J. W. GOTTSTEIN MEMORIAL TRUST FUND

The National Educational Trust of the Australian Forest Products Industries

COMPUTER-CONTOLLED OPTIMISATION IN CUT-TO-LENGTH HARVESTING SYSTEMS AND ASSOCIATED DATA FLOWS

JIM PRIDDLE

2005 GOTTSTEIN FELLOWSHIP REPORT

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Joseph William Gottstein Memorial Trust Fund

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national educational Trust for the benefit of Australia's forest products industries. The purpose of the fund is *"to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products."*

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organization (CSIRO) when tragically he was killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are:

1. Fellowships and Awards - each year applications are invited from eligible candidates to submit a study programme in an area considered of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their programme. These are then distributed to industry if appropriate. Skill Advancement Awards recognise the potential of persons working in the industry to improve their work skills and so advance their career prospects. It takes the form of a monetary grant.

2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.

3. Wood Science Courses - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.

Further information may be obtained by writing to:
The Secretary
J.W. Gottstein Memorial Trust Fund
Private Bag 10
Clayton South VIC 3169
Australia

Jim Priddle from Green Triangle Forest Products Limited has worked in the forest industry since leaving high school. He has completed the Advanced Forestry Certificate developed in Mt Gambier especially for the radiata pine industry. He has been involved with growing and measuring forests and currently combines nursery management with technical duties. In his time in forestry has witnessed the introduction of mechanical harvesting and the reduction of people involved in the industry.

The technical work has involved establishing and measuring progeny trials and has shifted if focus in later years to organising the fieldwork for wood quality and harvesting trials. The change of focus is the result of wanting to see the forests established from plants grown in the past to achieve the best possible utilisation. He welcomes the introduction of machinery that is able to optimise the value of the products harvested as something that was long overdue from a pure forestry perspective.

ACKNOWLEDGEMENTS

This study tour was kindly funded by the J.W.Gottstein Trust Fund, with some assistance from Green Triangle Forest Products and I thank them for this and the opportunity to undertake this study.

I would also like to acknowledge Simon Shackleton and Rick Murphy for not only their assistance in organising part of the visits, but for their introduction to the subject initially.

I am extremely grateful to all the organisations that I visited and for their interest, cooperation and hospitality that I could complete this study.

I would also like to acknowledge the support of my employer, Green Triangle Forest Products for their support and interest especially Laurie Hein and Andrew Moore for their ongoing support and assistance.

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1 Executive Summary

Machine optimisation and data collection is a routine part of Scandinavian harvesting without which much of the planning and efficiency could not be achieved. The process of placing values on logs is the method used to ensure that the processing facilities receive the range of lengths and diameters that they require to fill orders from their sales section. These values are determined by the processing facility and passed on to the harvesting section, along with requested amounts, where they are put into a cutting instruction, simulated to determine the planned outcome and then passed onto the contractor to cut the forest. The actual result is sent back to the harvesting section so that any adjustments can be made and arrangements made to transport the logs to the processor that placed the order.

The value of the forest is increased by filling the orders taken. These orders can originate from the end user and are driven by the need to eliminate waste in the finished products. A premium is paid for logs cut to the customers specification which allows for a reduction in log and more particularly sawn stocks. Tight specifications and size tolerances are placed on orders and these are passed from sales, along the chain to the processor. The processor can then optimise the diameters needed to produce the best recovery and required product allowing a real value to be put on each length and diameter combination. These values or relative values are then used by the harvesting manager to compile a cutting instruction for the contractor that will produce the log assortment required. All orders are aggregated along with log values and this allows the contractor to cut for many customers at once which optimises the value of the forest.

While processing the stems the machine is able to store the stem and log data in many forms. The most used format is the production file that separates the material into the orders or assortments that have been put into the cutting instruction. This enables all parties to track the actual cut compared with the required cut and adjust the log values in the cutting instruction or the distribution percentages as necessary to align the two.

It is not always possible to achieve full log requirements from any one area being harvested. With data collected from all operations there can be adjustments made so that all the orders

are filled to the customer's satisfaction. Third generation systems are capable of further increasing the value of the forest, both in terms of optimisation of which forest is cut, along with improved use, less resource being needed to achieve the required volumes. These remaining trees give added value to the forest owner when they are cut down.
Additional data collected by the machine can be used by the contractor to optimise the machine in terms of time and repair availability, fuel usage, trouble shooting, operator productivity and to track actual costs to simplify future tendering. The forest owner can also use stem data to simulate production and manipulate the cutting instruction to return the best result for them. It allows negotiating of harvest rates to be a more open and informed process.

2 Objectives

There has been ongoing development of harvesting machinery to the stage where third generation machinery is becoming available in Australia. These third generation systems uses PC computers to optimise the value of the stem and in so doing, they can increase the returns to all sectors involved in growing and processing. There has been misinformation about the benefits to the forest grower of these systems in Australia resulting in some reluctance to consider their application.

It was proposed to use the J.W. Gottstein fellowship to travel to Scandinavia to:

- Learn about the introduction of this technology and use in Sweden and Finland.
- Gain an understanding of the requirements for the introduction of these systems.
- Note the methods employed to ensure that all parties are satisfied with the results.
- Visit both industry bodies and development companies such as Skogforsk and CC Systems that has been involved in the development of these systems and monitor their performance.
- Investigate and learn what operators skill levels are required to use these systems to their full capabilities.
- Discussions will be held with contractors who buy and use these systems on a daily basis to learn of the benefits to their business.
- Discussions will also be held with industry bodies to gain an understanding of who in the industry is the driving and controlling force in making these latest systems mandatory in these areas. In these talks I will gain an understanding of the data flows

and requirements used to benefit the optimisation within industry as a whole. The types and form of data that is transferred between the relevant sections of the industry and the methods employed for transfer and the perceived "ownership" of this data are other topics to be researched.

- Manufacturers of both machinery and systems will be visited to obtain an appreciation of their development, their future direction and to fully understand how the requirements of industry are being turned into reality.
- This research report describes to industry the benefits of this technology and the possible requirements for introducing it into Australia. An appreciation of its development and introduction in Scandinavia will ease its introduction to Australia.

3 Introduction

The introduction of harvesting machinery into Australia has been a long process, partly driven by the need to reduce the reliance on motor manual harvesting and its associated dangers and costs. Mechanisation was also driven by the reduction in numbers of available people for this type of work. There was a local progression of machinery that was able to do some parts of the task until in the early 1980's when machinery was imported from Sweden to undertake thinning operations. Initially mechanisation was not favourably viewed, with much opposition in the industry on the basis of a loss of jobs and reduction in quality of material harvested in the forest.

Slowly these concerns were overcome and machinery improved to the extent that the only limiting factor was the size of the trees to be harvested, and this hurdle was solved and machines were introduced into clear-cutting in early 1990's. During the development path there has always been an issue with length and diameter measurement and the need for more accuracy in these areas. This problem has been in a large part solved as today only small percentages of logs are out of specification.

During the same period of forest mechanisation, sawmills and computers were also improving to the degree that sawmills were able to use computers to generate better solutions for cutting logs and returning higher lumber recovery. Computers could be installed in dry stable environments in sawmills and the improvements continued to the degree that mills began to

be able to match logs of certain diameters to products and maximise returns or “Optimise”. These developments then led to sawmills then seeking to purchase a range of logs that would best suit the markets that each mill was targeting, which led to them beginning to specify the diameters and lengths from the forest.

The development of harvesting machinery was slower than in the sawmill with the need for rugged, simple and robust machines that could cut the lengths required and de-limb and measure diameter to near specification. There was a reluctance to put too much technology into machines as it was seen as being a potential weak point and could reduce production if it was unreliable. This meant that the operator needed to make all or most of the decisions required, with the sensors measuring only the diameter and length. As computers improved it was possible to begin to program set lengths into the system, but still provide the capability that the operator could accept or over-ride. The information gathered had gone from stem count to log count and then a measure of volume in the various lengths that could be printed out, but could not distinguish between products of the same length. This is the stage that we have in Australia, and have had for the last 5 to 7 years.

During this time the major manufacturers in the Scandinavian countries had been developing systems that have made it possible to “optimise” according to the required distribution of products. These systems became available in the early 1990’s and were capable of collecting production data, stem files and other data that could be stored onto a memory card and retrieved and printed out as required. Initially computers used were generally DOS driven and limited in their storage capacity and decision making ability. As computers rapidly developed so to did their use in all facets of the industry, and as they became more robust they were used more and more in non-traditional uses such as Military and Forestry.

4 Development of optimising technology

4.1 Protocols

Development in Sweden began with each manufacturer developing a file system unique to their machines. The forest industry in Sweden at the time could see that the information that was being generated from these machines was of benefit to all parties in the industry, but the

different protocols being used made the information very hard to use and require parties to have numerous changing systems to interpret the data. Developers held a meeting and made the decision to standardise the file format and protocols used in harvesting machines so that regardless of the "brand name" the data could be transferred and used by all parties. This decision was made in 1987 in Sweden with Skogforsk being commissioned to co-ordinate the standardisation. Skogforsk is a research organisation funded by the forestry companies and the Swedish government.

The harmonisation process took two years to complete and was named StanforD (Standard for Forest Data and Communications) was implemented in 1989. All of the parties involved in forest and forest related industries have subsequently adopted these file protocols and were soon joined by Finland, the other major forest machine manufacturing country. The protocol is now used throughout Europe and has also incorporated some German features. Two meetings a year are held to discuss new initiatives and maintenance and improvements to the system are agreed. The secretary of the StanforD committee is John Arlinger and this task is thought to take up 50% of his time. Representatives are from all parts of the forest industry, including the manufacturers. All meetings are conducted in English.

The reasons for standardising were: -

- To reduce the cost of development and maintenance of systems
- To balance the advantages of machine system versus independent system
- Freedom for forest companies / contractors to buy from any machinery company
- To cover temporary machines coming into an area
- A larger and more open market for the product

This agreement allowed manufacturers to concentrate on developing systems that would deliver the needs of the purchasers. It also creates an open forum and a means by which each brand of machine can be compared against an agreed standard.

