WAIARIKI INSTITUTE OF TECHNOLOGY

The evaluation of full stem optimization with the Forest Bucker, and comparison with manual log making

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Table of contents

Executive summary

In this study I set out to compare the manual log making method with the automated method,. My aim was to determine whether or not full stem optimization on site can achieve improved value recovery over a log maker. What benefits could a system like the forest bucker offer over manual methods? And what benefits could a system like this offer financially After having Peter Stephens experienced "log maker" log make 20 stems, and then having the forest bucker re-make those stems the result was a 17% increase in value recovery (added forest value) which in turn gave me an estimated $400,000 dollars add value over a harvest area of 90 hectares. Full stem optimization opens the door to fully mechanized harvesting which will improve health and safety within the forest industry and can also improve supply chain management with customized software.

I. Can full stem optimization improve value recovery over manual methods? **Yes!**
II. Can full stem optimization improve financial return over manual methods? **Yes!**
III. Are there more benefits in using Full stem optimization over manual methods? **Yes!**

Section one introduction;

Background

The Forest Bucker is a semi-automated system developed by the New Zealand Company ELECTRONICS 123 Ltd, to scan and scale a de-limbed stem and then calculate the optimal log-grade solution for the stem and insure maximum value. The system is designed to operate at or near the tree harvesting site the forest bucker system was designed more for hauler landings but is able to accommodate some ground based operations. Scanning and scaling the stem, before the bucking decisions are made, yields maximum value for the stem. The system is not currently being used in production; however the system has been trialed in Kinlith forest from the 18/02/2013 to the 20/03/2013 in a simulated production format. The systems software was developed here in New Zealand and the steel tracks and trolley that carry the scanners alongside the stem were manufactured in South Africa along with the stem bed, as for the scanners themselves they are manufactured in the U.S.A by Joe scan.

Objectives

To report on the forest improvement achieved by using the forest bucker system, to ascertain whether or not full stem optimization can achieve grater value recovery when using a full stem optimizer such as the forest bucker, over manual log making methods and what benefits could a system like the forest bucker give forestry, and what financial benefits are there to using such a system.

Scope

I. Investigate the ability and limits of the Forest Bucker system to be assembled in the forest at the harvesting site on sloped and/or uneven terrains. Quantify the limitations and discuss safety issues in this regard. Investigate the portability of the forest bucker.

II. Investigate the ability of the Forest Buckers software: 1) LGM (log grade manager) to switch or increase log grades and cut plans to accommodate new specifications and value priorities. 2) Investigate the pros and cons of profile it 3D and detail any limitations

III. Investigate the accuracy of the Forest Bucker to determine sweep and wobble and defects such as knot size, machine damage.

IV. Prepare a time study on the operational cycles of the Forest Bucker system: Loading, Scan and optimize, and Unloading the stem from the stem-bed.and determine a reasonable production target (scanned stems in one day)

V. Do a direct/ in-direct comparison with a manual log maker grading stems and then with the forest bucker grading stems i.e. value recovery, grade recovery, and volumes

VI. Investigate the health and safety issues surround the forest bucker (pros and cons) as well as social, environmental, and financial impacts.

Section two data collection methodology

Study design

The study design is in the order in which I completed each segment.

- Assess the forest buckers system (software and hardware)
- Assess the forest buckers accuracy
- Assess the forest buckers portability (break down and set up)
- Asses the forest bucker performance in a simulated harvest format (conduct a time study to give an indication of daily production target)
- assess value recovery (comparison between manual and automated methods)
- asses any safety issues
- Record and report on the above.

Data collection

Data for this project was collected by direct observation using digital cameras and data sheets.

Section three: data processing and analysis

Data and information review

All data collected is as accurate as it can be, within reason and is appropriate to this research. There where however some limitations to this study they are

- Data collected on one operator only
- Data collected on one forest stand only
- No comparison with similar machines (i.e. The log Meister at Panpac)
- Only one market type

Further data collection

Further data was needed as a result of insufficient data when doing analysis on the value recovery aspect of this study. I was able to go from 15 stems to 20 stems then I had to leave one out of my final analysis as the log maker had made the logs from that stem out of spec so I ended up with a total of 19 stem in which to do my study with.

