THE DEVELOPMENT OF MECHANISATION IN AUSTRALIAN PINUS RADIATA HARVESTING

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DEVELOPMENT OF MOTOR-MANUAL SYSTEMS, PRE 1975

An important development in the extraction of Australian exotic timber came with the use of 4-wheel-drive trucks. These became widely available after the second war and were used as extraction units which travelled into the stand. In South Australia where some of the earliest radiata pine plantations were established, the crane truck system evolved. This was a truck fitted with a winch and a crane and enabled self-loading to be undertaken at the stump. Loading of larger diameter and longer logs thus became an easier task. The success of the crane truck concept in this region was because of the proximity to the mill of flat terrain and sandy soil which enabled the trucks to be used for most of the year. It persisted there until the mid 1970s, longer than it did in other areas. Light weight chainsaws arrived in the sixties, reducing the work load of felling and cross-cutting. Manual loading of shorter wood was replaced by the use of steel pallets, particularly in NSW, which were hand loaded then winched on to the back of trucks. In South Australia shorter wood, predominantly pulpwood, continued to be loaded by hand.

Rubber-tyred skidders were first introduced into Australia by the Forestry and Timber Bureau (F and TB), who purchased a Timberjack 205 in 1963. They promoted the use of this type of logging equipment by conducting trials in several parts of the country in softwood plantations. Studies carried out by the F and TB reported the advantages of this type of system over the current practices. The number of skidders grew fairly rapidly. In 1965 there were 21 and by 1970 there were 189 (1). A large proportion of these were Timberjack models, the 100th of which was imported into Australia in 1968 (2). A tree-length extraction system similar to that used in most New Zealand thinning operations was advocated (3) but cutting to length was preferred, the logs either extracted by conventional manner with strops or in some form of pallet. The reasons for this were to reduce residual tree damage, avoid the embedding of sand and other material into the logs, and the wood in this form suited subsequent handling methods.

The next stage in the development of mechanisation was the introduction, again by the F and TB, of the first forwarder in 1967; a Massey Fergusson 'Treever' (4). This unit underwent some trials (5) but the machine which enjoyed a success similar to the earlier Timberjacks was the larger capacity Volvo. One of these units had made an impact at the 1970 Forest Industries Machinery Exposition (FIME) held in Jenolan, NSW. In the following years, forwarders replaced many skidders and crane trucks in softwood harvesting operations, particularly in early thinning operations which still dominated the harvest cut. The reasons given for the preference of forwarders to skidders were (4,6)

