# POTENTIAL UTILISATION TRENDS FOR REGROWTH ASH-TYPE EUCALYPTS

GODFREY LADU

1995 GOTTSTEIN FELLOWSHIP REPORT

The information contained in this report is published for the general information of industry. Although all reasonable endeavour has been made to verify the accuracy of the material no liability is accepted by the Author for any inaccuracy therein nor by the Trustees of the Gottstein Memorial Trust Fund. The opinions expressed are those of the author and do not necessarily represent the opinions of the Trustees.

# 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 - each year applications are invited from eligible candidates to submit a study programme in an area considered to be 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.

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.

4. Study Tours - industry group study tours are arranged periodically and have been well supported.

Further information may be obtained by writing to,

The Secretary,
J.W. Gottstein Memorial Trust Fund,
Private Bag 10,
Rosebank M.D.C.,
Clayton, Victoria, 3169 Australia

Godfrey Ladu is a technical officer with Marbut Pty Ltd in Seymour, Vic. He has a Master of Forest Science degree from Melbourne University, as well as qualifications in timber technology from Buckinghamshire College, U.K. On his Fellowship, Godfrey undertook a survey around the main hardwood processing and application centres within Australia with a view to gaining knowledge that will help to develop ways to increase designer and specifier confidence in the use of ash-type eucalypts.

Of special interest was the application of value adding techniques using the latest adhesive technology in the manufacture of engineered timber products. The locations visited were South-east Queensland, northern New South Wales and Western Australia.

# POTENTIAL UTILISATION TRENDS FOR REGROWTH ASH-TYPE EUCALYPTS

Godfrey Ladu
Gottstein Fellowship 1995

# CONTENTS

**Table** **Page**



**Figure**



**List of Plates**

## ACKNOWLEDGEMENTS

I express my sincere thanks to the Gottstein Fellowship Trust for awarding me the 1995 Fellowship and strongly appreciate Mr.Bill Keating's assistance during the preparation of my tour itinerary.

Also, I thank my employer Marbut Pty Ltd for providing me the valuable time for the study tour and preparation of the report.

I am indebted to all who provided assistance during the tour particularly Mr. Graham Keegan and David Hayward of TRADAC, Queensland, Mr. Len Wilson and Paris Alexiou of WESFI, Mr. John Clark of CALM and Ed Valom of Bunnings.

## ITINERARY (1995)

### SOUTH-EAST QUEENSLAND AND NORTHERN NEW SOUTH WALES.

Monday 15 May-

Gunns, Glulam Plant-Brisbane
Spring Wood Beams-Brisbane
3-D Door Manufacturer-Brisbane

Tuesday 16 May-

QDPI-Forest Service-Beerburrum District.
Grant Timbers-Woodford

Wednesday 17 May-

Hyne and Son-Sawmill and Glulam plant-Maryborough

Thursday 18 May-

Boral-Drying plant-Murwillumbah.
N.S.W State Forests-Coffs Harbour.

Friday 19 May-

Nataras and Sons-Sawmill-Grafton, N.S.W

### WESTERN AUSTRALIA

Monday 17 July-

WESFI-MDF Plant Kewdale-W.A

Tuesday 18 July-

WESFI-Particle board plant, Bunbury-W.A
Dyno Industries, Resin manufacture, Bunbury-W.A

Wednesday 19 July-

CALM-Bunbury
CALM-Harvey Research Centre
Native Forest Logging

Thursday 20 July-

Whittaker, Greenbush mill.
Bunnings, Manjimup processing centre
Bunning-Pemberton and Deanmills

Friday 21 July-

CALM-Crawley
Bunning-Welshpool.

Wednesday 24 August

CSIRO Division of Forest Products, Clayton, Victoria.

## Executive Summary

The information provided in this report has been based on utilisation of hardwood species in three Australian States. It is hoped this information can be used to contribute to better utilisation of the regrowth Ash-type Eucalypt wood resource as well as provide some element of confidence for designers and specifiers who intend to work with such wood.

The Gottstein fellowship awarded to the author has allowed the reporting on developments in wood utilisation, including use of adhesive technology for value adding on timber species in different states of Australia.

Major recommendations relevant to utilisation of Ash-type Eucalypts are provided in the first section of the report and are summarised as follows:

- Intergrated logging system could be usefully introduced in regrowth Ash-type Eucalypt stands in order to effectively utilise all wood resources available in a given coupe.

- There is a need to invest in new machinery for better handling, sawing and drying of regrowth Ash-type Eucalypts. Also, efficient sawmill production runs may be achieved as a result of segregating logs in terms of species, lengths and grades.

- Use of adhesives for production of both appearance and structural products would boost the utilisation of regrowth Ash-type Eucalypts.

- Other recommendations include the need for increased communication between researchers and the timber industry, introduction of quality control mechanisms to facilitate consistent product quality and a need to review design criteria particularly for engineered timber products.

# SECTION 1

## 1.0 INTRODUCTION AND BACKGROUND TO THE STUDY TOUR

Nowadays smaller diameter logs from regrowth forests are a common occurrence in most Australian hardwood sawmills. This has been mainly due to the conservation of old growth wood resources and the introduction of new forest management practices.

Certainly the reduction of wood resources lead to increased awareness for the need to add value to the existing limited resource.