Data analysis and results

Investigate the ability and limits of the Forest Bucker system to be assembled in the forest at the harvesting site on sloped and/or uneven terrains. Quantify the limitations and discuss safety issues in this regard. Investigate the portability of the forest bucker.

I. The forest bucker takes between 2 and 3 days to break down and set up which is a weakness as this is to long and could create a bottle neck when moving to a different site or changing harvest settings.

II. The break down and set up of the forest bucker is as simple as it can be without comprising the strength of the system.

III. The system was design to handle uneven terrain and the trolley track and stem beds can be easily adjusted to cope with such terrain.

IV. The system can be transported from harvest area to harvest area on a flat deck tuck with a Hi ABB crane. It can also be done with a Ute and trailer between skid sites with a crane that has been made to attach to the tow bar of the Ute.

V. It is not recommended to set up or break down the forest bucker in wet conditions as the components are heavy and when wet it could easily result in an accident ending up in serious harm.

VI. The components of the system are heavy and should be treated as such a minimum of two people should handle these components, it should not be attempted by one person as doing so may lead to serious harm.

As you can see the system is portable but due to the weight of its components it can take 2 to 3 days to set up, however the system is currently undergoing further development to reduce this weight by half which should reduce the time to break down and set up by half and with time this time will also drop as a crew get used to the set up and break down of the system. It is my view that the end result will be one day to break down and set up.

Investigate the ability of the Forest Buckers software: 1) LGM (log grade manager) to switch or increase log grades and cut plans to accommodate new specifications and value priorities. 2) Investigate the pros and cons of profile it 3D and detail any limitations.

I. Both log grade manager and profile it 3D are simple to use with minimal training.

II. Both wirelessly feed information in to a SQL data base and the information can be easy accessed at any time by management staff.

III. Information from both applications can be used to make future predictions such as revenue on a similar harvest block.

IV. Log grade manager is manly for management staff to create and edit cut plans easily and then wirelessly send them to the crew it corresponds to.

V. Profile it 3D can be locked so that only an operator with an id and password my use, and his production information for the day can be viewed by management which will help them identify and fix any operator trends.

VI. Both applications can be integrated with existing in house software

VII. Information from the data base can be used to improve the effectiveness of a supply chain as you will know exactly what log stocks you have at crew using the system. No need for those crew to call in the log stocks twice a day.

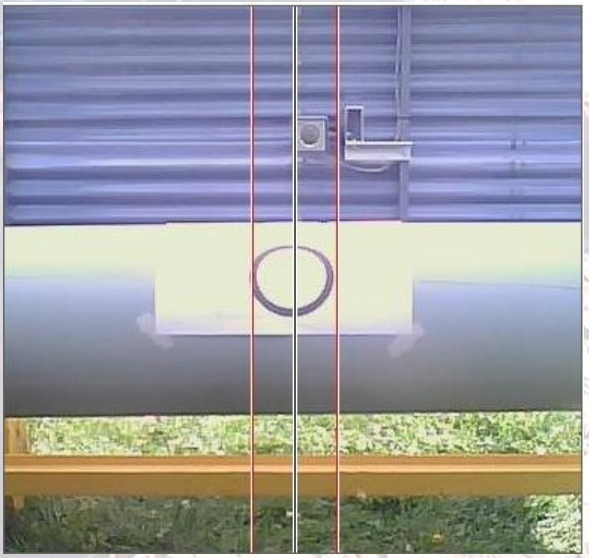
As you can see the software that comes with this system has the ability to make forest harvesting more efficient and the only limitations that I can see that there will be an need to train staff (management as well as operators) and that integration may take awhile, because when you integrate software with other software there will always be a few bug that will need to be fixed.