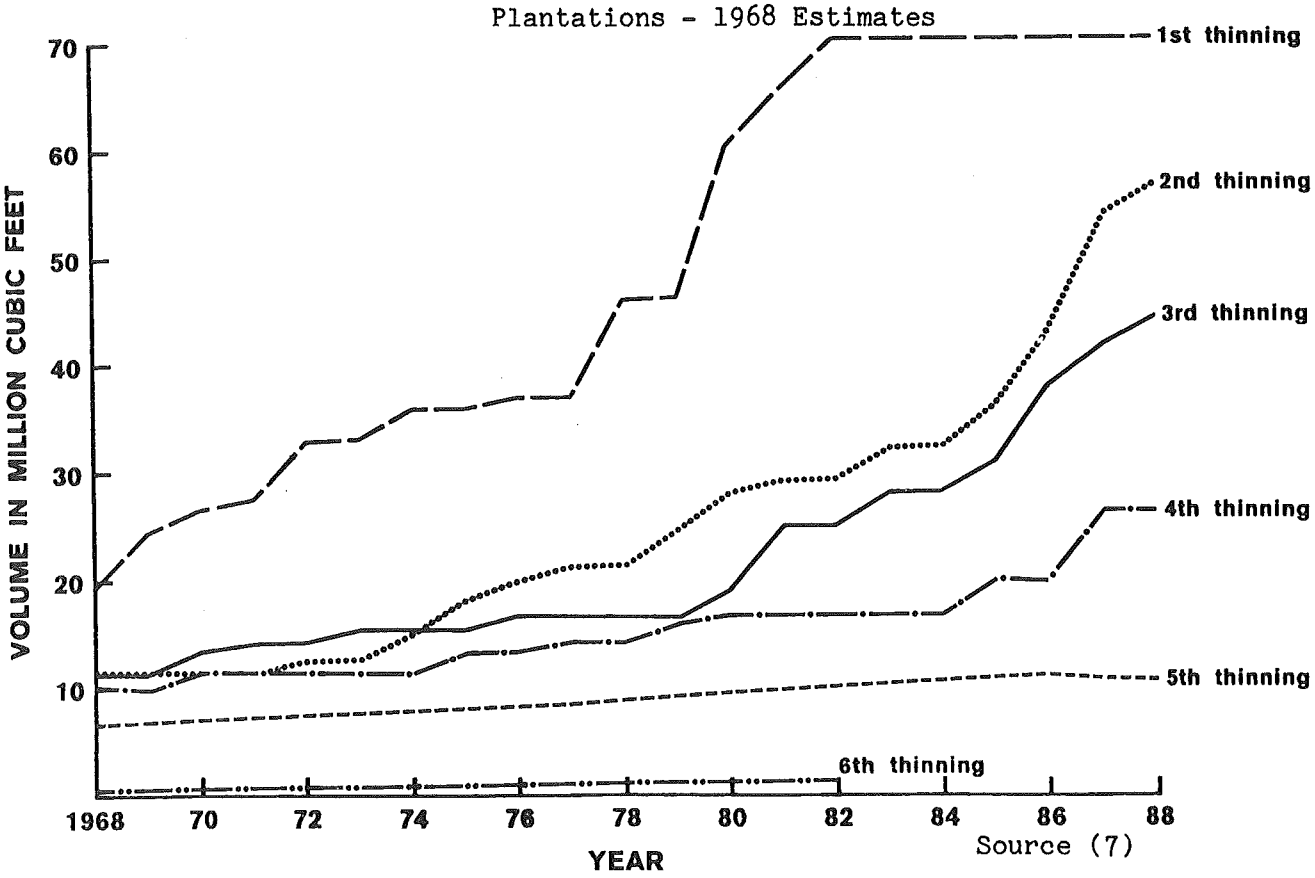
- the productivity of forwarders was less affected by the smaller piece sizes of early thinning
- wood was kept free from dirt

- wood was of standard lengths and enabled the maximising of truck payloads
- damage to residual stems was reduced
- forwarders had a better performance than skidders in wet weather.

INTRODUCTION OF THE FIRST HARVESTERS AND PROCESSORS - EARLY TO MID 1970s

One of the main recommendations of a major logging conference held in Canberra in 1968 was for logging research in the field of "mechanisation of 1st thinnings extraction including delimbing" (7). The reason for this interest in mechanisation can be shown in figure 1 which was presented at the time. Adherence to the prevailing silvicultural regimes would result in substantial amounts of first thinning material being available for harvesting.

FIGURE 1: Volume to be removed from Australian Softwood Plantations - 1968 Estimates



Source (7)

The response of the F and TB research organisation was to develop the concept of a small tree harvester to work in row thinning. A prototype was built by a Brisbane company, Windsor and Sons, in conjunction with APM Forests Pty Ltd. The Windsor harvester was built on a Timberjack 330 base. It had a forward mounted felling head which severed the tree and lifted it on to its back where the stem was delimbed and topped. A bunk on the back allowed the accumulation of approximately 2 m^3 (up to 25 trees). The prototype underwent development and a production model was built which became operational in APM's Victoria forests in mid 1973 in a first thinning operation with a third row outrow. The optimum tree size

for this machine was reported to be between 0.11 and 0.17 cubic metres and approximately 60 trees per hour were processed (8). Its standard of delimbing for Pinus radiata was not high, particularly with malformed stems and it could not delimb the first metre of the stem.

All of the three units sold in Australia were bought by APM, the company acquiring two Mark III versions in early 1979. At present two of the units, the Mark II and one Mark III version work on a first thinning operation, and produce log length material which is skidded to the roadside by a grapple skidder where it is cut into 1.8 m billets. The third unit is not in use. All three machines are near the end of their service life and it is likely that, with the change in the woodroom by APM to handle longer lengths requiring a better standard of trimming, the Windsors will be replaced.