All the above reasons would be equally applicable to our Australian industry situation.

There were originally 17 file types and these are being added to as there is a need have a standard format.

The current file types are:-

- CMB Combination file of some of the file types below eg STM and PRD
- APT These are cutting instructions that include price, distribution and limitation matrices that the harvester uses to maximise the value of each stem. Colour marking option is included to identify assortments.
- PRD Production file. The products cut are reported in assortments in number and volumes required.
- TID Time follow-up
- OAI Location details so that area, year and compartment details can be identified so that Forest Stewardship Council requirements are met.
- DRF Operations follow-up
- KAL Calibration of length and diameter
- MAS Machine variables, feed speed, roller pressure etc unique to each operator.
- AVS Instruction for bucking to taper
- REP Repairs follow-up
- PRI These are independent log data files that can be combined into PRD or STM files
- STM Stem values – measured length and diameter values
- STI Stem ID sent from merchandising computer to digital callipers or data logger to facilitate identification of control stems
- KTR Control measurements sent from digital callipers or data logger to merchandising computer and then on to office computer
- PSU Summed production file
- HKS Production variables (for Germany)
- INV Inventory variables- DBH and height etc
- GHD GIS/GPS data
- PRL Forwarder files to give pile information on species, weight and calculated volume and location for transport.

Current projects under consideration are the Operation Monitoring files to standardise requirements so that all machines and companies use the same criteria. This means that machines can then be compared across brands and companies with confidence. GIS data is also currently under review. There is also ongoing work with bark parameters to make volume measurement more accurate. There is also a file for use with forwarders to track the logs to the roadside.

4.2 Software

The StanforD format has been used by all software engineers to develop machine systems and support software. Companies such as CC Systems, DASA, and Mitron have written programs that allow their machines to use and produce the outputs in the required formats. Some manufacturers also produce software for their particular machines which follows the standard form but also enables them to manage and interpret the output from harvesting and machine performance. These companies can be divided into two main groups, the harvester manufacturers and the companies that build control systems to suit one or more of the different types of harvesting heads that can be fitted to the widely varying types of carriers.

CC Systems began in 1991 and it focussed on automation and optimisation in rough conditions, an integral part of harvester development. They saw the harvesting machine as the centre of the industry, as the link between growers and processors and therefore it was essential that it was capable of filling the needs of all parties. CC Systems have developed SilviA, a system used to produce APT files and read and define production files. John Deere use SilviA in their T300 system and it is included in Timber Office, a monitoring program that can be utilised by forest, contracting and processing companies to monitor all file types. SilviA comes in many formats and levels and as SilviA sim package is capable of using stem files to simulate production, an important optimisation tool for forest owners for the creation of the APT (aptering – crosscutting) files. They have also developed Virtual Forest making it possible to simulate a forest from available data and test various bucking strategies.
The other main manufacturers also have systems that they use to complete these functions. Komatsu have their Valmet Maxi Manager, Ponsse have developed “OPTI 4G”, Mitron have “motomit” IT and PC and DASA have their “dasa 4” system. All of these systems are capable

of providing the outputs that the industry requires. The systems are being constantly updated as required by industry and agreed at the bi-annual StanforD meetings.

4.3 Optimisation

The combined development of protocols, software and harvesting machines has meant it is possible to predict the merchantable stem from initial data as the harvester cuts the tree from the stump. The diameter at breast height over bark (DBHob) is used in conjunction with a stem taper from a data base of previous stems to predict the height and taper factor of the current stem being processed. The length of stem that has to pass through the measuring sensors before prediction also varies, as can the forward predicted length. The forward prediction needs to be twice the longest log length to be more productive and the more logs in the stem the better the system works. When it is initially supplied the computer on a new machine already has some stem data but it needs to process some stems to fine tune the prediction. The more stems it processes the more its “adaptive” properties give more accurate predictions. The ability to save this stem prognosis (prediction) is a particular feature of the Timbermatic 300 system.

4.4 APT File (Cutting instruction)

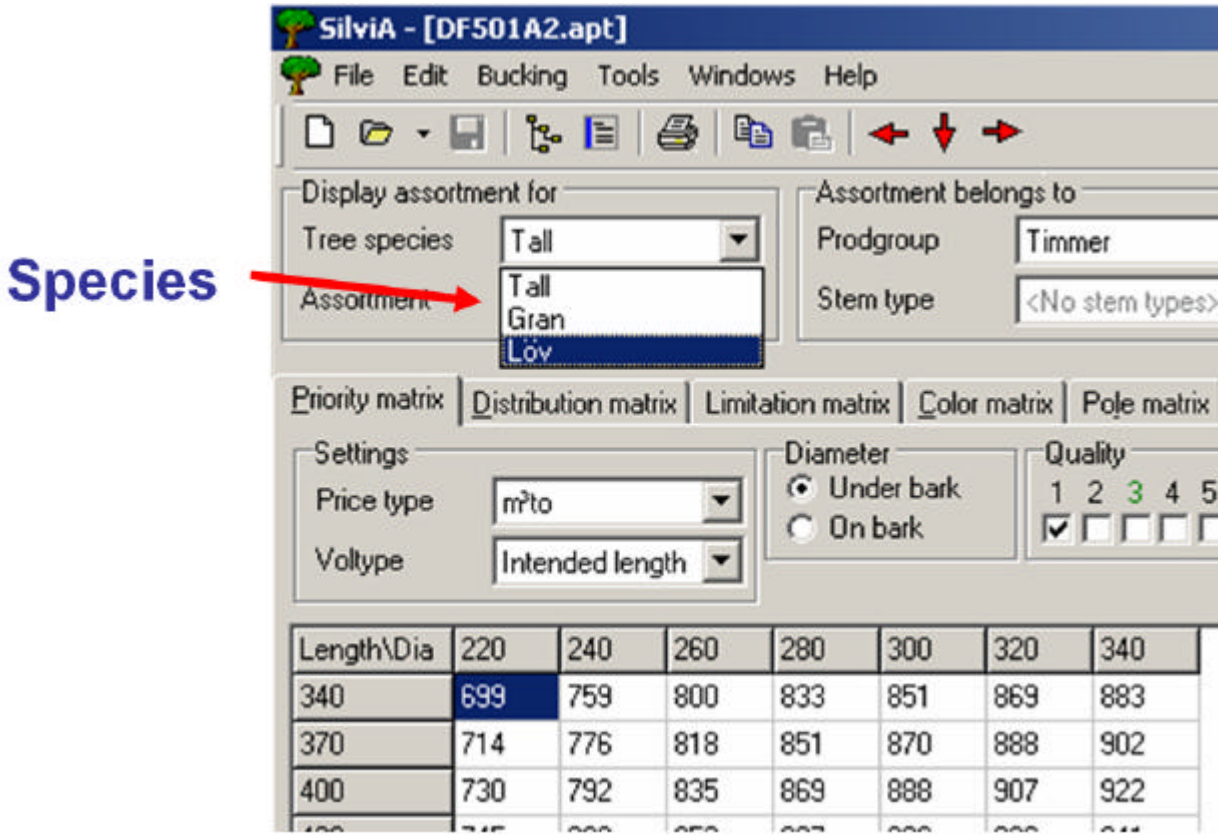
The key to the computer being able to convert the stems into the most valuable and required products is the APT file which is normally created by the forest company with input from customers.

The main elements of the APT file are:-

- Species,
- Assortment (Customer),
- Priority (the range of lengths, diameters and values) all of which are further defined by
- Distribution
- Limitation matrices.