Besides developing suitable log handling, sawing and drying practices for regrowth timber resources, use of adhesives to transform small pieces of wood into larger sections for both structural or appearance products is a worthwhile move, and such practices may need to be manifested in the utilisation of Ash-type Eucalypts in order to improve specifier and designer confidence.

In the light of the above a study tour of wood processing industries that utilise other hardwood species was proposed by the author and submitted to the Committee of Gottstein Memorial Trust for assistance.

The main thrust of the study tour was to observe sawmilling, drying and use of adhesives for the production of engineered and appearance grade hard wood materials in South East Queensland, Northern New South Wales and Western Australia. At the same time, the author had the opportunity to observe forest management practices and the use of adhesives for the production of reconstituted wood products from plantation softwoods.

## 1.1 RECOMMENDATIONS RELEVANT TO REGROWTH ASH-TYPE EUCALYPTS

After the study the following recommended practices were perceived as being examples of efficient utilisation that would be applicable for regrowth Ash-type Eucalypts.

### 1.1.1 FOREST MANAGEMENT PRACTICES

Integrated logging systems could usefully be introduced in the regrowth Ash-type Eucalypt forest stands in order to utilise all the wood resources available at each coupe. Clearly large quantities of forest residues are often left on the forest floor to rot. Where residues are extracted in an integrated logging system and used for such products as short length sawn timber for furniture components, chips for pulp, chip board, particle board and medium density fibre board utilisation is improved markedly. Also, with the adoption of an integrated logging practice other minor tree species found in a coupe but previously not harvested are extracted and utilised.

### 1.1.2 LOG YARD, SAWMILLING AND DRYING PRACTICE

There is a need to segregate the regrowth Ash-type Eucalypts logs at log yards by species, lengths and grades in order to improve mill production run efficiencies.

Many of the current sawing practices for regrowth Ash-type Eucalypts may require updating due to the inherent growth stresses in the regrowth logs. This would require investment in new machinery for handling and sawing.

The concept of pre-drying the timber in a suitably enclosed and controlled environment before kiln drying can be most successful and needs to be encouraged for regrowth Ash-type Eucalypt timber. Where this practice is in place overall drying times are reduced and good quality products in terms of colour and drying degrade are produced.

### 1.1.3 SAWMILL RESIDUE FOR FUEL

Some Ash-type Eucalypt producers utilise their own sawmill residues such as saw dust for fuelling boilers. This practice ought be encouraged since utilisation of mill residue would contribute to substantial energy cost savings especially if such energy is used for provision of heat for kiln drying operations evident in the state of Victoria at Marbut, Mt Beauty and Goulds kiln drying facilities.

### 1.1.4 USE OF WOOD ADHESIVES

Use of wood adhesives for the production of large members or larger sections from small pieces obtained from mill off-cuts would boost utilisation of the regrowth Ash-type Eucalypt resources for both appearance and structural products. Products such as benchtops, valwood, laminated beams, laminated veneer lumber, parallam, particle board, and medium density fibre board could be manufactured from this resource using adhesives. Examples of the efficient use of adhesives in this way were in operation at Westralian Forest Industries (WESFI) in Western Australia, Gunns, Springwood Beams and 3-D Doors manufacturer in Brisbane, and Hyne and Son in Maryborough, Queensland.

### 1.1.5 OTHER RECOMMENDATIONS

#### 1.1.5.1 Communication

Information sharing between researchers and Industry is a vital proposition. Industry personnel need to be included in research committees so that industry perspective may be included in research proposals and activities. Timber Research and Development Advisory Council (TRADAC) in Queensland and Conservation and Land Management (CALM) in Western Australia seem to be good examples.

1.1.5.2 Quality control

Quality assurance by automation would be a suitable alternative to human controls. Such a move would mainly reduce the subjective nature of human judgements and reduce errors in objective measurements. Where automation is impractical regular training schedules for workers on those aspects of quality control that are relevant to timber production need to be encouraged.

1.1.5.3 Design criteria for laminated timber

Design values for structural timber take into account strength-reducing defects such as knots. However, engineered wood materials such as glued laminated beams often have these strength reducing defects removed during production and the final products have no such defects. Thus, provided the engineered timber has been suitably glued, its strength value would be expected to be greater than current allocated design values of unglued timber, or its performance would at least be much more realised as per the Australian Standard 1720.1-1988, Timber Design Code.

The use of modulus of elasticity values (E-values) appear to be a useful development as deflection values count far more than rapture values in most applications. Hyne and Son at Maryborough, Queensland have adopted this approach. It would seem appropriate to specify regrowth Ash-type Eucalypt timber on the basis of its deflection values as this accounts more if the timber is used for purposes such as lintels, floor and ceiling joists.

# SECTION 2

## 2.0 FOREST RESOURCE SITUATION IN AREAS VISITED.

### 2.1 GENERAL

The study tour included forest areas in Queensland, New South Wales and Western Australia.

Currently in Queensland one third of the native forests are in conservation reserves where no harvesting is permitted. Commercially productive native forests are confined to less than five percent and concentrated in the east and south of the state. In the last 10 years logging has been forbidden in many areas such as in Fraser Island, and towards the early part of next century there is an expected decline in the available area of commercially productive native forest. Thus increasingly resource problems affect most sawmills, including those mills that own tracts of forest for their utilisation.

