

Forest

Knowledge

Know-how

METLA

Well-being

The Importance of the Forwarder Operator in Loading Phase During Virtual CTL-forwarding

Sami Lamminen,
Kari Väätäinen and
Antti Asikainen
Finnish Forest Research Institute,
Joensuu Research Unit

Introduction

- Forest machine work is highly skill demanding – operators ability to handle the crane plays a big role in productivity
- Share of crane work is up to 60 % of total forwarding time, where loading and unloading are included; depending on forwarding distance
- Aim of the study was to clarify the factors between the operators that affects to productivity → what are the differences between operators during loading phase

Virtual Forwarding

- Forwarder simulator offers some advantage in terms of research
 - Working conditions are constant for all operators
 - Possibility to gather precise data of movements of forwarder and crane
- Research was carried out in close co-operation with:
 - Ponsse
 - Creanex Ltd., developer of Ponsse's forwarder simulator
 - Forest machine operator school Valtimo

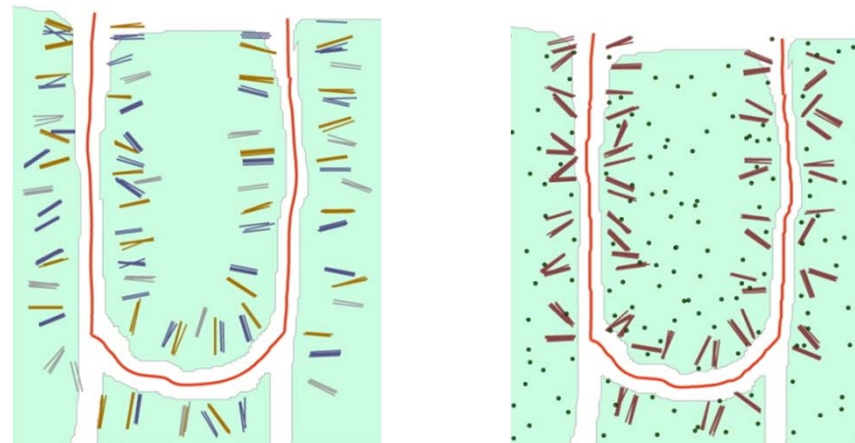


Working conditions

- 2 different work sites

	Clear cut	Thinning
Loaded assortment	Spruce saw log	Pine pulp wood
Number of bunches	24	40
Bunch volume, m ³	0.50	0.23
Number of bolts in bunch	3.11	4.55
Bolt volume, l	132	50
Load size, m ³	10.79	9.55

Distribution of bunches in both sites






Operators

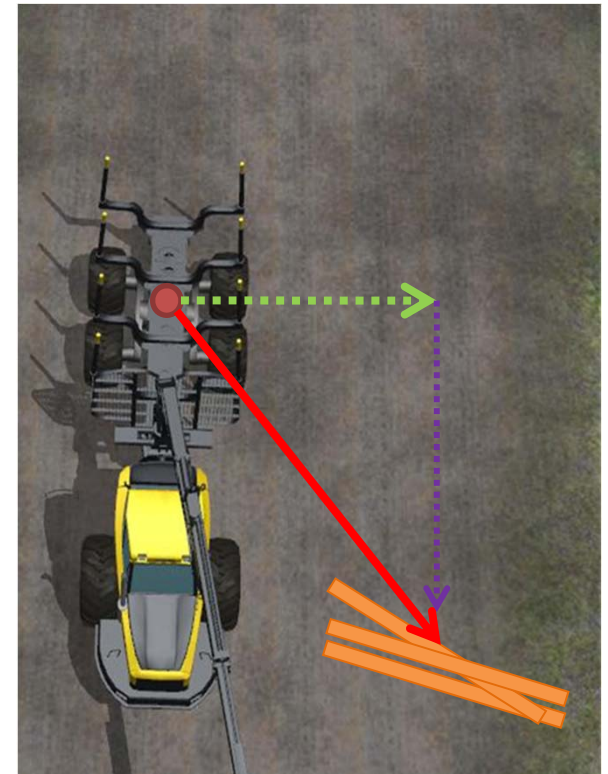
- 10 Operators
 - 3 Ponsse factory test operators
 - 2 teachers
 - 5 students
- Operators had 15 min warm-up period to get used to simulator and crane
- Operators completed three stage crane usage training (10 min) before the study
- Operators were instructed to work similiary as in a real life

Methods...