See Fig 1 and 2

Figure 1: Typical Three Species and Priority Matrix

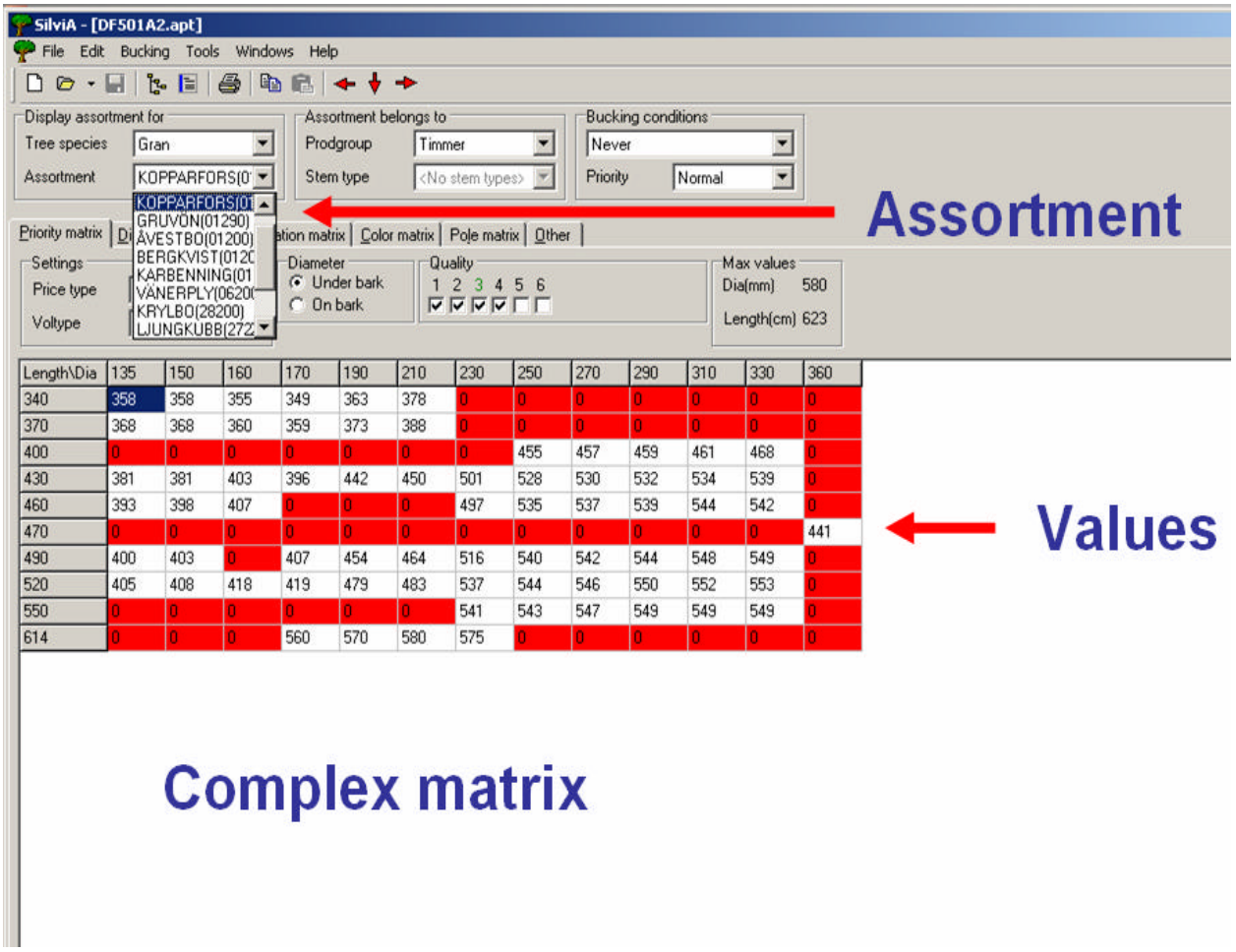


Species in Figure 1 are Tall = Pine, Gran = Spruce and Lov = Birch. The required Quality is 1 with the diameter and lengths shown in the priority matrix.

The operator needs only to enter the species and stem quality (eg. branch size, sweep) of the current stem section going through the processing head. The computer collects data and stores it in discs of varying capacities into the stem file which is used in future predictions. Older systems, with limited memory, used the last 10 stems for the prediction of the current stem, but this number can be 5 to 50 or more stems of that diameter, weighted towards the last stem of that diameter to better reflect the current stem being harvested in order to arrive at an average for the prediction. The prediction and selection of product to be cut will change if the predicted diameter varies by a selectable range (+/-2 cm) or the quality changes.

There are other decisions to be made when products are cut to maximise value as well as recovery. The distribution of log diameters and lengths that can be profitably used is another critical aspect that can be entered into the optimising system to ensure that customers receive the products they specify. Balancing recovery with product specification is an issue that can sometimes cause conflict in returns from the forest where different parties are involved. But typically the system allows issues to be minimised by the collection of stem files and the simulation of differing cutting strategies to balance the less than optimal orders that could arise.

Figure 2: APT file showing the assortments included and priority matrix for the blue highlighted customer. Red areas are diameters and lengths not required by this customer



4.5 PRD (Production) File

The on-board computer stores details of all products cut into a production file (PRD) and this can be used to determine if the forest is able to meet the predictions made from inventory and

current orders. There has been research on pricing the stem on the actual volumes of each product, so that the forest owner is not losing value as a result of a processor making compromises that decrease the value of the forest. This is currently an issue in Scandinavia, which has large numbers of small forest owners and the parcel size and location can compromise the value prediction to improve recovery.

Fig 3 is an example of some of the available production data and the forms it can take. The file comprises of a table format or graphical depiction. The table format can be exported into Excel if required or into other products, such as Timber Centre within Timber Office, to be totalled with all the other production files from all contractors to give daily, weekly or monthly reports as required. The PRD file contains links to the APT file that was used to cut the forest and all control measurement and calibration information that is relevant to that production. This information is used to ensure that the required cutting instruction was used and that the machine has been calibrated as necessary. See Figure 3B.

Figure 3A PRD file showing both formats available

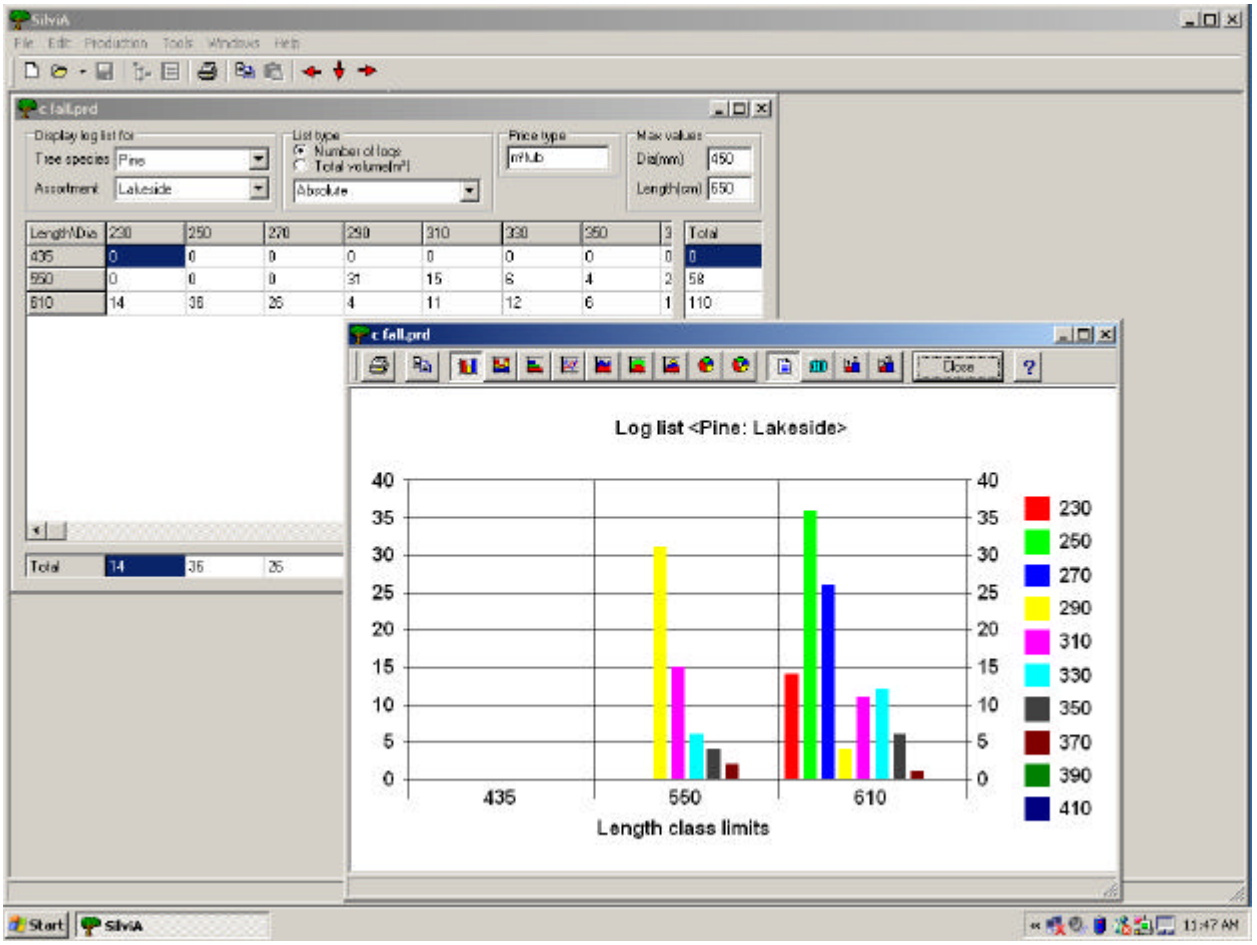
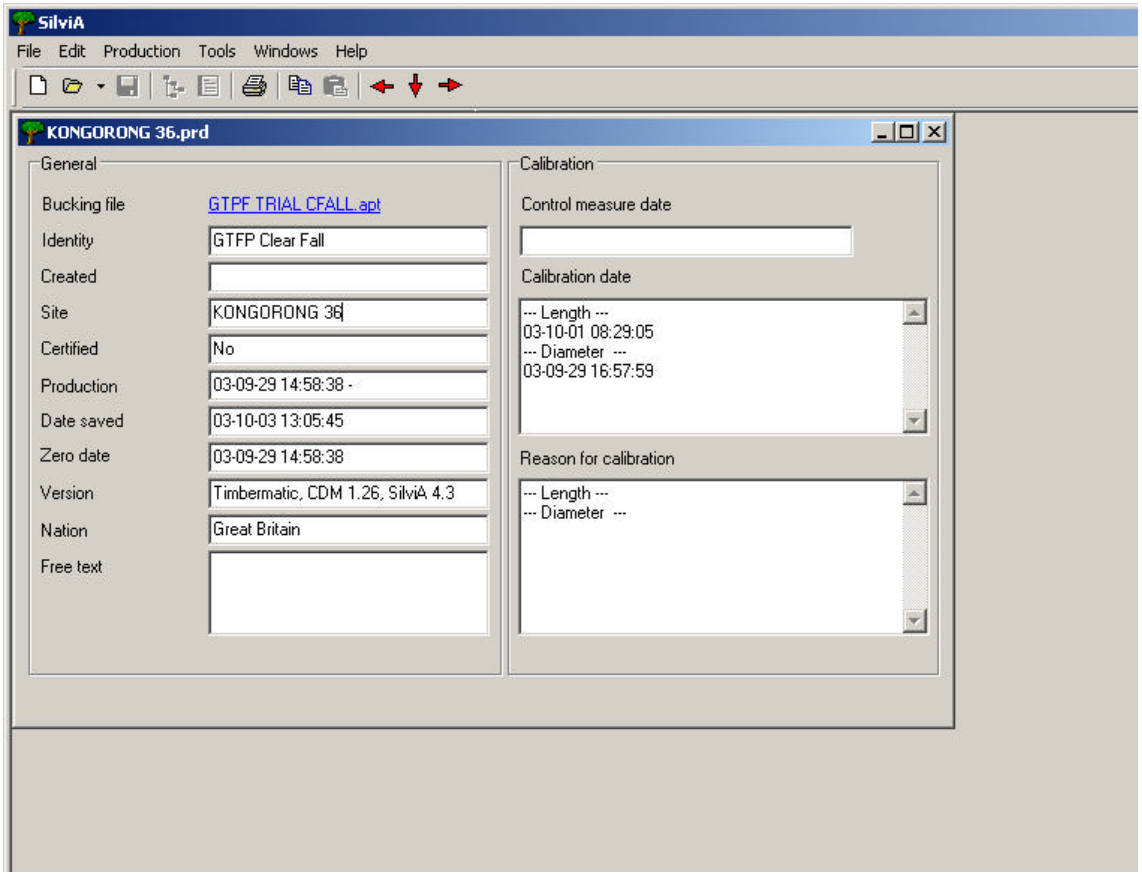


Figure 3B: PRD file showing Location, APT link and Calibration dates etc.