In New South Wales (NSW) large areas of old growth forests have been reserved. Currently there is more focus on environmental sustainability in forestry harvesting and general expansion of the state's plantation of hardwood resource. In June 1995 the NSW state government suggested that the proposed establishment of hardwood plantation of 3000ha in 1996 would be increased so as to eventually reach 10,000ha per annum by 1998.

Western Australia's forest practice has been largely restructured to suit the state's timber Industry. A ten year forest management plan involving among other things the silviculture of two of the state's main timber producing species such as *Eucalyptus marginata* Don ex Sm (jarrah) and *Eucalyptus diversicolor* F. Muell (karri) is now under way.

During the tour specific forest types and areas visited by the author included regrowth hardwoods forests around Beerburrum in south east Queensland, Harvey and Manjimup

in the central and southern forest regions of Western Australia, and a plantation hardwood forest in northern New South Wales.

## 2.2 SOUTH EAST QUEENSLAND

In South East Queensland, approximately 1.5 hours drive to the north of Brisbane is the Beerburrum natural forest area which covers 40,000 hectares. In this forest average tree Diameter Breast Height (DBH) is approximately 40cm. Regrowth Eucalypt species such as *Eucalyptus pilularis* Sm (blackbutt), *Eucalyptus maculata* Hook (spotted gum) and a mixture of other species such as *Eucalyptus microcorys* F.muell (tallowwood), *Eucalyptus grandis* W.Hill Ex Maiden (rose gum) and *Eucalyptus eugenioides* Sieb.ex Spreng (white stringy bark) are common in the area.

Of the 25,000 $m^3$ of log harvested per annum from this forest area, approximately 80% is *E.pillularis* and less than one-third *E. maculata.*

Log harvesting is by contractors who supply local Sawmills with the logs. The harvest strategy is a selective logging rather than coupe logging. At each felling area all the over-mature trees with Diameter Breast Height (DBH) 80 cm are automatically removed as well as any other trees of diameter greater than 40 cm that has been marked by the State Forest Department Officers. Seed trees are always left standing since less than 40% of the standing saleable timber in any area would be logged at any one time. Natural regeneration occurs after and between each selective harvest, leading to the forest containing a mix of ages.

Most of the trees harvested are sold by the State Forest Department at a fixed log price of $\$40/m^3$. However, when the log has 51% defect the price is reduced to \$3 per $m^3$. There is no segregation of logs into different grades. The logs are regarded as being suitable for saw or veneer production. This method was adopted because the earlier method of segregating logs by grade was regarded as being time-consuming and required more resources in order to be effective.

## 2.3 NORTHERN NEW SOUTH WALES

In the Coffs Harbour area of northern New South Wales is a 1970 plantation of *Eucalyptus maculata* Hook (spotted gum). The plantation was part of a large area planted by Australian Paper Manufacturers (APM) in northern New South Wales but subsequently sold to the New South Wales State Forest Service when APM abandoned its plan to build a pulp mill in the area.

A thinning operation by mechanical means was observed in part of a 10,000 hectare section of the plantation (Plate 3). This operation which involves felling, debarking and cutting the log to suitable lengths for supply to the local mills in the area is conducted by contractors who have been trained in tree selection as well as log grading. Logs with small end diameter greater than 30cm are regarded as saw or veneer logs and those of less than 30cm are categorised as useful for pulp, poles and girders (Plate 4). Approximately $100m^3$ is harvested per hectare leaving 120 standing stems per hectare.

During the visit it became clear that processing plants for such products as chip board or particle board would be required in the area to process the wood from some of the smaller defective or wolf trees extracted during thinning operations.

## 2.4 WESTERN AUSTRALIA (W.A.)

Most of the timber producing hardwood forests of *E.marginata* (jarrah) and *E. diversicolor* (Karri) are found in the south and central western region of W.A.

During the tour it was noted that West Australia's Conservation and Land Management (CALM) has a 10 year forest management plan involving among other things the silviculture of two of its main timber-producing species, the jarra and karri found in the south and central region of the state. For these species the following silvicultural treatment is being progressively adopted over the period 1994-2003.

2.4.1 *E. marginata* Forests (Jarrah Forests)

In jarrah forests the restructuring has to some extent meant reduction in area for harvesting as the following indicates.

(a) The maximum cleared area (gap) size has now been reduced to approximately 10 hectares and its shape is varied to meet visual resources and management objectives. Only sufficient trees in terms of number, age and condition are retained in the gap to provide a habitat for hollow nesting species.

(b) Regrowth jarrah stands are to be thinned to a minimum basal area of $10m^2$ per hectare (Plate 1). Exception to this will be in areas with higher risk of discharging saline ground water for which the minimum basal area will be $15m^2$ per hectare.

The current estimated increment of 1.1 $m^3$/ha/year for the cut jarrah, and this includes a substantial area of regrowth, has the potential to increase to $2m^3$/ha/year following the adoption of appropriate silvicultural treatment.

2.4.2 *E. diversicolor* Forests (Karri Forests)

In Karri forests the restructuring has meant the following.

(a) Maximum coupe size has been reduced from 200 hectares to 80 hectares.

(b) An additional 3200 hectares of mature karri has been excluded from timber harvesting for retention as patches for hollow nesting amongst clearfelled and regenerated stands.