- Simulator: Ponsse MetSimulator v. 1.3.3.1
- Positions of forwarder_(X,Y,Z) were logged, interval 20 ms:
 - centre of load space
 - attachment point of crane
 - crane tip
- Screen capture video recording for time study
- Measured work phases were effective crane out (reaching the bunch) and crane in (lifting the grapple bunch); grabbing and arrangement of bunch, and releasing grapple load and arrangement of forwarder load were excluded

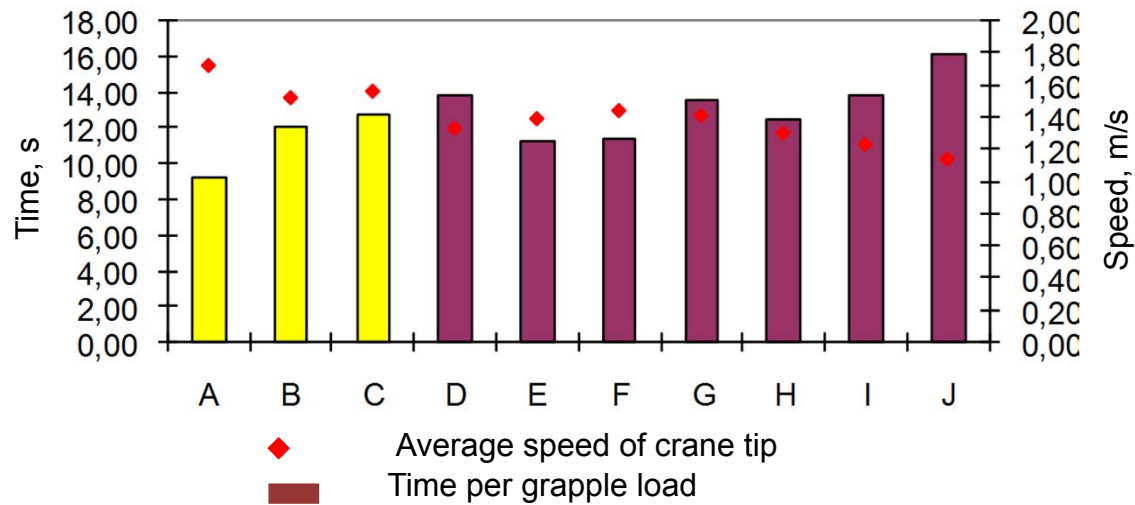
Methods...

- Calculated factors:
 - Time per grapple load
 - Length of trajectory of crane tip
 - Average speed of crane tip
 - Straight distance to bunch: 
 - Parallel distance to bunch: 
 - Perpendicular distance to bunch: 