5 Some applications

5.1 Swedish and Finnish forest Industries

Sweden is a small country of 8 million people with large forest holdings with fifty two percent of the total area of forest being owned by private individuals with the rest shared evenly between Public and private companies. The timber industry has a large influence on the economy given an annual cut of 75 million cubic meters per annum. Finland, which has 5 million people has an equally large forest holding, with a greater percentage of sixty one percent being owned by private individuals and the total annual cut is 56 million cubic metres. The scale of operations in both these countries was responsible for the development of firstly the data production followed closely by individual stem optimisation.

The climate makes it necessary to harvest and extract a large percentage of logs in the winter when the frozen ground allows machinery to access the swampier areas and the frozen lakes allow transport of logs across them. The massive log stocks required are one of the main financial drivers behind the computerised control of wood flow as it gives the opportunity to reduce the expensive inventory of not only log but also the sawn stocks. The scale of operations is so enormous with one company in Sweden, Stora Enso, cutting more than the total combined softwood cut in Australia. In Finland Metsaliitto's cut is more than the combined softwood and hardwood cut in Australia from 130,000 forest owners. These large organisations and others like them supply many small mills, some high specialised in the product they produce and the log they require. There is a premium for such logs and the range of log values is much higher than in Australia.
The necessity for improved logistics and utilisation has driven the development of technology in these countries.

Two large forestry companies were visited in Sweden to better understand how they used the new harvesting capabilities and the data. The common theme with both companies was the flat response:
"If a machine can not optimise, it is not allowed to work in our forest and if it can not provide the files and format of data we want, it is not allowed to be used."

Both companies were very clear in their requirements from contractors and both gave regular feedback to the contractor on their performance to the expected accuracy. The rating and prestige of being the best contractor was a very sought after position as it brought with it benefits when tendering for future work and bonus payments.

Two large companies were also visited in Finland to better understand their need to use the new technology and the similarity and the differences between the two countries. One was a government organisation which was very similar to the involvement of State governments in Australia in the forestry and park areas. The other was a cooperative of many small individual owners which gave an insight into the varying needs of parties and how they are better satisfied by the use of the new technology.

5.2 Stora Enso

Stora Enso is a huge international company that came about by the amalgamation of Stora in Sweden and Enso in Finland. I can only comment on the Swedish operation.
Stora Enso manages forests for Bergvik Skog AB (a combination of their previously owned and those of Korsnas), giving a total of 2.3 million hectares. They have to annually supply 14.5 million cubic metres to their sawmills and pulp and/or paper mill. Their forests are split into 3 management regions, North, East and West, with most planning for all harvesting being centralised at Falun.

Each region has a Harvesting Manager, who suggests areas and timing of thinning and clear-cutting, so that an overall plan can be developed. Once a logging schedule is produced, then each manager works with the mills in their area, to develop a price list that reflects the worth of each log assortment based on the expected sawn timber returns. Using these values they then produce the cutting instructions (APT files) for each mill and send these out to Contractors by the most timely method. Email is the preferred and is used in most cases, but personal delivery of a floppy disc or post is also used if there is no other method available. The APT files can be very complicated because there are many assortments and many customers to supply. Each file is tested and fine tuned to give the required harvesting outcome, or at least the best fit available. This testing is carried out with SilviA simulation, using the existing data bank of stem files collected from contractors, that best represents the forest to be harvested. Some orders are for a limited range of log diameters and to facilitate supply simulations are run in order to return as close as possible to the maximum value whilst delivering the required distribution to the Mill.

Each night the contractor send the daily production (PRD file) along with a copy of the APT file used to the Skog (Forest) Data Centre (SDC), an independent organisation that receives and stores data from every contractor in Sweden. When there have been major changes to an APT file or a new harvest area is begun these files are also sent to the Harvest Manager so that they can check that the actual result matched the simulated result.
Each contractor runs a “chain of equipment”, a harvester and a forwarder, and is paid initially on the PRD file he sends to SDC, according to the volumes it contains. SDC collects the data from all operations and this information is available to any who have permission to access it.

Each contractor can access their own data, each forest owner their forest data and their contractor's data, with permission it is possible to access data from another company for uses such as comparisons of accuracy of log measurements.

The accuracy of every machine must be maintained so most companies insist on three calibration checks a day on selected trees. After processing the stem a file containing the stem dimensions is sent to the callipers and each log is measured manually, first for length and then diameters at 500mm intervals. Once measurement is completed a comparison between measurements can be made and loaded back into the machine computer. The operator has the option of using this measurement in calibration, as he has with a control tree, but sometimes the control stem is not acceptable for calibration. All machines store these calibration trees in their memory and these can be retrieved by the contractor.

Figure 4: Layout for Control Measurement to facilitate measurement

Figure 5: Callipers used in Control or Calibration measurement

Once harvested timber is extracted to the roadside then haulage is arranged by a central body that tries to minimise the empty travel of trucks. The latest project of StanforD is to have forwarder production reported on a daily basis with GPS co-ordinates of log piles to further optimise transport as well have constant information on roadside volumes for planning purposes.

Each delivery location has a measuring station run by another independent body VMF (Timber Measurement Association). Each load is measured, pulp and chip by volume by an accepted method, while all log is assessed for bark thickness and quality while being measured through a 2-dimensional scanner for length and diameter. All this data is sent to SDC and is automatically entered into the corresponding harvesting data sent from each machine. As the chain of custody requirements of the Forest Stewardship Council (FSC), each load has to trace back to the forest with all parties involved being identified.

Figure 6: A VMF measuring and assessment station

There are systems in place that automatically test the accuracy of each machine as well as each VMF assessor. In the forest there is a requirement that one tree in 1000 is control measured with callipers and this data is sent along with the other files to SDC for comparison. At the measuring station a random log is selected after being assessed which stops the chain till this log is tagged and sent to a special bin for the controllers to assess and measure. Assessors are certified and retain their certification if these control measurements are satisfactory.

Forest companies access data at SDC and have production checking systems that take this data and assess the accuracy of each contractor for length and diameter with 90% of logs expected to be inside the 9cm limit allowed in the industry as normal range eg 4.3 m to 4.39m. Ninety percent of diameter measurements must be within the range of $^{+}$/_4mm. Contractors pay is adjusted for rejects or down graded product using this data. All contractors are ranked using this accuracy data with a high ranking being the aim because of the associated benefits in current tasks and future tendering.

Contractors visited at Stora Enso were happy with the system and the company's expectations of them. There was a general contractor distrust of data sharing, tempered with the independent roll of SDC, but most accepted the need for the interaction between parties.

5.3 SCA (Svenska Cellulosa Aktiebolaget)

SCA is another integrated Swedish company that has large forest, and timber and paper mills and world wide interest's. SCA is the largest private forest owner in Europe with 2.6 million hectares forest land, 2 million of which is managed for wood production. They are all managed under FSC (Forest Stewardship Council) principles, which they believe provides a competitive advantage, because many customers consider it important that raw materials come from responsibly managed forests. SCA intake is 8.7 million cubic metres of timber annually (4.8 from their own forests) of which 22% is pulpwood, 35% for timber, 16% containerboard, 17% for printing paper and 10% in tissue. Of the production of solid wood products one-third becomes chips which are also used in the production of pulp products.

They use similar systems to Stora Enso with the same controls and interaction with SDC. This major difference being that VMF do not assess quality from SCA owned forests and these logs pass through their system collecting only length and diameter which is used to validate accuracy of harvester system. These logs are further scanned by the 3D scanner after debarking and sorted into diameter ranges for optimising runs into the saw-mills. The log yards and bin systems are massive with control of log yard being by GPS co-ordinates to satisfy chain of custody requirements. As logs are unloaded the machines are given co-ordinates for storing material and all log bays are monitored to fully track each bay of material. See Figure 7

The mills use the Production files sent to SDC to plan long sawmill runs of each diameter sort in order to minimise downtime in pattern changes. They provide a simple example of how the forest data is used to fine tune the overall performance of the integrated company.

Figure 7: Computer display showing locations for logs in log-yard

SCA are a progressive company which expects the best from its contractors and does much to achieve this. They, like all other companies, want their contractors to be efficient but they ask for a lot of data from contractors. They also specify the types of machinery that their contractors can use and in the few cases, where machinery other than the specified brands are used, it has to meet the strict data collection and transfer criteria. The company's logic is that if there is only two brands of machinery in the forest then it is easier to assist the manufacturers to overcome problems and work on solutions with them. SCA also run some company crews and they use these crews to test and develop solutions to common problems as well as the introduction of new technologies in order to ensure that they are fully practical before they are introduced.

Their motto is: "**No backward steps – test and introduce**".
All contractors are rated for accuracy and rewarded for good performance by allocation of better areas and larger parcels, as well as a score that is used in new tenders. Poor performing

teams are questioned and penalised for continuing poor performance but the main concern is to identify the reason for out of specification wood or failure to meet supply quotas and fix the problem. SCA can use the data collected to assess if the problems are machine or contractor related and are then able to focus on the key area to achieve the best and speediest solution. Where machine problems are identified SCA use their power to motivate manufacturers to rapidly implement solutions.