(c) Rotation length is now varied to ensure forest structural goals are achieved. For instance, over 20% of the pre-1940 regrowth is being deferred from clearfelling and left to develop mature/senescent characteristics. The rest is being managed on a rotation length of at least 100 yrs. Over 30% of the total area of regrowth forest regenerated between 1940 and 1975 is being deferred from clearfelling, the rest being managed on a rotation length of at least 100 yrs.

The current estimated increment for even aged regrowth karri of 5 $m^3$/ha/year has the potential to increase to 8$m^3$/ha/year following the adoption of the appropriate silvicultural treatment.

Also, CALM's management plan involves the setting of annual harvest limits in the period 1994-2003 as shown in table 1.

Table 1: Annual harvest limits 1994-2003

| Species/Grade | Premium grade + First grade | Second grade | Others including residue | Total |
|---|---|---|---|---|
| Jarrah | (A) 490,000$m^3$ | | up to 870,000$m^3$ | 1,360,000$m^3$ |
| Karri | 214,000$m^3$ | (B) 203,000$m^3$ | | 417,00$m^3$ |
| Total | | | | 1,777,000$m^3$ |

(A) Volume of premium grade, first and second grades are combined.

(B) Volume of second grade and others including residue are combined. (Adopted from Clarke, John-CALM: personal Communication 19 July 1995).

In addition to the above volume of timber there are 559,000$m^3$ of *Eucalyptus calophylla* R.Br.Ex Lindl (marri) included in the annual harvest limits for 1994-2003. However, details of quantities of specific log grades as well as management regimes for the marri was not available to the author at the time of the visit.

An integrated logging system is now in place in Western Australia. This implies in each coupe contractors are responsible for harvesting all categories of logs marked by State Forest Department officials. These include sawlogs, chip logs and fuelwood. Indeed, currently 60,000$m^3$ of log residues are collected for Industrial charcoal production and 40,000$m^3$ for domestic fuel. It is expected that approximately 11,000 $m^3$ of jarrah residue (Plate 2) would be collected from these forests due to more focus on integrated logging.

Also, species previously not harvested for sawlogs such as *Causarina fraserana* Miq (sheoak) are now being harvested provided in a given coupe the stock density of such a species can constitute a truck load for transportation to a processing plant.

Clearly, the timber industry in Western Australia has been restructured and CALM's timber strategy has given resource security to the timber industry thus facilitating the industry to carry out investments, conduct research, and develop new markets. The industry in turn agreed to pay an increased royalty for the increased resource security.The resource security provided spin-offs like increase in the general output of value-added products such as laminated beams etc. Also, logs that were previously burnt in the forest are now being sawn and/or processed further into other uses such as wood chips, or short pieces for furniture components.

The restructuring of the forest industry also means that CALM now deals directly with the logging contractors, and has computer records for log output from the forest, and automated control for revenue collection and contractor payment. The new move is because the traditional system was so complex and difficult to control since the logging contractors were mainly answerable to the sawmillers as far as log harvesting was concerned.

# SECTION 3

# 3.0 RESOURCE UTILISATION

## 3.1 SAWMILLING-GENERAL

Generally products from milling logs using saws include timber and by-products such as wood chips and sawdust. It was evident during the study tour that provided a log is defect free, its size has an important bearing on the quality and quantity of timber and by-products produced. It is also generally known that decreasing log diameter lead to less output of sawn timber and increased log diameter lead to higher output of sawn timber relative to yield of chips and sawdust as roughly shown in the following figure.

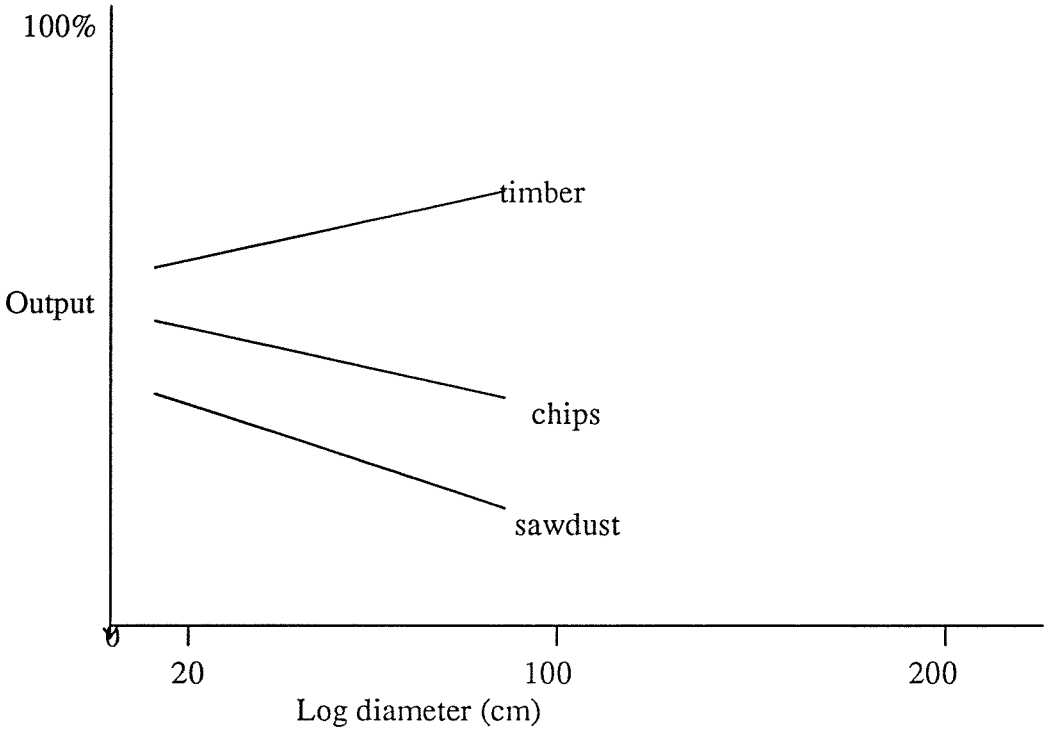


Figure 1: Relationship between log small end diameter and mill output.