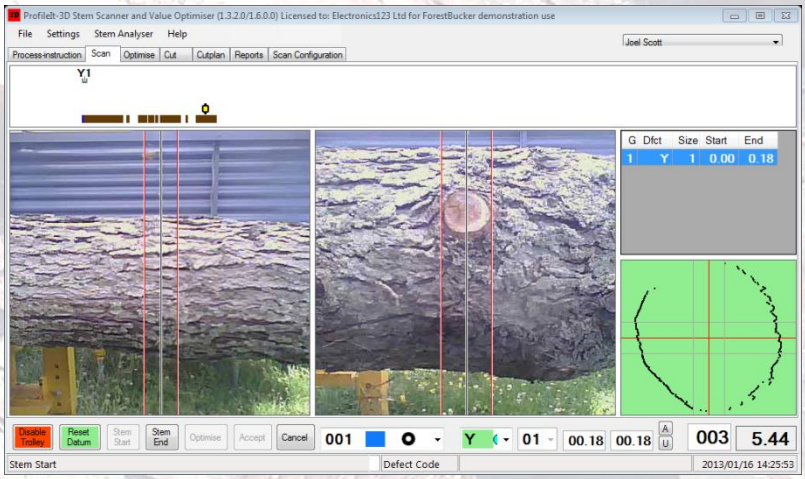
Investigate the accuracy of the Forest Bucker to determine sweep and wobble and defects such as knot size, machine damage.

The forest buckers scanning technology allows it to automatically scan sweep so to measure it accuracy two bricks were placed in opposite ends of a culvert pipe to simulate sweep. The pipe was then scanned. Next a piece of sting line was placed from one end to the other. I then paced a tape at the point where the gap was largest and took that reading which the forest bucker was between 6.1 to 6.2 cm of sweep measured 6.1 cm of sweep. In summary the forest bucker measures sweep very accurately.

When manually measuring sweep the tape measured 6.1-6.2 cm of sweep
The Forest Bucker scanned sweep at 6.1 cm.

The next step in this testing phase was to measure wobble but unfortunately there was no way we were able to simulate wobble to measure but with all the other results I am confident that it would of passed this stage as well. The final phase was to assess the accuracy of the forest bucker ability to scan knot size, however this is not done automatically as the technology for that is not available yet, so it is still reliant on an operator to assess, this has been made easier with the help of gauge lines which help the operator see what size the knot is by placing the knot inside two lines which are at known values in this case at 5 and 10 cm as you will be able to see in the picture below (the gauge line can be set to whatever interval that suits the harvest area). Steve made some simulated knots using auto cad software to ensure accuracy and then placed the simulated knots on the culvert pipes, one set of knots was at 5 cm and the other at 10 cm and when we re scanned the pipes you could see that the gauge lines were accurate. I also measured a knot on test stem that was available and scanned that as well. It to was clear to see what size the knot was and assign the right knot code. In summary the forest buckers ability to accurately scan knot sizes is only limited to operator error.





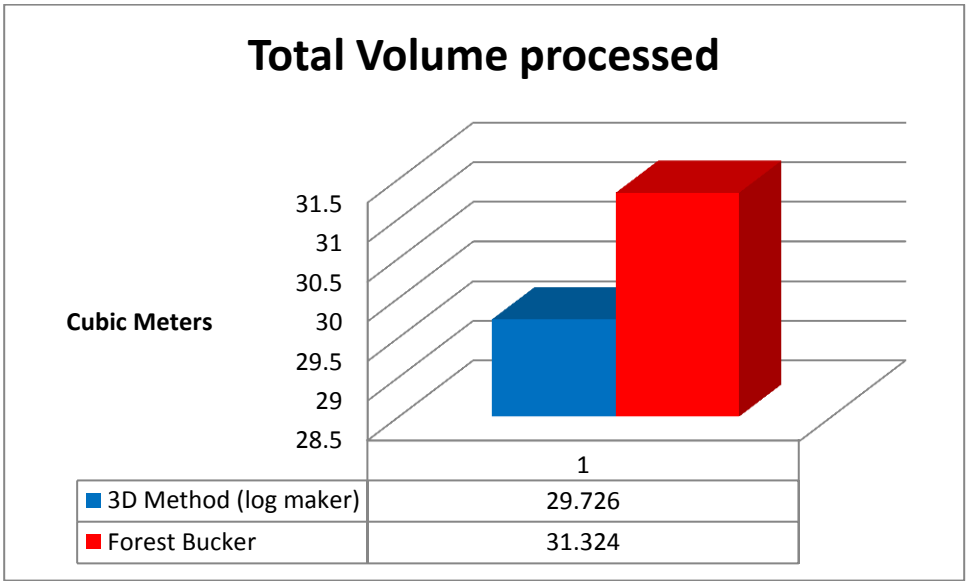
Prepare a time study on the operational cycles of the Forest Bucker system: Loading, Scan and optimize, and unloading the stem from the stem-bed. And determine a reasonable production target (scanned stems in one day)