Early in the development of the Windsor, the manufacturing rights to the harvester outside of Australia were obtained by Eaton Yale, USA. A number of these were built for use particularly in North America. A machine of similar design and function still forms part of the "Series 30" system promoted by Timberjack.

The first display of a Swedish built delimber-processor, the Volvo Tvigg 985 processor was seen at FIME 1975. This is a self contained unit which is mounted on a Volvo SM868 forwarder. In this unit, trees are fed by knuckleboom crane to the continuous feed delimbing function which has a delimbing head consisting of one fixed and two moving knives. The processor can be set to delimb automatically and cut-to-length freeing the operator to select another stem with the crane.

Trials in first and second thinnings indicated productivities of 74 to 100 trees per hour in the first thinnings and 70 trees per hour in the second thinning, (0.17 m^3 and 0.48 m^3 average merchantable tree size respectively) measured on a gross data basis (9). Delimbing quality was good. However, the unit had difficulty with heavily branched stems and malforms which required manual intervention in the otherwise automatic processing.

Another problem with the Tvigg is that the delimber unit is aligned at right angles to the extraction track. The processed billets are therefore placed among the residual stems at the edge of the track. This can cause damage to the residual trees and makes extraction more difficult for the following forwarder.

The felling unit for the Tvigg was a small tracked feller-buncher which had a locally made head. A fifth or seventh outrow system was used accompanied with selection thinning. At present the Tvigg processor is not being used by its owners, Pyneboard Pty Ltd of NSW, but may be used again in thinning steeper areas of the region.

Around the same period as the introduction of the Tvigg a variety of various felling devices on different prime movers were tested, mostly in early thinnings, and the results of trials reported (10, 11, 12). Some of these units, such as the Bobcat, found a place in harvesting, others, for example the Can-Car Hydrostatic clipper, did not. In general they were units not specifically designed for harvesting operations.

ADVANCEMENT OF MECHANISATION - LATE 1970s TO EARLY 1980s

Importation of two machine systems in 1977, one of North American origin from John Deere and the other from the Swedish company of Kockums, was the beginning of the current dominance of these systems in the Australian mechanisation field. The first John Deere 743 Tree Harvester was introduced into Western Australia where it was used in first thinnings on a fifth row outrow (13). The harvester is based on a JD 740 skidder. Its knuckleboom mounted shear head enables it to fell either side of its outrow and place the felled stems into the forward mounted delimbing head. The delimbing head consists of a set of three knives and a pair of feed rollers which drag the stems through the knives. Processing is in tree length so subsequent processing is required before forwarder extraction, although a docking saw can be added (14). There are now four John Deere 743's in each of the states of Western Australia, South Australia and Tasmania. All are working in early thinning operations.

A long term productivity study on the harvesters indicated a productivity of between 16 and 22 m^3/hour in stands with an estimated average tree size of between 0.2 and 0.3 m^3 (15).

The first Kockums processor, the Logma T310, was introduced into Australia, jointly by three major private forest companies to assess its suitability to Australian conditions. After a production trial the major contributing company (APM) purchased the unit.

A feller-buncher from the same manufacturer, a Kockums 880, was added in 1979 followed by a second Logma processor to match the production capacity of the feller-buncher. Unlike most of the other processors, the Logmas have worked in clearfelling operations in Australia. It has the capacity to handle larger sized material in the region of 1 m^3 and is able to satisfactorily delimb the wood.

Productivity for the Logma has been recorded as approximately 17 m^3 per machine hour in a fifth thinning operation where the average tree size removed was approximately 1 m^3. In the same conditions the feller-bunchers productivity was 50 m^3 per hour (17).

The Logma limber-bucker processor is an articulated frame-steering unit with the power unit in the rear frame and the cab and delimbing unit on a swivel base on the forward frame. Delimbing is achieved by a telescopic boom with a set of wrap-around knives on each of the fixed and extension booms. The stem is step fed along the boom through the knives and is cut to length by a hydraulic chainsaw mounted behind the set of knives on the fixed boom. The Logma processor is a comparatively large unit; it has a service weight of 22 tonnes. It is one of the oldest and most robust of the Swedish built processors still in production. The first production model was built in 1968 (16).