Log costs usually represent up to 70% of cost of manufacturing sawn timber. Moreover, royalties are constantly being revised by various state governments in Australia with a view to increasing revenue. Therefore additional ways need to be found for improving the log processing by such means as adoption of sophisticated scanner/computer technology and use of high strain thin kerf saws to improve conversion efficiency. Also,

the change of resource to regrowth or young plantation logs would require new log handling, new processing equipments and new techniques due to the inherent growth stresses in the smaller diameter logs.

During the study tour, sawmilling operations were observed by the author in South East Queensland, Northern New South Wales and Western Australia. Some of the mills were conventional while others had been upgraded to handle and process smaller diameter logs. Grading of the sawn timber was mainly as per Australian Standard 2082-1979. However, in Queensland green hardwood products are graded as parcels of F14. This is more or less similar to some Ash-type Eucalypt producers in Victoria who grade all green Ash-type Eucalypts as F8 instead of segregation into F8 or F11.

The following is an overview of observations at sawmills visited.

### 3.1.1 SOUTH EAST QUEENSLAND (S.E Queensland).

In S.E Queensland, Grant Timbers sawmill located at Woodford utilises wood resource obtained from its private forest area around Woodford. Annual mill input is in the order of 10,000-ll,000$m^3$. About 50% is *E. pilularis* (blackbutt), 15% *Tristania conferta* R.Br (brush box) and the rest comprised of *Eucalyptus spideroxylon* A.Cunn.ex Wolls (red iron bark), *Eucalyptus acmeniodes* Shau (white mahogany), *Eucalyptus grandis W.Hill* ex maiden (rose wood) and *E.microcorys*(tallowwood). Average log diameter at the mill is 30-40cm, though some old growth logs had a diameter greater than 40 cm, and were segregated by species and lengths. Many old growth logs were hollow or have a large proportion of decayed heartwood.

The increased quantity of regrowth logs has necessitated investment in new machinery for log conversion. The new machinery is a twin edger (double slabber) of size 1500mm and designed to handle logs up to 6.9 m length with an overhead dogging mechanism. The saws have the capacity to move on the arbor from 75mm to 860mm separation and this maximise the width of timber that can be recovered (Plate 5). A transfer system has been installed with a rollcase that leads the timber either into a roundabout or storage area for later resawing, or direct to a line bar bench. The roundabout is particularly

useful as it allows the mill to be more flexible. Overall the new edger aims to reduce tension stress evenly on the log and combat spring in the sawn board. Thus small diameter logs can be processed economically and effectively to produce straight and accurately sized products.

Large old growth logs at the mill are broken down by a conventional circular saw with a log carriage and the sawn planks are processed further down the line on the bench.

At the mill, flat sawing pattern is employed for both the regrowth and old growth logs to produce both structural and appearance grade timber. Overall timber recovery from logs processed at the mill is approximately 46%. The Grant timber sawmill at Woodford could be said to be an example of a sawmill suited to production of quality products from a small log resource.

The second sawmill visited by the author in S.E Queensland was located in Maryborough and owned by Hyne and Son. The mill cuts mainly *E. maculata* (spotted gum) which occupies 60% of the production. The rest of the mill input consist of other high density Eucalypts such as *E.pilularis* (blackbutt) and *E. sideroxylon* (red ironbark) which are obtained from the Maryborough area. Again, as at Grant Timber sawmill in Woodford, most of the old growth logs at this mill have some level of decayed centre.

Log input at the Maryborough sawmill is approximately 90-100 $m^3$ per day. The logs are broken down on a single bandsaw headrig with a carriage. The flitches and sawn boards are further reduced by three circular saw benches. Sawn timber recovery ranges between 39-42%. As at Grant Timber sawmill at Woodford, the cutting pattern is flat sawing for production of structural and appearance grade timber.

### 3.1.2 NORTHERN NEW SOUTH WALES

The mill visited was located at Grafton in northern New South Wales, and is owned by J.Notaras and Sons. Log resource obtained from Coffs Harbour forest area is processed at the mill. Approximately 50% of the log input is from a 20 year old regrowth forests of *E. maculata* (spotted gum) *and Tristania conferta* (brush box) of diameter less than 40

cm. Old growth logs with diameter greater than 40 cm, some with decayed centre, are also processed at the mill.

The sawing pattern is essentially flat sawing. The old growth logs are broken down by a conventional single circular saw with a carriage. The sawn flitches are transferred to the resaw bench for further processing.

The company has invested in a twin edger similar to the one at Grant timbers in Woodford, S.E.Queensland for processing regrowth logs. However, the transfer system is not similar to the one observed at Woodford since there is no rollcase leading to a roundabout or storage area. Therefore initial cuts from the edger are sent directly to the resaw bench.