Please refer to the appendices for the full results of the time study. In summary a reasonable target rate for the forest bucker is 200 stems per production day (piece size does not matter when it comes to the speed of scanning) which can range from 300 to 500 tons per production day.

Do a direct/ in-direct comparison with a manual log maker grading stems and then with the forest bucker grading stems i.e. value recovery, and volume recovery.

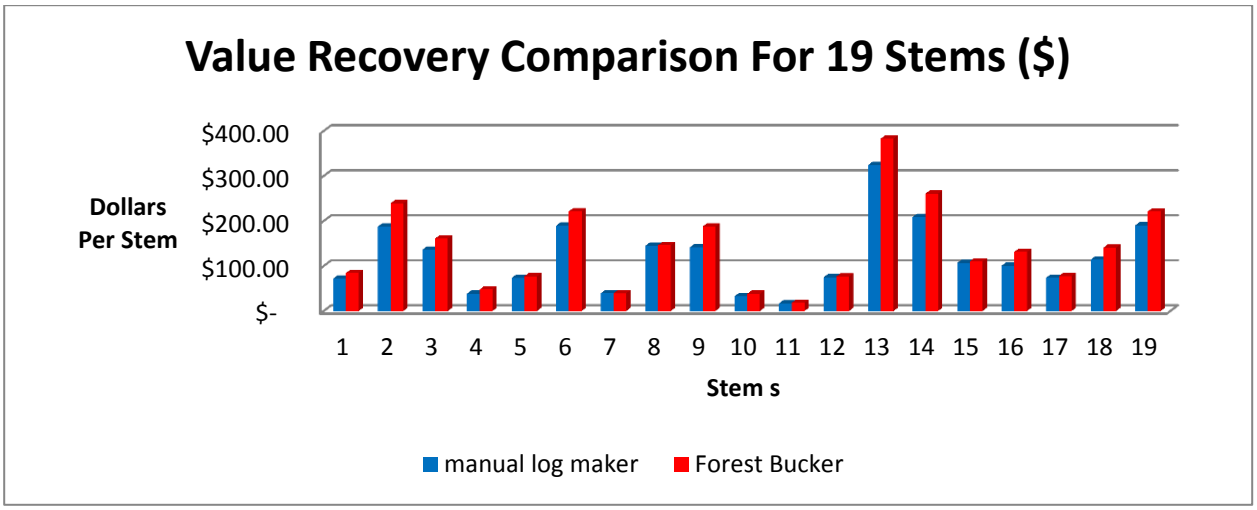
Volume recovery

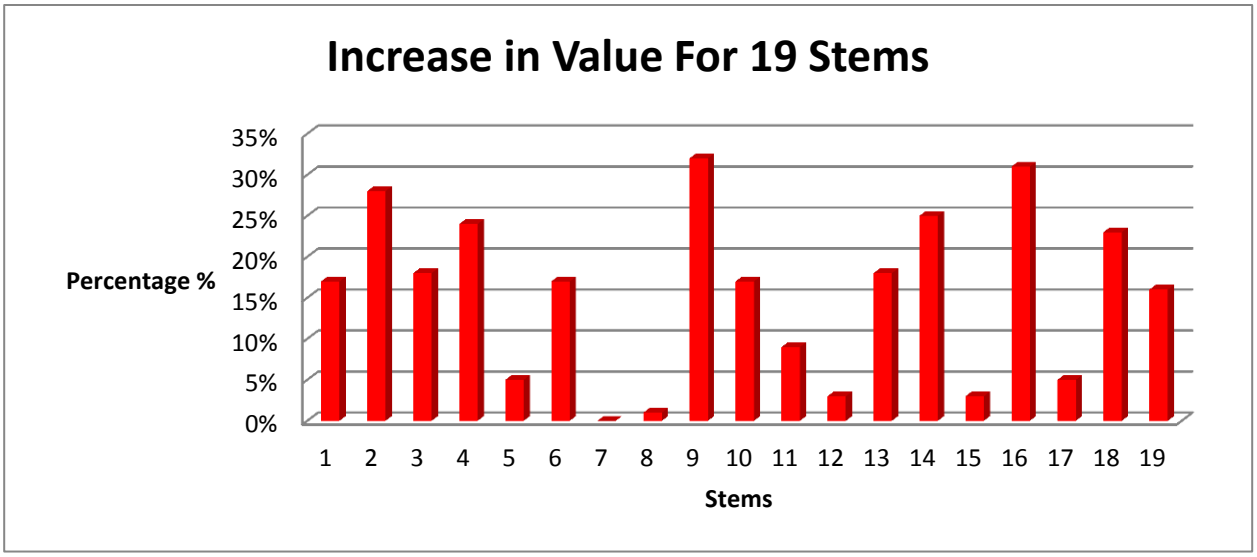
Before the stems were scanned by the forest bucker I followed the log maker as he graded the stem and recorded the LED and SED of each stem as well as the stem length.(the stem length was called out by the log maker and I took the LED and SED using the under bark 3D method) I then noted each grade the log marker marked. This then allowed me to apply the 3d formula to calculate the volume that the log maker had processed. This how they work out volumes when scaling at the ports except they use the JAS (Japanese