Company crews are seen as a method for SCA to understand the real costs of harvesting in order that they are better informed on contractors costs in rate negotiations. These crews compete in the rankings on the same basis as contractors for accuracy and efficiency and are sometimes used to complete less productive and more difficult sites so as to limit the financial pressures on contractors.

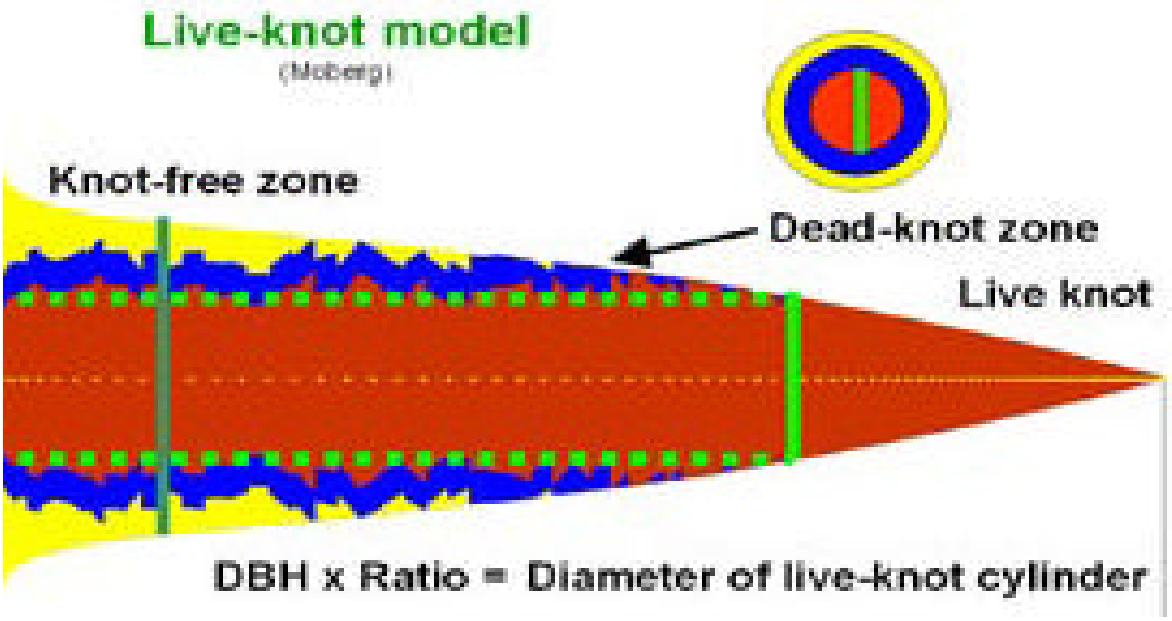
Harvest areas are planned well in advance using inventory data collected and aerial photos with final areas being marked on the ground and GPS surveyed. Safety and environmental risks are identified, harvest and haulage plans completed and sent to contractors 6 months in advance. The order of areas to be harvested is decided allowing contractors to inspect areas and make their own plans. This makes it possible for all parties to identify and solve issues well in advance. Figure 8 shows how a stand can vary over small distances.

Figure 8 Illustration of species mix, with photos taken at 90^{o}. Left photo is 100% Scots pine and Right is almost 100% Spruce.

All machinery is kept up to date as possible. Older machinery cannot collect the required data or value optimise and is renewed. The oldest machines are 7 to 8 years old and soon will not be able to meet the requirements. Production has risen to 56 m^3/ man-day for all people associated in the forest, and this is expected to continue to rise.

While visiting Bollsta, a recently updated mill, that mills Spruce (Picea abies) a new project being conducted by Skogforsk under guidance of the StanforD committee was observed. The butt section of the tree contains dead or black knots which are only acceptable in structural timber and the butt has traditionally been cut at a set length. However, a proportion of that log contains green knots and is suitable for higher priced products. The project is using the diameter of the tree to establish the change from black to green knots in order to optimise the higher price green knot material by varying the butt log length. This is one example of the use of data to further increase the returns possible. Figure 9 illustrates this.

Figure 9 Typical Knot type with tree stem



(Since my visit this technology has been implemented and is working with greater than 75% accuracy using a Timbermatic 300 system.)

SCA had recently begun to use a new software that enables them to further track the timber. By assembling all data from machines, forwarders, trucks and mill scanners it is able to make changes so that customer's needs are better met. A level of 70% of mill orders is achieved by changing matrices and classes over a period and this can be further improved by adjusting prices and taking the machine program version into account.

One challenge that SCA is facing is the phasing out of a system called “Mobi-tex”, which is used in the northern areas for daily data communication between contractors, SDC and SCA. As yet no replacement system is available. The system is older technology and does not have enough users to be profitable. Global System for Mobile Communication (GSM) phone coverage is not available in some of these less inhabited areas so a new method is still being sought. Satellite coverage has improved in the area and is thought to be one solution possible.

Finland

Finland is country covered with forest and the forest industries make a major contribution to their economy.

Land use classes	**000,000 ha**
Forest land	20.2
Arable land	2.8
Other (including scrubland)	7.5
Forest ownership,	**% of total forest**
Private Owners	61
Companies	9
Other	5
State Forests	25
Total fellings Finland, (mill.m^3)	55.9
Metsahallitus annual fellings (% of total)	8

5.5 Metsahallitus

Metsahallitus is a Government body that controls all the State Forests and Parks with the Forestry section harvesting in prescibed areas. While the areas involved are large they only make up 8% of the volume harvested in Finland. As a forest owner they focus on providing the required product to the mills. Their services include management of harvesting and transport operations, cross-cutting to customer requirements and delivery to suit the needs of

the customer. To achieve this it is essential to have very detailed planning which necessitates large data bases to store collected data.

All decisions are made centrally by one Supply team and are then implemented by one of the four Regional Timber Supply teams. This prevents potential internal competition and any sub optimisation due to regional targets. All operations are sub-contracted with most contractors being small scale, the need for close communications between Supply Teams and contractors is essential to ensure successful logistical control systems, quality and environment management and customer driven activities to name but a few activities.

All contracts are tendered as required by law and only pre-approved contractors can bid. The criteria for approval includes no tax residuals, pensions paid, organised waste service, equipment for data transfer and capacity to deliver services. Quality is scored on age of equipment, training, reliability, and quality management system, number of vehicles and suitability of equipment. The bid is a ratio (coefficient) to a fixed price table, $ per cubic metre harvested and extracted for an average tree volume.
Final selection of the contractor is based on a Price + Quality contract for 2 to 4 years with annual revision of volumes and price (by negotiation). E-Learning packages are available for new contractors and driver/operators and these include a test which must be passed.

Metsahallitus employ 200 contractors, with 100 in harvesting, 20 in extraction and 80 in Transport. Conventional Scandinavian harvesting techniques are used with equipment from the three main suppliers Ponsse, Timberjack and Valmet dominating. All equipment as, stipulated in the contracting criteria, has to be able to collect and transmit the required data and able to meet the strict quality requirements of Metsahallitus and their customers. These criteria make the use of the latest equipment a necessity.

A simple system is used to create cutting instructions. A general value is placed on an assortment eg. Log – 400 and then a distribution matrix is added to give the required output with some lengths and diameters forbidden. This drives the optimisation. Results are checked against the daily production figures and are modified to give the required percentage of assortment to mills. The total list is huge, but is achieved without the same high reliance on prices. The instruction is created in Jakomies (Crosscutting man) program and an “AP1” file along with an OAI file and GPS data is sent to the harvester. The harvester operator is able

with one click to create an APT file to use for the current task and to track boundaries with the GPS data.

Data transfer from Metsahallitus to contractors is made easier by 100% GSM phone coverage in Finland. All logging instructions are emailed directly to machine, including maps and all production files (PRD) are sent back to Metsahallitus at completion of the days work. Extraction data is also transmitted and because all data is sent direct to Metsahallitus and they are able to have daily updates of the log availability. This data includes species, product, volume or weight and location of heap which is then allotted to a transport contractor, to whom details are emailed. All transporters have GPS, as do the forwarders, so it is possible for timber to be picked up by any contractor who is in close proximity, thus minimises unladen travel.

Volume measurement for payment of the contractor is made by the harvester and by sawmills scanners for the transport companies. There is no Metsahallitus enforced calibration of the harvester, but it is a legal requirement for them to be accurate. The legal requirement is for the Harvester measurement to be within **+/- 4%** of the Mill scanner measurement for sawlog, which the Industry has reduced to **+/- 2%** as it believes this can be achieved and this is borne out be the current level of **+/- 1%**.

To track contractor performance Metsahallitus use a Sampo system, a combination of three systems and an Oracle data base, to give each contractor a rating. They give regular feedback of this rating to the contractor as a form of motivation. Contractors, whom I met, all valued the feedback because it enabled them to arrest any problems and gain a higher score, which is beneficial for contract negotiations.

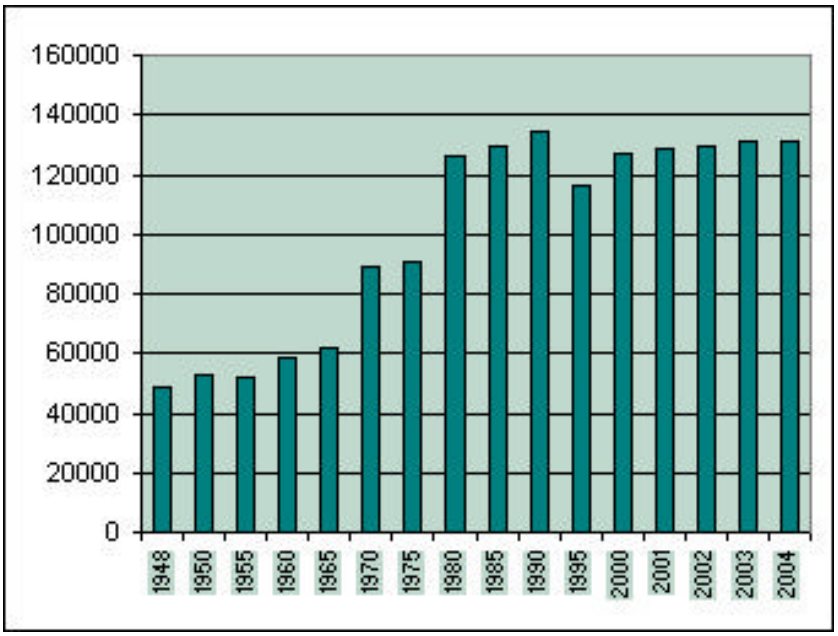
Data transfer has become a normal part of harvesting and is seen by all as a tool that is used by all parties in negotiations and makes the tendering and awarding of contracts an easier process with the use of real data.