At the Grafton sawmill, recovery of timber from logs of diameter less than 40 cm is approximately 40% and from logs of diameter greater than 40cm approximately 30%. The mill output is approximately 19$m^3$ per hour and most of it is for structural application such as lintel, scantlings, and for appearance products such as flooring, and landscape timber obtained from poor quality cores of logs of durable species such as blackbutt.

Timber with sapwood susceptible to borer attack is preservative treated at the site using Copper-Chrome-Arsenic (CCA). It was evident that 85% of the lyctus susceptible sapwood from regrowth timber is treated green using this preservative before air and kiln drying.

Wood waste is burnt in an incinerator at the mill site.

### 3.1.3 WESTERN AUSTRALIA

In Western Australia the processing of the two main hardwood timber producing species namely *E. diversicolor* (karri) and *E. marginata* (jarrah) was observed by the author at separate processing sites owned by Bunnings and Whittakers respectively.

At Bunnings Pemberton sawmill approximately 100,000$m^3$ of logs mostly karri has been made available for sawing. This includes both old growth and regrowth logs. The mill has two processing lines. One line processes old growth logs and the other regrowth logs.

The old growth log line at the mill has a single Mckee bandsaw headrig for breaking down logs into sawn boards of the required thickness to be further processed by a multi saw to finished sizes. The boards are then end trimmed and transferred to a two-person operated high speed 10 saw docker line that has saws placed at 900mm centres. If the board is seen to have a combination of product grades such as pallet, structural or appearance grades along its length, it is docked simultaneously into the respective grades using two or more of the high speed docker saws. The docked piece is then transferred to the respective lines for grading and stacking. In this way large quantity of timber can be sorted easily and a consistent quality becomes readily attainable. The docking system is not fully automated as visual observation and judgement by the docking saw operators is the key to its successful operation.

Regrowth logs, most of which are of 40-50cm small end diameter are processed at the mill on the second production line that has modern Mckee equipment. The processing involves scanning the log and then a computer program is used to determine the optimum cutting pattern which is then shown on a monitor to assist the sawyer in the cutting process. The sawyer, however, may adjust his cutting operation to suit the prevailing log quality following the initial cut.

A twin band saw (chippercanter) simultaneously makes the initial cuts on the log to produce two side slabs and chips, the log is then turned $90^0$ and the same process is repeated (Plate 6). This sawing strategy is meant to reduce stress on both sides of the log and aid in production of timber free of spring-a defect associated with regrowth logs that have inherent growth stresses. The sawn boards are further processed by a multi-edger which has laser guides for accurate sizing. Along the production line the sized boards are end trimmed. The trimmed boards are then transferred to the high speed 10 circular saws docker that has saws placed at 900mm centres and docked where necessary in a manner described earlier on the old growth log production line.

Overall daily timber production from the Pemberton mill is approximately 200m$^3$ and recovery 45%. Approximately 90% of the timber is sold green-being exported to Europe and in niche Australian markets and 10% is seasoned mainly for the flooring market in the eastern states of Australia. In the near future there will be increased production of seasoned karri timber.

Bunnings process jarrah logs at Deanmill. The layout of the sawmill at Deanmill was designed locally by the Bunnings own engineering arm. There are two production lines each with a headrig, a band resaw, a circular sawbenchs and a docking line.

Production at Deanmill is approximately 160m$^3$ of logs per day and recovery 30%. The trend at the mill is grade cutting as most of jarrah timber does not constitute clear grades due to inherent defects in the logs. The by-products from the mill such as off-cuts are sold to charcoal producers, sawdust sold for gardening or burnt in incinerators

It can be seen clearly that the security of timber resource has led Bunning to invest in new technology for efficient processing of the logs at both Deanmill and Pemberton.

Whittaker's sawmill at Greenbush process mainly regrowth jarrah of average diameter ranging from 30 to 40cm. The logs are obtained from forest areas in the radius of approximately 100km from the mill. The mill also process regrowth karri of average diameter ranging from 50 to 60cm obtained from the nearby southern forests around Manjimup. Both the jarrah and the karri are of age class 60-70 years.

The karri logs are received at the sawmill in a debarked form while jarrah logs are mechanically debarked at the mill site.

The sawmill operates two shifts. It has separate processing lines for jarrah and karri. Basically each line has a bandsaw for breaking down the logs, circular saws benches for further processing, and a docking saw arrangement. The difference between the two lines is the flow pattern of the timber.

The flow pattern on the karri processing line is straight with all the timber flowing in the same direction to feed the line bar bench and resaw. The jarrah processing line, however, has orientations in which sawn boards from the headrig(breakdown) are conveyed perpendicular to the original direction of the breakdown in order to feed a Gibson line bar bench. The resaw bench has power hobs and is reversible thus providing the sawyer with greater flexibility and resawing capability. However, most jarrah logs have defects and therefore short and narrow pieces are produced which often get tangled in the process and slow the flow of timber in the production line. Thus mill efficiency for the jarrah production seemed lower than for the karri.

Log input at the jarrah line is approximately 90-100$m^3$ per shift with recovery of 33% and for the karri processing line approximately 150$m^3$ per shift with a recovery of 45%.