Agricultural standard) method as that is what applies to their export requirements. The 3D formula is a more accurate means of working out volume (Log Scaling Guide for Exporters John C. Ellis, D. A. Elliott) and thus it was more appropriate for this type of study. Once the stems were scanned by the forest bucker which automatically works out the volume processed, there proved to be a difference between the total volumes, which isn't possible as they are the same stems and the total volumes should be the same. The difference was due to the inaccuracy of the 3D method and the accuracy of the forest buckers system.

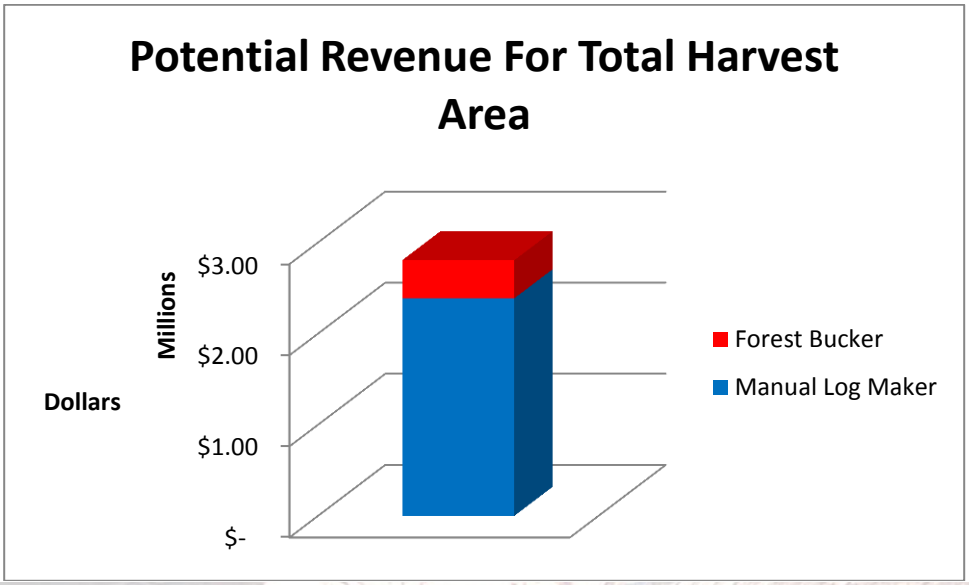


Value recovery

The forest bucker preformed exceptionally well in this aspect of the study. Over the page are some charts mapping out the results of my findings. The forest bucker achieved a 17% increase in added value over the log maker and as a result it showed the potential revenue for the block would increase by 17% percent and in this case it added a further $417,463.15 to the potential revenue.