5.6 Metsaliitto

In 1934 some forest owners in SW Finland established Metsaliitto Oy and paved the way for forest owners to work together. The Metsaliitto Cooperative was formed in 1947 to continue their work. It was soon realised that exporting unprocessed logs would not provide a long term profitability so in the early 1950's it began to establish sawmills. Pulp, paper and board

soon followed and now the Metsaliitto Cooperative is a group of 130,000 members who together own about 5,100,000 hectares of forest.

Members of Metsaliitto Cooperative 1948 – 2004



Each year Metsaliitto enters into 45,000 timber purchase contracts, of which 75% are purchased on a stumpage sale basis which allows Metsaliitto to organise the harvesting and transport. The remaining 25% is bought at the roadside where the seller has harvested the wood and delivered the agreed volume to the roadside for transport. Total wood volume procured in 2004 was 24.5 million cubic metres most from its members. This required 360 harvesters with forwarders which are owned by private contractors.

As with the other Companies visited Metsaliitto had the task of organising the work with the added burden of meeting the expectations of the individual Forest Owners. They have delineated 5 areas in Finland which are sub-divided into 18 districts, with each area controlling harvesting in its area. An area supervisor takes mill orders and converts these into APT files and sends them out to contractors. Inventory information from harvesting areas is very important to facilitate the matching of orders to the available forest.

A contractor is obligated to calibrate the harvester at each harvesting site and this file is sent, along with production, to the area office. As the wood is extracted, forwarder operators input data on the volume of wood at roadside landings. Most wood is transported by road and controlled by a specialised computer program that optimises transport routes in order to maximise two-way transport and improve cost-efficiency. Once routes have been determined this information is transmitted by the GSM network to computers in the trucks. All trucks are equipped with digital mapping systems and GPS thus making it possible for drivers to locate even the most remote roadside landings.

Metsaliitto use the data produced from harvesting sites to ensure that all mill orders are filled and their members are receiving the best possible result from the operation. The use of less capable machines by some forest owners who wish to harvest their own trees is a flaw in the follow-up system but the scaled volumes that are provided are used until logs are scanned at a processing facility.

6 New developments and their introduction

6.1 Timberjack (John Deere Forestry)

Timberjack is a major manufacturer based in Finland and is now a part of the John Deere company. Their harvesters have developed to a stage that they will only optimise and while this is a key requirement in Scandinavia it is not widely understood and is little used, outside those countries.

The latest Timbermatic 300 series is a PC version of the Timbermatic 3000 and was a major step in user friendliness. The system integrates the control of the harvesting head, the measuring of the timber, bucking and the control of the basic machine. The system highly automates the control of the head in adjusting feed speeds and knife pressures based on stem diameter while dividing the stem into the most valuable pieces. The system is self-learning and becomes more accurate as it processes stems. An anti-slip system ensures high accuracy, minimises the need for reversing in the cut window, both of which speeds up the production times.

Fig 10: Timbermatic 300 screen showing cut and suggested next cuts

Calibration is made easier and more accurate with on board manual callipers being used to ensure that the accuracy of the measuring system is checked regularly and more often in the spring when frost can create problems. This method of calibration quickly detects problems in the machine system and allows performance to be kept within the legislated tolerances. The system uses random sampling to achieve increasingly high accuracy which leads to improved quality of the timber produced.

There are two other Timbermatic systems, the 700 and the 900. The 700 system is for forwarders and combines the TMC (Total Machine control) with GPS, email, data transfer, front and rear cameras, active load space and weight scale systems making the forwarder the next part of the optimising chain supplying data for the transport stage. The 900 system is used on the slash bundler used in the recovery of harvesting residues for bio-fuel. It has all the features of the 300 and 700 along with functions for the control of bundling.

Figure 11: A John Deere Slash Bundler at Elmia Forest Fair

John Deere also use “Timber Office” a group of programs which allow Contractors and Forest owners to use the data produced on the machines.

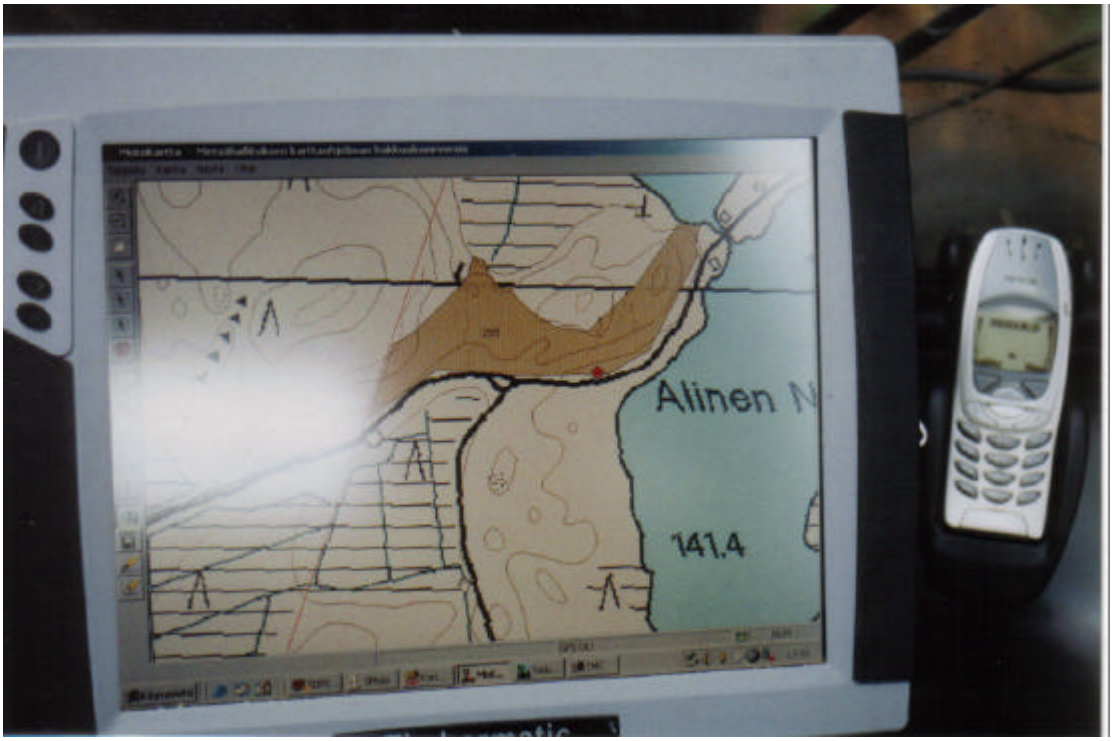
Timber Office incorporates:

- Timber Centre: manages all information and e-mail within the system. It monitors the users e-mail in-box and extracts the Timber Office related data and saves it to the relevant databases
- Timber Calc: is three integrated programs; Machine cost, Follow up and Estimate. Machine cost calculates the fixed and variable costs of operating forest machines and machine teams on a time and volume basis. It also enables the user to compare and analyze the differences in these operating costs and to predict the impact on their business of a change in a particular cost.
- Timber Monitor: used to analyse machine errors and events including calibration history, parameter changes and shift start and stop information.
- Timber Navi: a Geographic Information System (GIS) that uses Global Positioning System (GPS). TimberNavi can be used in harvesters, in forwarders and also in the office. When TimberNavi is used in machines, the system shows to operator his position on a digital map and the system also reacts to information on the map. (see Fig 14)

- SilviA: is a management program for bucking that helps create and manage price lists. Bucking instruction files created with SilviA can be sent to a harvester working in the forest.

The use of these programs allows the Contractor to track costs and productivity of machines, repairs and other problems using data downloaded from one or more machines. The Forest owner can use the same package to track total production from many machines, prepare APT files and simulate harvesting with stems collected by machines in the normal operations. It can use past production to forecast future yields etc. These programs can be used with data from any machine type which proves the value of the standardisation of the systems into StandforD.

Figure 12 GPS Map of Coupe with Harvester location



There are some aspects of the programs that may seem to be unnecessary in practical harvesting but once seen in operation the benefits of more sophisticated management systems can be appreciated. The onboard computer allows operators to access problem solving help manuals as well as the Internet for additional help, changes the focus and application of the machine computer system.

6.2 Valmet (Komatsu Forest)

Valmet, now part of the Komatsu group, is located in Umea, where all Valmet harvesters and forwarders are built and all the development work that precedes new innovations is undertaken. Valmet has been associated with Forest machinery since 1960 with a De-limber and forwarder.

They focus on ergonomics and operator comfort. Development of their harvesting systems has been driven by the Scandinavian market that they service. They have a Maxi Harvester system that does all that is currently asked of it and have developed a file system Maxi Manager that can be used to handle all the files encountered in harvesting and some other tools that can be used on the PC based systems. Figure 10 shows the Maxi Manager screen.

Fig 13: Valmet Maxi Manager Screen with all the file options

Valmet have continued to produce two systems, the Maxi Log that uses pre-set lengths and diameters and the Maxi Harvester that supports Value bucking. They have marketed the Maxi Log in Australia, because as yet Australia has not yet realised the benefits of value optimisation and it is a simpler operation that requires less training of operators and service people.