In the largest influx of forest logging machinery seen in one period, ANM Ltd in 1981 installed ten mechanised systems, all using Kockums machinery, each with a feller-buncher 880, a Logma processor and a forwarder. All this equipment was to work in first thinnings on a fifth row outrow basis in forests of the Tumut district of NSW and in the forests of NE Victoria, and supply pulpwood for the Albury pulp mill.

Productivity can be expected to be lower than above as the tree size processed is considerably smaller.

The only other Logma processor in Australia works in pine thinning operations in Western Australia. It processes wood fallen by a JD743.

Also in 1981 a new type of mechanised machinery was introduced by Pyneboard in Tumut, NSW. This used two standard Kato hydraulic tracked excavators as the base units for felling and processing. Typically subsequent extraction was by forwarder. One of the units has a locally built felling head and operates as a feller-buncher. The other has a Swedish built Skogsjan grapple processor head at the end of its boom. Trees are grappled and rollers feed them through a set of delimbing knives. A measuring system combined with a programmable device enables automatic stopping of the feed rolls at the programmed lengths when the stems can be cut by a hydraulic chainsaw. The delimbing capacity of the Skogsjan is less than either the JD743 or the Logma. However, it has the advantage of being able to position accurately the output because of its location at the end of a boom. The resultant piling from this system is very neat and eases the subsequent loading by the forwarder. The Kato/Skogsjan operator also is able to segregate readily pulpwood and sawlogs if necessary. Another significant advantage is its low capital cost compared with either the Logma or John Deere processors.

Finally, the latest harvesting system to be imported is one of New Zealand origin, a Waratah delimbing head mounted on a Kato excavator base. The Waratah head consists of a set of shears at each end (one to top the stem and the other to sever the butt) and a set of four delimbing knives. Stems are delimbed standing before severing. Delimbing quality is high because the head is moved from the top down against the angle of the limbs. The boom can only reach a height of 7 metres. However, trees with a longer merchantable stem can, with sufficient operator skill, be delimbed in two pieces.

Production figures available from New Zealand's Lake Taupo operation where a tenth row outrow with selection thinning was used, show the unit produced 95 m^3 per day in an average merchantable tree size of 0.11 m^3 (18). Production figures from the Australian Waratah are not available as it is at present being used in early thinning on a trial basis by APM in their Gippsland forest.

Table 1 gives details of the number and types of currently used mechanised felling, delimbing, and bucking units in Australian P. radiata plantations.

TABLE 1: Summary of current operational felling and processing units in Australian P. radiata plantations

Western Australia	1	Bobcat feller-buncher
	1	Logma processor
	4	JD 743 harvesters
South Australia	4	JD 743 harvesters
Victoria	4	Kockums 880 feller-bunchers
	5	Logma processors
	2	Windsor harvesters
	1	Kato/Waratah harvester
Tasmania	4	JD 743 harvesters
New South Wales	7	Kockums 880 feller-bunchers
	1	Kato feller-buncher
	7	Logma processors
	1	Kato/Skogsjan processor

WHY THE TREND TO MECHANISATION?

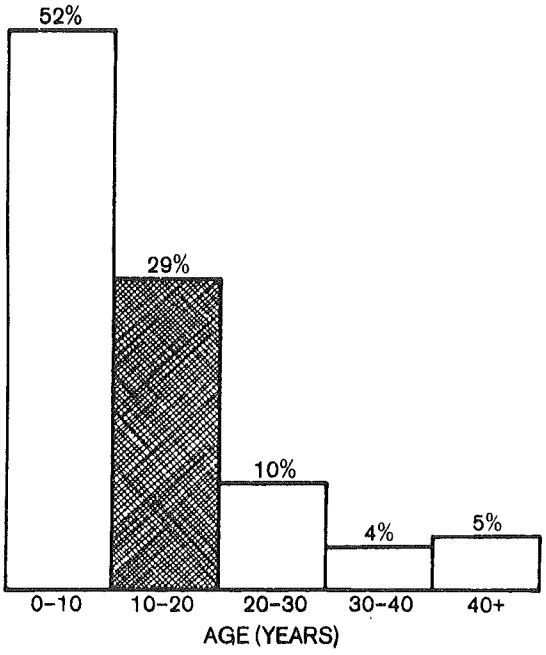
Recently Australian companies have progressed rapidly into mechanisation of some of their harvesting operations, particularly early thinnings. The main reasons why they have done so are:

