The Logmaister log merchandizer.

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Introduction.

The Logmaister system has now been operated for three and a half years by Pan Pac Forest Products Limited (Pan Pac) in Hawkes Bay, New Zealand. These years have seen an evolution of the system from in forest ground base settings to an in yard process where 60 feet and full length stems are trucked in to the system from five harvesting crews. The system has unearthed a number of ancillary benefits (reduced harvesting and landing costs; reduction in the number of in woods saw hands and log makers, significant fuel wood provision to the Pan Pac cogeneration plant) in addition to the expected benefits of increased log value recovery and better control of woodflow.

What is it?

The Logmaister is a mobile log merchandizing plant. It consists of a scanning cab mounted on rails and a log deck with kickers that provides optimized bucking solutions to excavator mounted processing heads. The system is bound together with software, a database, internet and wireless communication that allows value optimization of stems for maximum value recovery, remote download of cutplans, communication of the optimal log solution between the scanner cab and the cutting head, upload of production data to a remote server and access to data via web reports or direct interrogation of the database.

The Logmaister scanner

The system was designed with these broad specifications in mind; better log value recovery performance than the Timbertech[1], production targets of 200 stems per day (about 400m3 or 88 MBF[2]), mobility (disassemble, transport and reassemble within 24 hours) and an ability to fit within the space limitations of a "standard" ground based landing (150 by 250').

The system was born from the belief that emphasis on log value recovery was the primary motivation for a timberlands (stumpage) owner cutting down forests; that electronic optimization was vital for this to happen and although Timbertechs achieved this end they were highly reliant on trained operators who were increasingly in short supply. Another perspective around the system is that it combines the positives of mechanized harvesting (production and safety) with the benefits of optimization (increased revenue per tonne harvested). Usually these separate processes are seen as incompatible; mechanized processors will do the volume but are not as precise and accurate as manual bucking.

The Logmaister in a forest setting

The system was designed and built in Rotorua by Awdon Technologies Limited. Interpine Forestry Limited developed the database and reports for the system and Logjiztix Limited has developed the system beyond the released prototype.

The Pan Pac example.

Pan Pac (Pan Pacific Forest Industries) is an integrated forestry sector company operating in the North Island of New Zealand. They harvest 250,000 MBF of *Pinus radiata* logs/ year mostly from their own timberlands.

Pan Pac is the ninth largest timberlands owner in New Zealand and operates a large sawmill and a moderate sized

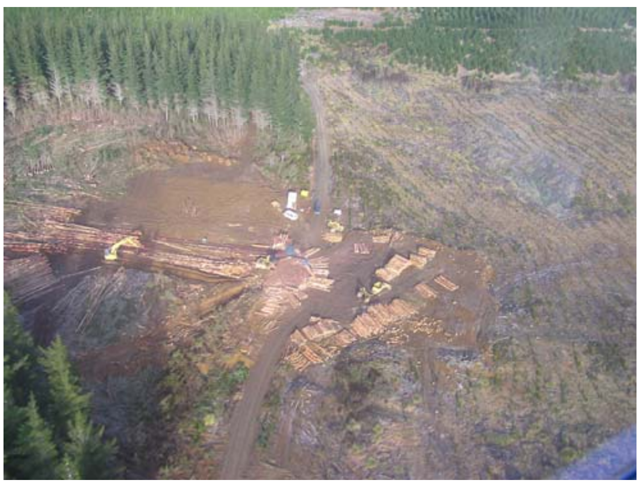
[1] The Timbertech is a hand held log optimizing caliper that had some success in NZ in the early 2000s.

[2] The conversions used here loosely follow Spelter (2002) and a factor of 4.63 is used to convert NZ metric volume to Scribbner.

pulp mill. The company is jointly owned by Oji Paper and Nippon Paper.

Panpac Whirinaki site, Hawkes Bay, NZ

Initial Logmaister trials at Pan Pac utilized the system "in woods". In these instances the Logmaister was integrated within existing harvesting crews operating in different forests. At the in forest sites full stem lengths were processed by the system.