The Maxi Harvester system operators and service technicians require more training initially because of the higher demands of the system.
The system has:

- TMC (total machine control) which allows all functions to be set from the operators seat and can be customised to suit each operator.
- Maxi A is the tool used to generate, view and edit APT files.
- Maxi P is used to review production (PRD) and can be sorted to show production of each customer.
- Maxi GIS is used to provide information for the operator on location and if other maps are included can show boundaries, sensitive areas, contour lines and can be used to direct strip direction when thinning.
- Maxi D is the machine operational file system that allows the contractor to track downtime and the reasons for it. This is a helpful tool in highlighting problems on the machine that are sometimes hard to track with more than one operator.
- Maxi Time is a wage system only available in Sweden.
- Maxi Manager is used to handle all files.
- Notes for communication between operators.
- Manuals to find the required parts and when combined with,
- Email can order parts directly from the machine.
- Internet.

All the Harvesting measurement needs to be reliable and accurate and the program is equipped with a system that uses callipers connected to the cross-cutting computer. When a stem has been selected, either randomly or by the operator, and has been processed, all data is transferred to the calliper. The length is measured first and then diameter is measured at points specified by the calliper. Once measurement is complete the calliper matches the two files and makes suggestions where necessary regarding calibration. By reconnecting the calliper to the computer calibration is done automatically, if the operator approves the selection. See Figure 11

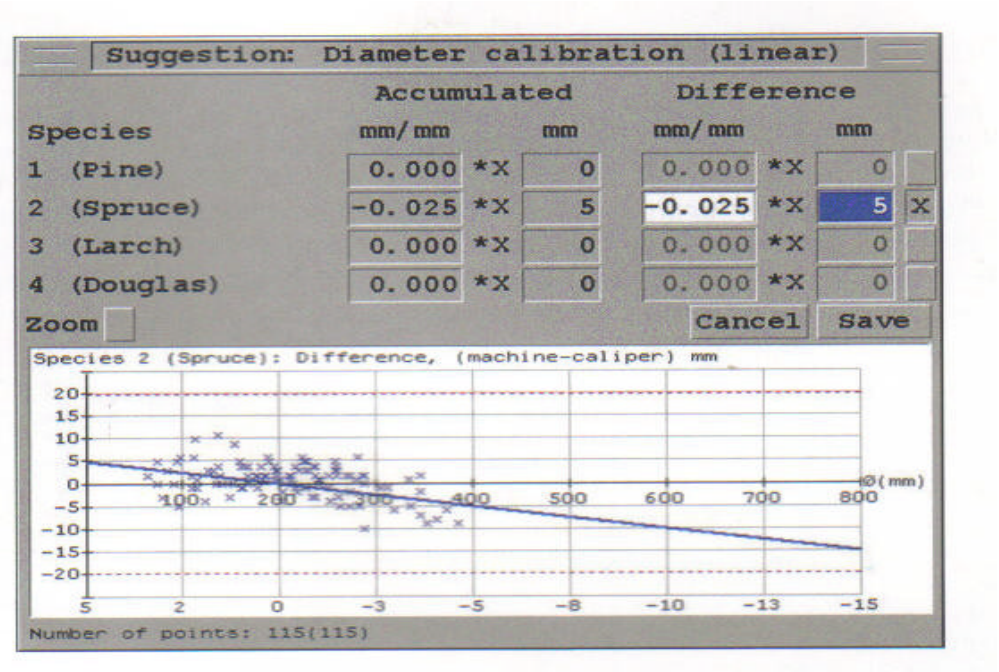


Figure 14: Calibration screen

6.3 Mitron

Mitron is a Finnish company that specialises in computer control systems for diesel engines, automatic transmissions, LCD and TFT display screens as well as audience survey meters for the likes of AC Neilson and Gallop. They also manufactured control systems for harvesting heads, which now comprises 20% of their business.

Their Motomit system has been used intensively for 14 years on Lako and AFM heads and they have also been involved with Logmax . Their business is mainly based in Sweden and Finland and has developed along the same lines as major manufacturers with optimisation and TMC systems. They have developed standardised solutions for Waratah (European), Lako, Logmax, AFM, Keto and Kesla forest machines and are prepared to customise products to suit the platform.

Motomit market two main systems, the “Motomit IT” and “Motomit PC” with both being able to handled the required range of StanforD files and to optimise. Motomit PC is becoming the most used of these systems with more contractors wanting Motomit PC in preference to the cheaper IT Linux system. The PC and IT systems are both fully adaptive systems that use an updating system of 5 stems of that DBH to predict stem form. They can be used to update and upgrade AFM, Lako and Logmax systems easily, and Mitron are sure that within four

weeks of being asked they could have a system that would upgrade a Logrite, Valmet or Keto system.

The upgrading of the system was seen as the easy part of introducing optimisation compared to the inputs required to update the skills and knowledge of operators, harvest supervisors and the support system of the companies that service the machines.

6.4 Kuru International School of Forestry

The Kuru Forestry School takes students direct from High school into a 3 year course where they learn both theory and practical aspects of forestry and harvesting,. These students are the next generation for Forestry and have the skills to operate machinery and plan forestry from start to finish. When the students have developed adequate skills they are allotted to Contractors to learn the practical side of the forest harvesting.

The school is subsidised by government and costs are off-set by charging for timber harvested and extracted. This allows the school to charge modest fees and accommodation charges. They hire machinery mainly to access newer machines but do own some machinery for courses in Russia as well as other special courses.

The Students are the next generation for forestry workers and supervisors and have the skills to operate machinery and plan forest operations from start to finish. When the students have developed adequate skills they are allotted to contractors to learn the practical side of forest harvesting.In addition to a three year course they also run three month courses that introduce 12 to 15 students at a time to harvesting and extraction, using the latest technology. This type of course would be relevant for new operators in Australia. These courses are run in many languages including English and are aimed at producing operators with the skills to use optimisation and who are certified in data transmission skills. These courses are aimed at novice operators and from day one have practical goals. Students are expected to operate the harvester in first thinnings, initially taking trees selected for them by other students and harvesting them. Later they operate the forwarder to pick up the timber that they have harvested. This soon teaches them the importance of placing cut timber so that it allows easy collection. At the end of 12 weeks the Students have all the skills required to fully use the latest technology and are expected to work to at least 50% of normal production levels.

In addition to operator courses they also run management type optimisation courses for Forest and Harvesting management personnel. These are short six day courses and are designed to give harvesting managers the skills required to construct the cutting instructions required (APT files) for the machines to optimise and run at production levels that are profitable for the contractors. Participants are trained in construction of APT files and the simulation of harvesting. This is a course recommended for Australian harvesting people to gain the initial skills required to manage the systems.

People that complete the courses at the school are usually employed in the industry, with over 80% still operating machinery, while some use the course as credits to advance their studies at University. Students who finish the course have a professional attitude towards machinery, the environment and teamwork.

There were students from Uruguay at the school during my visit. They were in the early days of instruction but already operating the harvester etc and would be able to operate and repair the machinery in a few short weeks.

Figure 15: Uruguayan Students at work.

Training has been a key component to the successful implementation of Optimisation technology into harvesting and data handling, and without this continual training the adoption of new technology would stall if not fail. Australian contractors and companies would do well to consider the lessons learnt.

6.5 Elmia Wood International Forestry Trade Fair

Elmia Wood provided an opportunity to visit more manufacturers and system developers. Ponsse, a Finnish manufacturer, had all their forest machinery on show. They have developed their "Opti" systems to the same level as John Deere and Valmet but as they have no exposure in Australia, I only had brief discussions regarding their machinery. It has the standard features to optimise and has been developed with Finnish forests as a main focus, but it has been used in New Zealand. Training is seen by Sampo Pulju as a key factor, in not only the introduction of Ponsse machines into new markets, but in the introduction of any new technology. Development of local experts to continue the training is essential, as they understand the local needs required to service the industry.

"ESE Dasa" are system developers who have products in use here in Australia. They have an association with Rosin heads and their Dasa 380 system has worked well in the Tumut and Queensland regions. The system has many features, not all of which are used. This system has been further developed to a fully optimising PC system call "Dasa 4" which is sold in conjunction with a harvesting head. Waratah included the system in a package or option with one of their European heads at Elmia. The Dasa 4 system will soon become available with the Rosin heads in Australia.

7 Summary

The use of Optimisation, in conjunction with the third generation of harvesting computers is mandatory for all major Swedish and Finnish forest owners regardless of whether they are

international companies, co-operatives or government. This technology is a pre-requisite to tendering for all but some of the first thinning contracts. Most of the major companies actually prefer and specify contractors to use one of the three major manufacturer's machinery, Timberjack (John Deere), Valmet (Komatsu) or Ponsse. If other brands are used they must be able to meet the data transfer capabilities or they are not allowed into the forest.

The adoption of a standard format for forest data has made data collection and its transfer easier and has allowed more money to be channelled into machine development that would have otherwise been used in software protocol development by each manufacturer. The optimising technology has been developing along with computer improvement and they now have the ruggedness needed to survive in the forest environment.

The use of saw-simulation software has enabled sawmills to establish what raw material they required to fill the end-users needs and specified log products can now be ordered from the forests. This can result in a greater range of log lengths and diameters to that traditionally cut in the forest. The end-user might have a special requirement for a length that will reduce the need to waste part of a standard length (eg. Ikea furniture). The matching of diameter and length, to optimise through the whole processing chain to the end-user becomes a reality previously not possible with the older harvesting machinery. This matching of production to end-user needs reduces the area of forest required to fill each order. It also combines and tracks many orders at once. As well as improved utilisation other advantages to both forest owners and mills is the reduction of log stockpiles required and the expensive stock of sawn material is also reduced.

The predominance of mixed species forest requires even more flexibility and tracking capabilities of both the operator and machine. The optimisation computer allows the operator to concentrate on recognising species and quality. The computer, using the price and distribution matrices, along with its predictive ability, decides on which lengths and diameter variations will produce the best value for the forest owner as well as meeting the customer's orders.