Value Recovery Comparison For 19 Stems ($)
Dollars Per Stem
$400.00
$300.00
$200.00
$100.00
$-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Stem s
manual log maker
Forest Bucker


Increase in Value For 19 Stems
Percentage %
35%
30%
25%
20%
15%
10%
5%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Stems


Potential Revenue For Total Harvest Area
Dollars
Millions
$3.00
$2.00
$1.00
$-
Forest Bucker
Manual Log Maker

Statistical analysis

Paired T test

With assistance from professor Glen Murphy of Waiariki Institute of Technology I preformed a paired T test on my data to determine whether or not there was a significant statistical difference within the data and whether or not it the results I got were by chance, below is the results of the T test:

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*	
Mean	119.3924737	140.2657895	
Variance	5887.523497	8841.863037	
Observations	19	19	
Pearson Correlation	0.992898987		
Hypothesized Mean Difference	0		
df	18		
	-		
t Stat	4.539077329		
P(T<=t) one-tail	0.000127069		=1 in 10,000
t Critical one-tail	1.734063607		
P(T<=t) two-tail	0.000254138		
t Critical two-tail	2.10092204		

These results show that there was a significant difference in the data at the 95% confidence level. There was a 1 in 10,000 chance that the improvement in results with the forest bucker was by chance (as highlighted in yellow).

Section four: conclusions

Conclusion one, financial impacts:

1. As you can see full stem optimization with the forest bucker will improve value recovery, by how much will vary from site to site, in this case it was 17%.
2. After analyzing the results of this study it is clear to see that full stem optimization will improve forest value.
3. Further studies needed to analyze the cost that full stem optimization will have on production costs.
4. Studies suggest it is more economic to do a complete full scan than using partial scan or predictive methods.
5. Skids/landings would need to be configured with full stem optimization in mind so there is a potential cost.

Conclusion two, health and safety:

1. The Forest Bucker gives you the option to fully mechanize your harvesting operations by having all personal in cabs at all times and out of harm's way.

2. The forest buckers cabin can be up to a 100m away from where the system its self will be

3. The operator is less likely to take sick leave as he/she will be in a warm/cool cabin and not directly exposed to the elements.

4. Has the potential to make forestry as a whole a safer industry to work in, fewer fatalities.

Consistency of conclusions:

It is a well known fact that full mechanization will improve health and safety in forestry but it has only been in the last decade that technology has allowed this to become reality. Please refer to section six (Bibliography**)** for more information.

Section five: Recommendations

I. That more research into portable full stem optimization is carried out to help make the current and future systems quicker and accessible to more harvest areas.

II. That a production study is carried out to fully gauge the systems advantages and limitations on a harvest site.

III. A larger version of this study is done with a range of operators, harvest areas, and market types to acquire a base figure of improvement as it stands the figure is from 0 to 20% added forest value. some study suggest it may be possible to extract up 30%

Section six: References and bibliography

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Bibliography

Acknowledgments:

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Also thanks to Brent Donaldson, Kelvin Murdoch and Peter Myers of Hancock Forest Management for their ongoing support of this project and setting me up with a crew in which to conduct my study.

Big thanks to Peter Stephens and his crew for putting up with me and for the use of their machinery, time and harvesting expertise's of which without this study could not have happened.

And an extra special thanks to Mark Cleland, James Broadly, Trevor Gray and Ollie Kemp for their ongoing support over the last two years and for all your sound advice which saw this study really develop.

And thanks to Professor Glen Murphy for his knowledge on value Recovery and his help with statistical analysis.

Section seven: appendices

I. Raw data

II. harvest plan

III. Cut plan

IV. Time study