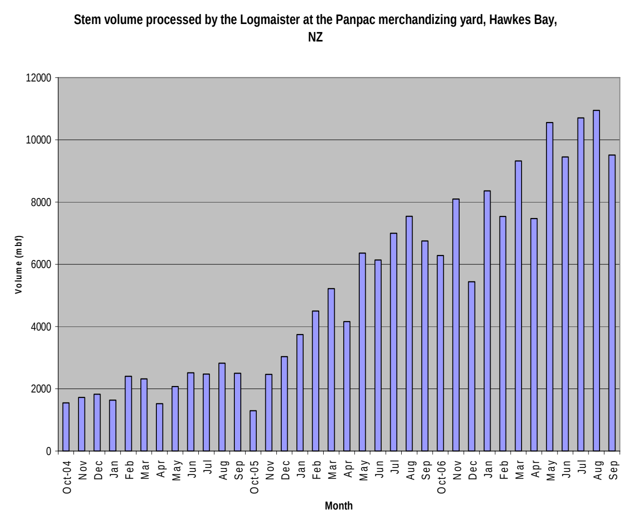
Logmaister in a forest setting.

From September 2004 the system has been operating predominantly at the Pan Pac log yard in Whirinaki, north of Napier. In this setting the majority of the stems processed have been from on highway carts at a maximum stem length of 60 feet. These stems have been interspersed with some full length stems from off highway carts. DG Glenn Logging Limited operators have manned the gear since it was moved to the Whirinaki site.

Significant gains in volume throughput have been achieved since October 2004 with the introduction of a dedicated excavator to load and unload the log deck, stem numbering to allow dephased operation of the processing head and the scanner bench, double shifting and, more recently, the introduction in 2006 of other processing heads that can accept optimized stem solutions from the scan bench.

Logmaister in a yard setting

The "standard' Pan Pac operation targets 2200 m^3 (475 MBF) of stems scanned, processed and fleeted every 24 hours, 5 days/ week. To achieve this two 9 hours shifts are run on the scanner bench and the processing head. Stems are loaded on to the scanner carriage by a third excavator and two wheeled loaders fleet and load logs from the stacks created by the processing heads.



Volume production at Panpac's log yard

In 2007, up to the end of September, piece size processed through the system average 2.67 m^3 (580 BF) and the greatest daily production since the onset of the two head system is 2708 m^3 (585 MBF). The average time to scan a stem, optimize and relay the solution to the processing heads is 35 seconds. In the period April 2004 to mid October 2007 the system has processed 900,000 m^3 (194,000 MBF) of stems and produced logs of approximately $63,000,000 value (NZD). Data such as this is readily available from standard reports.

Five extraction crews, one ground based and four haulers, supply the system with stems. Apparent to all, and backed by the intense accident reporting system that applies at Pan Pac, safety has significantly improved in the landing areas of the participating harvest crews. A graphic demonstration of the impact the system is having is the removal of staff from the high hazard situation of moving machinery, chainsaws and heavy logs on the forestry landings. They have been replaced by a much reduced workforce working in machines, fifteen minutes drive from Napier. Truck movements have reduced, harvest extraction rates have reduced, landing areas are smaller and the combined improvements to the Panpac supply chain justify the system alone without the principle benefit of increased log value. The Panpac target is to have 70% of their annual volume processed by the system in 2008.

Quality and performance monitoring.

The Logmaister system and the attendant changes to harvesting and trucking configuration represent large change for the forest owner and the workforce involved. It is critical that the system delivers and so it is being intensively scrutinized across a number of performance criteria. Downtime, causes of downtime, reject percentages, reasons for rejects and a host of other metrics are being quantified daily, weekly and monthly. A large proportion of this performance information is garnered from the system itself with additional data being logged and recorded by the system operators.

Some of the findings of this intense monitoring include: the scanner is not being operated at full capacity, double handling of wood/ stems slows the whole system down and the system (head and scanner) needs regular calibration.

Value recovery

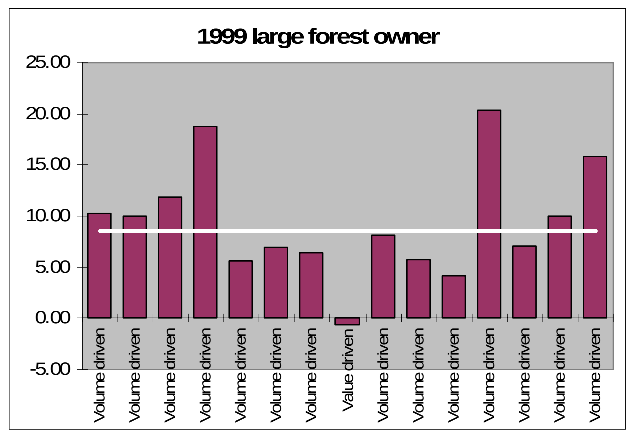
Electronic optimization and access to real time production data are the fundamental requirements for maximizing the log value from timberlands (presuming good log market breadth). The initial value recovery target of the Logmaister system has been met or bettered in the past two years. The simple value recovery target for Logjiztix is that optimized log making will deliver a minimum value recovery improvement of 10 % within *P. radiata* regions that have a broad suite of log markets. Simply put, a 10 % increase in log revenue.