Nearly 90% of karri and 50% of jarrah from Whittaker's Greenbush mill are sold as green structural products. However, there are plans to add value to 70% of the karri and almost all of the jarrah by seasoning.

## 3.2 TIMBER DRYING AND DRY PROCESSING

Several timber drying facilities were visited during the author's tour. At all sites air drying followed by kiln drying was the rule. The length of time for air drying varies from location to location and according to the timber thickness, it takes approximately eight months for 38mm thick timber and twelve months for 50mm thick timber to reach below the fibre saturation point (approx.20% mc). In places, the tops of the timber stacks are covered by corrugated iron-sheets held down by sleeper-like wooden weights to prevent excessive moisture absorption and heat damage as at Hyne and Son in Maryborough. Most of the air drying yards were neat, well drained, levelled and had the stacks of timber raised well above the ground level.

In addition to air drying, some enterprises had pre-drying chambers such as Boral in New South Wales and Bunnings and Whittakers in Western Australia where green timber is pre-dried under mild conditions before actual kiln drying

The kilns were essentially of conventional compartment types with internal fans, heated by steam from gas-fired boilers, and loaded by forklifts or a transfer system. Also, there was an Estron dehumidifier kiln of capacity 40-50 $m^3$ at Grants, Woodford and a high temperature kiln at Boral-Murwillumbah.

The following is specific information on some of the sites visited.

### 3.2.1 NEW SOUTH WALES (N.S.W)

The site visited was in Murwillumbah and owned by Boral. It is here that green timber, some preservative treated with Copper Chrome Arsenic (CCA), and obtained from a number of Boral's sawmills located throughout N.S.W, is brought for drying and further processing. At the time of the visit approximately 1,200$m^3$-1,500 $m^3$ of timber was being air dried and the 27 kilns were holding approximately 1,800$m^3$ of timber, most of which would be destined for structural timber products. About 75% of the stock is from regrowth forests and 25% from old growth forest. Species commonly available at the site were *E. pilularis* (blackbutt), *E. tereticornis* (forest red gum).

Dry processing of the timber involved planing and moulding to produce moulded products and flooring. 25mm thick boards are destined for use as floor boards, decking and weatherboards and 38 mm thick boards for lintels, beams, bearers and rafters. Also, at the site there were facilities for nail plating short pieces to produce longer pieces of up to six metres.

### 3.2.2 WESTERN AUSTRALIA (W.A.)

In W.A., Bunnings has developed its own up-to-date and unique state of the art timber pre-drying facility at Deanmill. At the time of the visit two pre-driers were operational and a third was being constructed.

In the pre-drier, timber is moved in an operation similar to a progressive kiln. There are eight chambers each holding approximately 40$m^3$ of timber. Each chamber is well sealed

and has its own set of drying conditions; temperature and relative humidity. Also, each chamber has suitably built-in measuring instruments such as psychrometers or equilibrium sensors with temperature probes which help the control of the required ambient conditions. Conditions are cooler or milder for freshly sawn timber and progressively become hotter at the end of the line (i.e. last chamber). 50 mm thick timber emerges after a 3 months period with a moisture content of 18-25% while 38 mm thick timber would emerge with a similar moisture content in 40 days.

An important feature of the pre-driers at Deanmill is that only the heat generated by the motors as they drive the fans for air circulation as well as the heat generated from the working of the compressors is used in the pre-driers to dry the timber. No additional energy is supplied to heat the timber in the pre-drier. Vents are used to moderate the temperature and humidity differentials in the respective chambers. Thus the pre-driers are cost effective.

All timber from the pre-driers at Deanmill is transported to Bunnings Manjimup site to be stored in sheds before kiln drying. There are 18 convectional kilns of total capacity 360$m^3$ and four humidifiers of 200$m^3$ total capacity. Currently at Bunnings about 70% of green *E. marginata* (jarrah) production is kiln dried. Bunnings plan to increase the quantity of its kiln dried timber with the aim of eventually kiln drying all jarrah production from its green mill. It also intends to construct a high temperature kiln for quick drying of its pre-dried timber as soon as experimentation and developmental work on such a kiln is complete.

At the time of the author's visit to Manjimup, approximately 25,000$m^3$ of kiln dried timber was being held in sheds at the site. It was also noted that Manjimup was the dry processing site for Bunnings with facilities for moulding timber for various applications such as garden furniture etc. In addition, the site serves as the dispatch point to markets.

Whittakers at Greenbush is also involved in the activity of drying some of its hardwood timber before sale to the public. However, the set-up at Whittakers is some what different from Bunnings.

The pre-drying at Whittakers involves subjecting freshly sawn timber to a forced air drying system for 5-6 weeks. The system consist of a battery of fans at the end of a tunnel. The tunnel is made of specially insulated black plastic of approximate capacity 400$m^3$. The fans force air through the stacks until such period that the timber attains the fibre saturation point At the time of the visit the forced air drying system was set in a shed under cover due to the winter weather. The system however, can be used under cover outdoors during summer months. Overall the system has greatly assisted the maximisation of kiln throughput at Whittakers, particularly for *E. marginata* (jarrah) timber.