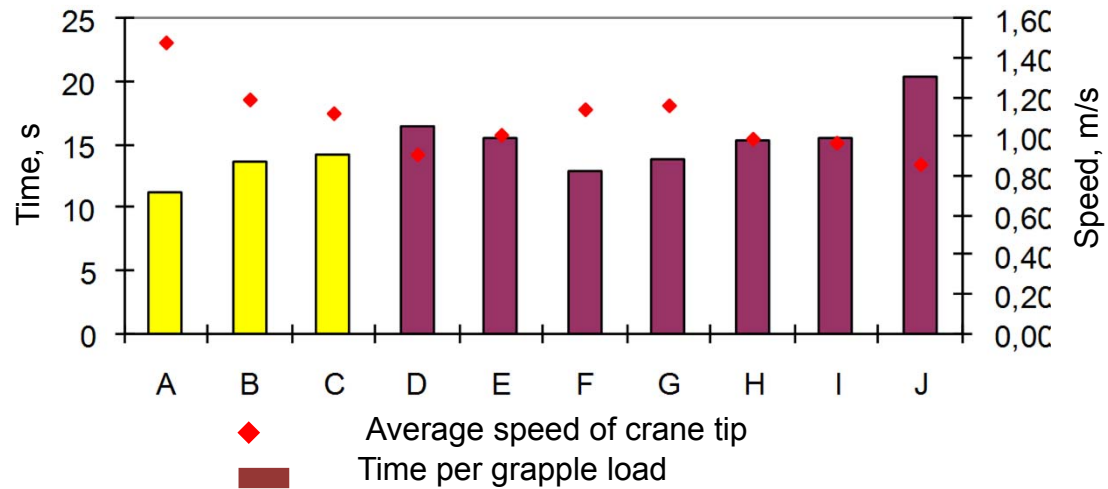
Results – clear cut

<u>Operator</u>	<u>Total time, s</u>	<u>Relative productivity</u>
A	221	1,00
B	290	0,76
C	304	0,73
D	331	0,67
E	269	0,82
F	263	0,84
G	323	0,68
H	298	0,74
I	330	0,67
J	387	0,57

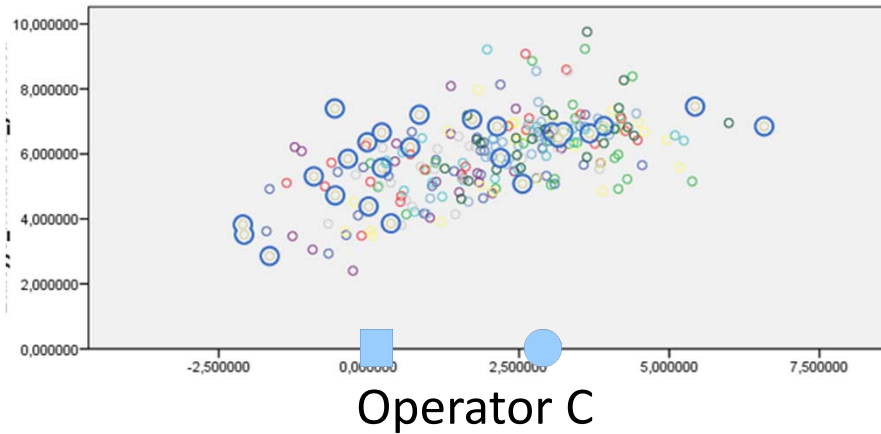


Results – thinning

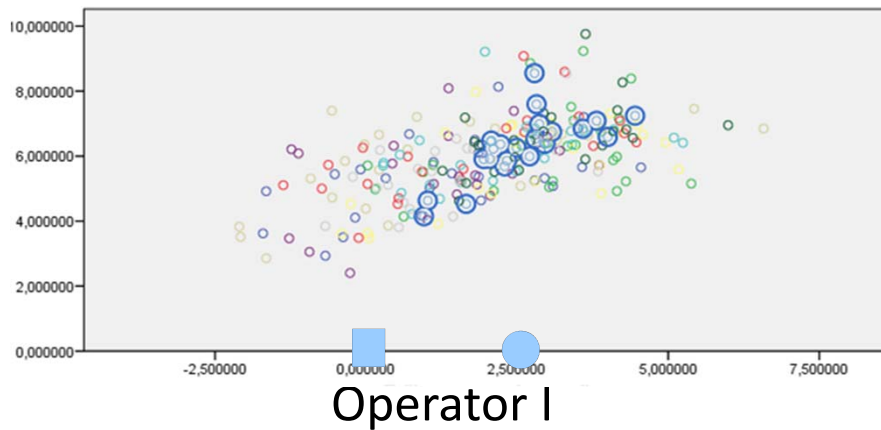
Operator	Total time, s	Relative productivity
A	463	1
B	564	0,82
C	575	0,80
D	709	0,65
E	636	0,73
F	540	0,86
G	575	0,80
H	637	0,73
I	635	0,73
J	814	0,57



Example of distribution of grapple loads in clear cut



	Operator C	Operator I
Time per GL, s	12.67	13.76
Trajectory of CT, m	19.24	16.14
Speed of CT, m/s	1.56	1.22



