only make up to about 15% of total time consumption at the median extraction distance. (It is not much to win by developing a forwarder driving much faster than today, if it costs more!)

Figure. The proportion of time consumption for work elements as function of extraction distance (mean of Driving loaded and Driving unloaded distances).
Results

Fuel consumption
Figure. Fuel consumption (l/load) as function of total driven distance (m) during separate work elements and in total.
At median total driven distance and for a load with a large forwarder, the typical fuel consumption per load is:

- 4.3 l for “Driving only”
- 3.6 l for “Crane work only”
- 0.5 l for “Simultaneous crane work and driving”
- 0.2 l for “Other time”

In total 8.5 l/load

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Conclusions

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(A presentation dealing with operator behaviour is given tomorrow afternoon:
*Evaluation of the educational influence on forwarder planning capacity*
- Ola Lindroos)
Final Words

And, if you are interested in more details from the studies behind this presentation, just attend to the PhD dissertation by Jussi Manner

Jussi Manner

11th of December 2015 at SLU in Umeå, Sweden
The End

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