1. Forest Resource Age Structure
   The Australians have gone through an expanded planting programme in the last twenty years which has led to a preponderance of young tree age classes. Unlike New Zealand, they do not have the supply of older stands planted in the 1930s and 1940s to enable them to manipulate their clearfelling yields.

   The current age structure of Australian P. radiata is shown in figure 2. A large portion of the radiata pine estate is in the age class 10 to 20-years-old, i.e., the age ready for a first commercial thinning. The estimated production for softwoods in 1980 was 5.1 million m^3, with sawlogs contributing 2.9 million m^3 and pulpwood 2.2 million m^3 (19).

2. Silvicultural treatments
   The States with the majority of the P. radiata resource, (NSW, Victoria and South Australia), have followed a silvicultural philosophy of multiple production thinnings, maintaining high stockings, and a full site occupancy. Only Tasmania and Western Australia, have employed comparatively severe thinning regimes similar to New Zealand's. However, one or more commercial thinnings are generally included, very little being thinned to waste.

FIGURE 2: Proportion of P. radiata by area in 10 year age classes (1980



Source (20)

The early thinning material has an average stem size of approximately 0.13 to 0.17 m^3 (19). It therefore suits machines which have been developed in North America and, particularly, Scandinavia to handle trees of this tree size and up to approximately 0.3 m^3.

3. Terrain
Australian terrain in general is much flatter and less broken than New Zealand's. The Australian plantation estate has not yet been pushed into the steeper regions as it has in New Zealand. Consequently a large proportion of the P. radiata plantations are on areas which are less than 15^o slope, i.e. suitable for wheeled machines.

4. Labour supply
Perhaps the single most important reason why mechanisation has advanced in Australia is a lack of labour. Documentation of the arrival and testing of mechanised operations have invariably been accompanied with comments on the inability of logging companies to attract and retain a suitable workforce for motor-manual logging techniques. An early report by Raymond (8) on the Windsor Harvester in Victoria comments on the difficulty in finding enough men to harvest their (APM) first thinnings material in 1972.

Similarly the introduction of the Tvigg processor in NSW was made with a comment on "the difficulty of attracting men to work in the forest, particularly in the traditional manner which exposes them at times to harsh conditions" (21).

Quill (22) discussing the background to the introduction of John Deere harvesters into the Mt Gambier region lamented on the lack of interest shown by fallers in early thinning operations because of "the high level of labour involved, comparative high level of injury, anticipated lower level of income and general prejudices against these thinning operations".

Finally, in ANM's introduction of specialised equipment to harvest early thinnings Beath (23) stated one of the reasons a mechanical harvesting method was chosen was because of "the difficulties in attracting and training adequate numbers of chainsaw cutters".

Thus, in spite of a general unemployment figure of around 6%, companies have found it difficult to attract the required manpower into the forest. The reasons for this are likely to be many. Quill (22) highlighted some, others could be:

- unpleasant working conditions for summer months
- unsocial working conditions, i.e. cutters working in isolation compared with New Zealand gang structure
- more attractive alternative work available
- forest areas distant from towns and cities of sufficient size to have desired amenities.

SUMMARY

Current Australian P. radiata harvesting is dominated by thinning operations. This is a result of the structure of the resource, the thinning regimes used, and the development of the user industries.

Mechanisation of harvesting has up till now been confined to thinning operations and more particularly to early thinnings. This, in part, has been enforced by a lack of suitable labour to carry out motor-manual techniques and encouraged by the availability of suitable machinery developed to harvest trees of an early thinnings size.

Australia is likely to see a continuation of this trend as the forest area expands and their experience in mechanisation increases.

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