- Attachmentpoint of crane
- Centre of load space

Time consumption of grapple load, based on the position of bunch

2 separate regression models for clear cut and thinning

Independent variables:

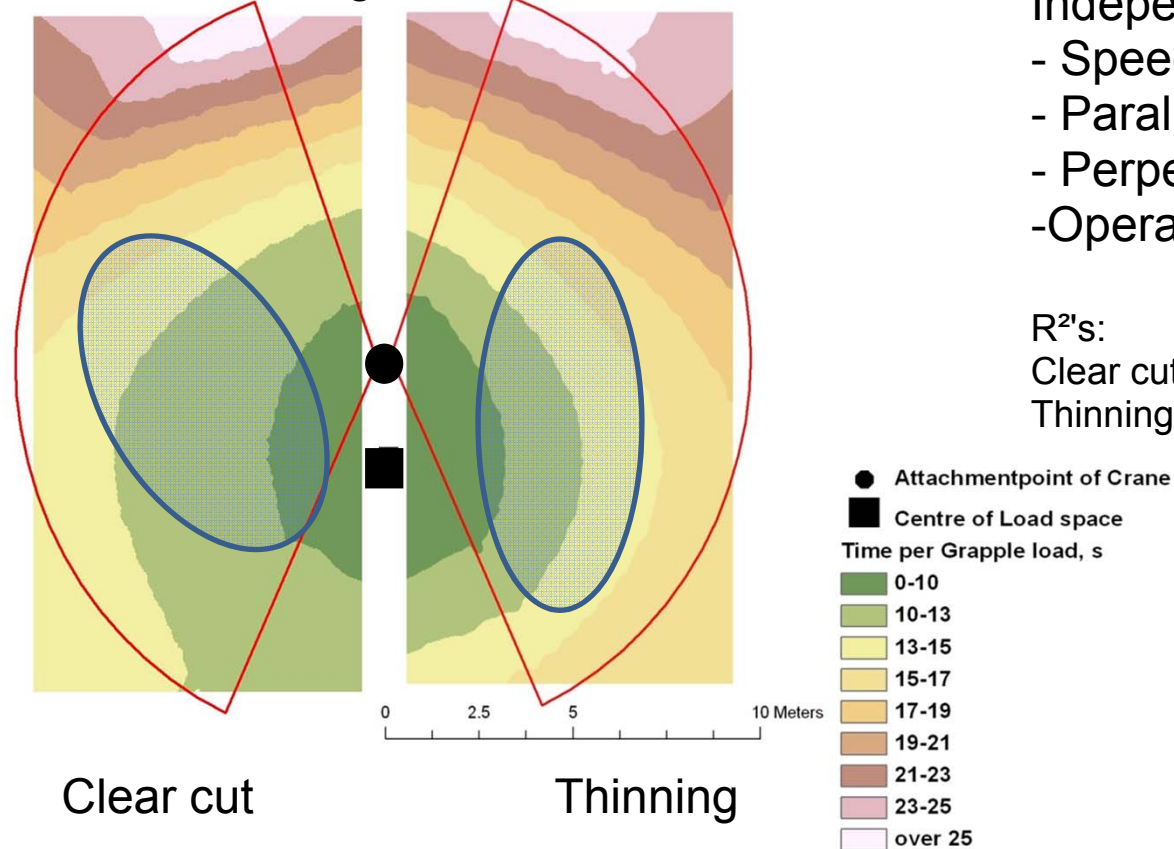
- Speed of crane tip
- Parallel distance to the bunch
- Perpendicular distance to the bunch
- Operator as a dummy variable

R²'s:

Clear cut: 0.77

Thinning: 0.80

Results of regression models



Conclusions

- Huge difference in productivity between operators
- Experienced operators performed higher crane tip speed, but much variation on length of trajectory of crane tip
- "Sweet spot" for loading grapple bunch was located close to centre of load space
- Visibility of simulator environment might have some effect on results, it is rather difficult to perceive distances correctly through 2D-screen

Forest

METLA

KNOWLEDGE

Well-being

Know-how

Thank you

10/7/2011

13