Value recovery gains are difficult to measure. This is the major reason why forest managers focus on easy to measure indicators of supply chain performance such as harvest costs per tonne.

The target for value recovery is to convert standing trees to the highest possible log value. The start point for the measurement process is to describe the standing forest in terms of log grades and yields. Once done, through diligent inventory cruising and analysis, the test for the felling, extraction, bucking, loading, delivery and marketing processes thereafter is to match in delivered log sales the value that was represented in the standing forest. The attainment of this potential is simply described as the log value obtained in delivered form versus the value assessed in standing form, as a percentage or as a dollar/tonne difference.

Example 1.

In the second largest forest in New Zealand, harvesting supplier log production performance was compared with the pre harvest inventory information from individual blocks harvested by each supplier across a 12 month period. The "average" $/tonne performance of suppliers are compared. The centre "value driven" supplier centered his business model on extracting the maximum value from a standing forest through use of electronic optimization. His average performance indicated that he produced more log value from the forest than what the forest owner thought existed there. On average, this supplier delivered an additional $10 to the forest owner for every tonne of forest he harvested and manufactured in to logs.



Value recovery performance

Example 2.

While yard based in the Bay of Plenty in 2003, comparisons were made between the log output and value from the Logmaister system compared to in yard manual log makers.

In that comparison the Logmaister generated logs of 9.4% greater value than the logs produced from the same stems by manual logmakers.

Example 3.

In Hawkes Bay, the Logmaister initially operated in Mohaka forest. Value recovery performance against projected log grade (PHI) was carried out on a block where all production went through the Logmaister system.

Scanned log solutions from the Logmaister were of 7% greater value than inventory projections for the block using the same cutting instruction. The system generated more log value than the value that was assessed to be present in the forest.

Example 4.

In the two months that the system was operating in Kaweka Forest the scanner log solutions bettered the inventory data by 3.2 % across the course of the operations. Again, the system generated more value than the forest owner believed was standing in the forest.

Economics.

The Logjiztix vision is that value recovery underpins the whole economic base of harvesting forests and manufacturing and marketing logs. All other processes and operations need fit with value recovery principles. Logjiztix strongly subscribes to the policy of spending $5 to recover $10 and absolutely rejects the notion that "cheap" logging and trucking is a measure of supply chain performance where there is a range of markets and healthy competition for logs. The timberlands manager that is not measuring value recovery performance is selling his estate owner short.

The economic benefits of the Logmaister system vary as the setting for each operation is considered; for example the large scale volume benefits and economics for an integrated company like Pan Pac are different from that of a stumpage operator using the system.

Unit on an integrated site with cogeneration capacity. On highway cart of 18 m stems. Merchandising at the processing plant. (eg Pan Pac).

Direct economic benefits.

- Increased log revenue
- Reduced landing construction costs (smaller landings with minimal in forest log making).
- Reduced landing rehabilitation costs (minimal solid wood waste left in forest to deal with).
- Reduced transport rates (quicker loading, unloading and lower vehicle tare weights lead to more volume carted than conventional units).
- Reduction in harvest extraction and log load costs in forest (less loading excavators, minimal log stacks, minimal on site log making, less employees in forest).

In forest 18m stem loading. Reduced landing requirement.

Indirect benefits.

- Safer (less people on landings in forest).
- Cleaner work environment.
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Direct economic costs

- System costs (one off capital cost, database and software licenses).
- Back carts (carting stems to a processing site and then sending logs to market past the forest they have come from).
- Double handling (a stem load and unload cycle is entered into the merchandising process)

Indirect costs.

- Unemployment of skid workers.

Reliability and back up.

The system takes a physical pounding from the production demands and the large piece size of the Pan Pac set up. Since January 2006 the system had been down due to malfunction for three days when a hydraulic fault took a lot of time to diagnose and repair. The development of additional capacity (a standard processing head that accepts optimized stem solutions) rapidly followed after that hiccup. As with other machinery the Logmaister gear suffers a normal cycle of wear and tear of hydraulic hoses, pins, bushes etc. The head has required more repair and maintenance than the scanner bench although the scanner bench has a wider variety of specialized and custom components.

Road legal stems. No pilot vehicle required.

Reporting

If the heart of the system is the optimizing software, reports and the data gathered from the system are the eyes. Any effective value recovery system has to provide real measurement of production and value gain within 24 hours.