Whilst all major manufacturers produce machines that meet most of the above requirements, some machines perform better than others in some or all of the functions. All systems are able to learn from the forests as it is being cut to make more accurate predictions of taper and

height. Timberjack is the only system that allows the “Stem prognosis” prediction to be saved for use when a similar forest is going to be cut.

There are some differences in the way each country has organised their industry and how accuracy and information are treated. Sweden has a third, independent organisation with Skog Data Centre that receives the data and makes it available to the relevant organisations. The VMF group run the measurement stations and are accredited by random control measurements, the same way that individual machines have random control measured stems that check their accuracy. This system is funded by government and industry and is seen as a neutral player by concerned parties. Over years an agreed system of measurement has been developed, where the accuracy is an accepted factor more than the absolute. All systems of measurement except immersion can have inaccuracies but the agreement to accept the one method throughout Sweden makes good sense. Most of the larger Swedish companies run some company owned machines to keep a check on actual costs and production as a reference guide when tenders are negotiated.

In Finland the only exchange of data is only directly between the contracted parties. Each forest company receives data direct from their own contractors and they use this information to benefit their own organisations. There is no formal control measurement system but contractors are expected to have their machines properly calibrated at all times. Each organisation can have some agreement with their own contractors on control measurement but a contractor is expected to do a control measure each week and at each new forest area.

Harvesting machines are seen as part of any measurement system and it is a legal obligation of the contractor to keep their machines accurate because they are paid by the data produced. Finnish law is such that all harvesting machines must on a yearly basis be within $^{+}/_{-}$4% of scanner volume. This has been seen by the industry as being too imprecise, so $^{+}/_{-}$ 2% is now the industry accepted figure and nationally in reality it is closer to $^{+}/_{-}$ 1%. Forest operations with the use of company owned machines are seen as an expensive option and this work is 100% contractor based.

Common to both counties are the contractor’s concerns on the type of information that they are asked to provide and how it is used. There is a feeling that costs are as low as possible, while they are expected to invested an increasing amount in machinery. Production gains by

improved systems that allow operators to maintain higher levels of productivity are reaching the limits of possibility as the human eye and brain are tested with higher feed speeds.

The use of Optimisation on harvesters has allowed the Scandinavian industry to further gains by extending the optimisation into haulage and sawmilling in order to make the most of the resource available to them. The optimising of the forest on a stem by stem basis is not only possible but is a reality and when the data that has been collected is added to the equation the gains multiply. The data collected can be used in many ways, not only for immediate needs but also for future planning. In the same way that the computer uses prior stems to predict the current stem, so can the cut forest be used to predict the log products yielded from future areas. The stems harvested in thinnings can be used in growth modelling to predict and plan future thinnings and final fellings. There are more options available and as machines, computers and our capacity to use the data are refined, others will be developed.

8 Recommendations

In most of Australia's plantations mechanised harvesting has followed the Scandinavian cut to length model from its introduction. The only exceptions were in clear cutting and steep areas where Scandinavian machinery was not able to cope with the size of the trees and terrain. Current Australian practice uses cut to length machinery in all of its operations and this creates the opportunity to use the latest optimisation technology without going through all the development phases. There are recognised differences between the Scandinavian forests and those in Australia, with Australia having the advantage of single species plantations and less variable stem size.

The new optimisation technology could easily be adopted in Australia within the next 5 years in conjunction with the purchase of new harvesting machines. At present there are some companies attempting to introduce optimisation into their business and they are finding that there are numerous hurdles to be overcome. A large investment in machinery is needed to introduce a basic improvement in cutting to value by the harvester. Preceding this investment there is an even greater need to train people from the forest and sawmills, to produce the information required to enable growers, contractors and processors to achieve the extra value.

Some of the areas where a common industry focus could be of an advantage are:-

Harmonisation of Protocols

There is much to be learned from the Scandinavian experiences in the adoption of stem optimisation and data usage into Australian forestry. The plantation based timber industry needs to recognise the benefits available with machine optimisation and insist on a strategic introduction of the technology. The adoption of the common StanforD (Standard for Forest Data and communication) protocol is the first step that needs to be taken. The relevant Australia wide forest industry body should become a member of the StanforD committee and have input into areas that are relevant to Cut to Length harvesting. Most machinery used in Australia is sourced from Scandinavia or New Zealand and uses a control system developed in Scandinavia. Waratah has been an exception to this but in the near future they will be adopting a new optimising system from Finland. Most machines used in Australia are older versions and while they are capable of data transfer, it is seldom used and it cannot fully value optimise.
It is recommended that in purchasing new machinery Contractors should give consideration to the system and the protocols used.

Training

Training represents a major hurdle that must be addressed to ensure successful full scale introduction of the latest systems into Australia. In Finland there are at least four main training organisations similar to the Kuru Forestry school that train operators and equally important harvesting managers. Australian machine operators need to be trained in the operation of the new systems which are important to maintaining productivity and profitability. This will happen as machines are replaced in the system but without a co-ordinated approach much of the possible gains will lost. There is a value improvement, by adopting the new optimising technology, in the order of 5 to 15% depending on the forest and markets available to the forest owner.

It is recommended that key forest companies and contractors use the Kuru school or similar to provide a core resource of trained harvesting and training people, so that the training can be further developed in Australia. The use of new technology in harvesting could be used to form the basis to attract more people into the industry. West Australia has recognised the shortfall

of operators to harvest Globulus for the wood chip industry and developed a training scheme to address the problem. Note hardwood chip-wood is a low technology operation and much more training is required to service the softwood cut to length operations. Training organisations like LITA, that once serviced the manual industry, need to be developed to provide the required training in partnership with schools such as Kuru and the manufacturers.

The manufacturers visited all had machinery suitable to meet the requirements of the Australian industry, but without exception they were concerned about the lack of training in Australia and whether there would be sufficient support from the forest industry to facilitate the successful introduction of the new optimisation systems. At this point they were not confident enough to recommend the use of optimisation in Australian unreservedly. The adoption of optimisation can continue in the current piece-meal fashion, with some Companies becoming aware of its value and attempting to introduce it. In Scandinavia, the industry were the driving force for optimisation and from there it has spread through-out Europe to the point where now people from South America are being trained. To be successful in Australia optimisation must be driven by the industry with the full training of key forest and contractor representatives. Australia needs to keep pace with competing countries if it is to remain competitive in the marketplace and until we begin training in optimising technology the manufacturers are unlikely to invest in providing fully trained back-up personnel to service their machines.

Data Ownership

As well as using one Standard for data it would be very beneficial to address the contractor / forest owner data issues at a national level and make a decision on agreed data ownership. This is an issue that has still not been fully agreed in Sweden or Finland and it is considered important that potential areas of mistrust between the parties be addressed prior to optimisations introduction. The key issues are productivity and costs that are seen as contractor specific. Tree data collected as the tree is harvested and processed is not considered to be in this category and is something that could and should be easily shared. Both parties would then be able to use this data for things such as rate reviews, tendering or payment.

Parties involved in such agreements would be groups such as Australian Forest Contractors Association and the Industry body. The data of concern is both internal and external nature. Internal data being any machine data, hours, productivity, repair and other, while external

being tree data, stem, products and production or anything to do with the forest that is being cut.

Calibration

An industry wide standard of accuracy should be adopted and enforced. There are incentives to all parties to produce the ordered products within agreed specification limits. Calibration and control measurement ensure that this happens thereby reducing the waste and extra cost arising from out of specification product.

At present different methods of measurement are used in Australia to measure cut to length material. The multiplication of measurement methods means much added cost to the industry. The higher value saw log is in most areas is scanned at the saw-mill and with some care, it can and should be possible to be trace this back to the machine that processed it. This data could be used to validate the volume and out of specification material.

Introduction

The Green Triangle region has been traditionally a leader in the radiata plantation industry with the oldest and intensively managed plantations. The region should continue to lead with the introduction of optimisation and data collection and with the organisations LITA (Logging and Investigation Training Association) and TAFE there is the basis of a training facility. The multi thinned forests of this area and the relatively small area are two factors that make the introduction of optimising technology a simpler process. The major companies of this area have a history of cooperation in many projects, Southern Tree Breeding Association and CSIRO fertiliser trials being two examples. The cooperation between these companies and the sharing of costs involved in training and introduction of calibration and quality controls will make introduction smoother and consistent allowing all to share in the benefit that optimisation on a stem by stem basis will provide. The other areas of Australia could join the Green Triangle region once the benefits have been proven.

The plantation softwood industry in Australia has already achieved world class harvesting by adopting Scandinavian harvesting practices, firstly motor manual techniques and then the mechanised methods. It would benefit equally by following the progress into machine optimisation.

9 Appendix

Organisations and people visited

Sweden	
Uppsala	
Skogforsk	John Arlinger
CC Systems	Markus Walmyr
Stora Enso	
Falun	Jan-Ake Ronstrom
	Hans Jonasson
	Marko Alm
SCA	
Sundsvall	Marten Larsson
	Per-Anders Hedstrom
Bollstabruk	Henrik Sjolander
Umea	
Komatsu/ Valmet	Per Annemalm
Finland	
Tampere	
Mitron	Markku Laaksonen
	Juha Koiranen
Vantaa	
Metsahallitus	Tuomo Vuorenpaa
	Heikki Kaariainen
Tampere	
Timberjack	Juha Jarvinen
	Jukka Moisander
	Mika Talola
	Markku Pusenius

Waratah	Joao Pontes
Metsaliitto	Vesa Virkkunen
Kuru	
Kuru Institute of Forestry	Jukka Aro
	Mika Laakso
	Chris Thomson
Sweden	
Elmia Forest Fair	
Dasa	Kjell Gransvik
Ponsse	

Plus anonymous contractors

(John Arlinger, StanforD secretary, Skogforsk, Uppsala Science Park, SE-751 83 Uppsala, Sweden)