Data is provided to managers and contractors in a number of formats. Standardized reports are available from a website. Information provided here includes daily production, grade mix, value recovery etc from a range of conditional fields (date, strata, forest etc). Data from these reports are downloadable in Excel format.

For serious users, direct access to the SQL database is provided. This enables tailored pivot table extraction and report development.

Support and analytical tools.

A number of tools are available to managers and users to interrogate and prepare data for the system. These include:

- A cutplan generator
- A "what-if" analyzer
- A "single stem" analyzer
- A "why not" analyzer

The first three of these tools are desktop mounted and are available to any of the managers and technicians within the data loop. The cutplan generator enables operators and managers to "tweak" a cutplan once it has been submitted by the woodflow coordinator without downloading a new cutplan. The cutplan generator allows the operator to read and print a cutplan in flat file format.

What if is a particularly useful tool that enables forest owners to alter grade specifications and cutplans to allow comparisons across a virtual forest (from the stem data collected and stored in the database). To activate and populate the *what if* tool the manager extracts cutplans and select stems from the database via an internet connection and simple extraction software that has been developed.

The single *stem analyzer* allows mangers and technicians to download and recover individual stem data and solutions for analysis and interrogation. This is a particularly useful trouble shooting tool.

Why not is a feature of the scanner bench software that allows operators to challenge the log grade solution that the optimizer has proposed. The operator suggests alternative grades to be made and the software will highlight the reasons why the operator grade was not preferred.

Scanning.

The scanner cab travels parallel to the log bed and creates a two dimensional picture on a display screen of the stem profile. The operator, via joysticks, inputs branch size zones and defects as he travels up the stem. Length position of the stem profile and position of defects are recorded by rotary encoders in contact with the guide rail underneath the scanner cab.

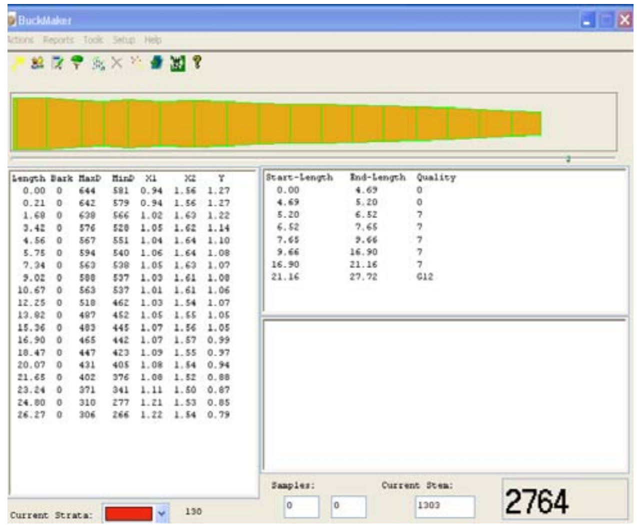
Scanner bed and log cradle in a yard setting. Secondary machine loading and unloading cradle. Logmaister processing head in background.

The stem profile is built on the LCD screen as the operator travels the length of the stem. Frequency of diameter generation is determined by the speed of cab travel and the cycle loop for the computer system to gather sufficient scanner sample points and complete the diameter picture.

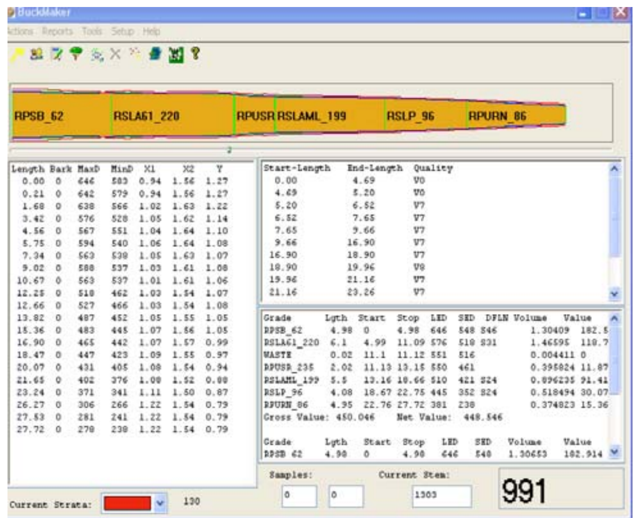
Once the stem has been scanned, the operator presses "optimize" and the system integrates the features of the stem with the grade specifications, the cutting instruction and the relative value of each grade to produce the most valuable log solution for that stem.

The operator is presented with the grade solution, the log parameters, the stem value and the qualities that have been called. He then has the opportunity to return down the stem and correct any of the parameters (eg add diameters, delete diameters, change branch size) and reoptimize. Once happy with the log solutions he then "sends" the stem solution to the processing head.

Each stem solution is appended to an output file that is uploaded to the remote database (via the internet) within seconds.



Developing the stem profile.



Optimized stem.

Processing

The processing head excavator receives each uniquely identified stem file (the machines are wirelessly networked) and these are available in a drop down list on the excavator's computer screen. After choosing the appropriate stem from the list the stem solution appears on the screen and the operator drives the stem through to the first cut point. As the machine is cutting the stem the operator slews the excavator so that the log cut falls into the fleeting zone for that log grade type. Once each stem is processed log details are added to an output file for upload to the database.

The head in a yard setting. Scanner cab in background.

System layout

A critical requirement of the system at the outset was portability and ease of integration into existing forest landing infrastructure. The system has now been operated in two separate log yards and 7 forest landings. In each of the forest landings minimal or no landing adjustments were made to accommodate the system. In each of these sites the gear was disassembled, transported and reassembled within a 24 hour period.

In yard settings, flow of stems in and logs out drive the location of the bench and the processing head(s); as does available space of course.

Outstanding issues/ enhancements.

Wood mixing. It is quite critical for yard storage efficiency and access to third party wood that the volume calculations of the system are accurate. Cubic measurement of stems through and logs from the system has to be auditable and verifiable. Critical to success here is the accuracy with which bark depth is estimated on the scanned stems. Successful scale measurement from the system is dependant on sound assumptions about bark thickness (scale volume is measured under bark while scanned stems are a mixture of bark on, bark off).

The system promises much in reducing the assumptions (and potential cost to either the forest owner or the processor) of conversion factors as every stem processed and every log produced now has individual scale volume.

Bark removal. The volume of stems handled through the system leads to large bark build up around the stem cradle. Excessive bark can affect the scanner's ability to accurately portray diameters and interfere with the movement of the scanning cab. To ameliorate this scanner rails and cradle were raised one meter above ground level to make removal of bark easier. However bark removal is still at the low level of sophistication (shovel power).

***Head performance*.** The Logmaister head was designed to be light enough to be fitted on to a 25 tonne excavator (affordability) and with four capabilities in mind; stem loading, processing, stacking and truck loading. Processing is the main requirement of the head and length accuracy is critical to the success of the system. It is commonly held, in New Zealand *P. radiata*, that log length measurement on processing heads is mediocre at best. The twin encoder system of the Logmaister head was designed to better this standard of performance. However, the length measurement performance of the initial head is not startling and is average at best. The original Logmaister head has now been replaced by heavier duty conventional heads (Waratahs).

***Internode*.** Pan Pac is particularly keen to have the system produce internode logs (USA shop grades). While these logs can be currently produced by the system, the process of calling internode from the scanner bench is slow. A new software module is being developed that will speed internode calling and allow the optimizer to still make best value decisions without major compromise of productivity.

***Other processing head integration*.** Software modules have been developed that allow third party processing heads to "talk" to the scanner bench.. The only limit on producing optimal logs is the length and cutting precision of the third party head. This represents quite a breakthrough for the system; no longer is a smaller operator compelled to buy a specialised processing head to make the system work.

***Stiffness testing*.** The Logmaister software and grade specifications have been designed with a log prescription limit on stem stiffness. It is certainly considered feasible, at moderate cost, to introduce stiffness (sonic) technology in to the system.

Conclusion.

The Logmaister system is the most significant mechanical forestry development for New Zealand since the development of Waratah processing heads. The appeal of the system stretches beyond New Zealand and *P. radiata*; there is Australian interest in the system for use with *Eucalyptus.*

The Logmaister system has achieved, in some instances spectacularly exceeded, the performance targets the owners had in mind when they commissioned the build of the system in 2002. That this has occurred at a time in New Zealand of reduced harvest, depressed log prices and forest ownership instability is testimony to the perseverance and belief of a handful of people.

The Logmaister system revolutionizes the way in which log merchandising occurs in New Zealand. The system will dephase log extraction and log manufacture to contractor and forest owner benefit. The contractor can concentrate on log extraction; the forest (or stumpage) owner can control the critical merchandising decisions that have huge impact on the log revenue generated.

The post prototype phase promises to be an interesting one as the wider implications and benefits of the system are communicated.

Acknowledgements.

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