Timber from the forced air drying system is kiln dried in the nine mainly "Windsor type" compartment kilns at the Greenbush site. Seven of the kilns are of 90$m^3$ capacity each and two of 60$m^3$ capacity. All kilns are loaded by a track transfer system, and all except one have three lines of tracks inside the kiln. Despite the usual reversing of air flows in these kilns at specific intervals, it would seem this type of kiln arrangement would affect drying efficiency as stacks of timber in the middle track may not dry quickly enough relative to those in the outer track lines.

Having been dried, the timber is further processed at Greenbush in the dry mill. Dry mill recovery for the seasoned timber is 60-70% good quality pieces whose length is greater than four metres, 30% low grade structural timber and 8-9% waste. Most of the wastage such as dockings are sold to industrial charcoal manufacturers. Also, most *E. marginata* of short lengths (approximately 1-3 metres) and smaller sections (approximately 25x75 mm) are aimed at the traditional furniture market.

## 3.3 USE OF ADHESIVES FOR VALUE ADDING-GENERAL CONSIDERATIONS

By using adhesives, pieces of timber of smaller sizes can be joined into larger sizes. Therefore structural and appearance wood products of higher value can be obtained by the process.

Several variables affect gluing of timber such as the density of the species and existence of resin or gum in the wood. In Western Australia the author was able to note that *E.calophylla* (marri) is not amenable to gluing because of its high kino-content. In addition the gap-filling properties of the adhesive and its close-contact attributes are important for successful and suitable gluing.

The key to using adhesives, however, is ensuring that the bond strength is similar to the strength of the unjoined wood and must remain unaffected by conditions of exposure throughout the life of the structure. This is particularly critical for structural products.

Structural products are produced using Phenol formaldehyde (PF), Resorcinol formaldehyde (RF) or a mixture of the two. These adhesives are weather proof. Systematic tests and records of service indicate that the glue lines of these adhesives are resistant to microorganisms, moisture and heat, and can be durable for more than 50 yrs, Knight (1968). Therefore these adhesives can be used in high hazard situations of full exposure like in marine situations, exterior structures, components or assemblies where the glue line is exposed to weather, or in low hazard conditions involving some protection from sun and rain like inside roofs, open sheds or porches. Also, RF/PF adhesive bonded products can be used for interior exposure in high hazard conditions like laundries, roof spaces, enclosed warm and damp buildings where the moisture content in excess of 18% may be exceeded and the glue line temperatures may be greater than 50°C, or in low hazard situations such as inside heated and ventilated house dwellings, buildings, halls and churches. In addition, structures built using the RF/PF adhesive can withstand usage in the neighbourhood of chemical plants or in an environment associated with the manufacture of electrical batteries, dye works, swimming pools and baths (Dinwoodie, 1982).

In general however, use of existing ordinary PF/RF adhesive for finger jointing may not constitute a suitable practice due to likelihood of timber surface irregularities and finger profiles not perfectly fitting. Therefore, special formulations are required that would lead to a high bond strength by either acting as a good gap-filler, or possessing molecules larger than the average wood pore thereby preventing penetration of the adhesive into the wood during the pressure application stage.

For appearance products like joinery and furniture adoption of RF and PF adhesive would not be cost justified. In these applications Urea Formaldehyde(UF), Casein and Poly vinyl Acetate (PVA) are used as these adhesives are usually cheaper and restricted to interior, fully protected and non-structural application. UF in particular is quick to cure and require a lower temperature for curing as well as being tolerant to wider gluing conditions and can be mixed with melamine to form Melamine Urea Formaldehyde (MUF); however the cost of melamine increases the overall glue cost thus leading to less profit margins when compared to Phenol Formaldehyde (PF).

Other adhesives such as Isocynates and epoxy lack experimental data with regard to their durability in different environmental situations and are currently not widely used in Australia.

During the author's study tour there was opportunity to observe use of adhesives for value adding in both solid wood and reconstituted wood products. The following is an overview of some activities observed in different states and sites in Australia.

### 3.3.1 SOUTH EAST QUEENSLAND (SOLID WOOD PRODUCTS)

In Brisbane, Gunns's plant produce structural glue-laminated timber (Plate 7) using mainly *Eucalyptus obliqua* L'Herit (messmate) drawn from Tasmania.

The production process involves docking the timber to remove defects and finger jointing the short defect-free timber using Resorcinol Formaldehyde (RF) adhesive. A similar adhesive is spread on the laminates during beam manufacture. Heat in form of hot air at temperatures of up to 60°c is blown over the beams which are clamped, held under pressure and covered with tarpaulin. Most of the beams produced are straight though others are cambered.

Also, at the Brisbane plant some steel reinforced glue laminated beams are produced under licence. The process involves inserting two steel bars of the same length as the

laminate into pre-drilled holes in the top and bottom laminates and epoxy resin applied for bonding the bars in the beam.

Overall production of the glue laminated beams at the Brisbane plant is approximately 14m$^3$ per day. Strict quality control procedures are in place and the plant has achieved a third party product certification.

In Maryborough which is approximately three hours drive north of Brisbane, the author also visited a glue-laminating plant owned by Hyne and Son. The Maryborough plant draws most of its hardwoods for use in manufacture of glue-laminated beams from the company's own sawmill in Maryborough although some of the timber is obtained from other mills. Approximately 2000m$^3$ of glue laminated structural beams and some bench tops are produced per annum. The species used are high density *E. maculata* (spotted gum) and *E.pilularis* (blackbutt) found in the vicinity of the Maryborough area.

Most of the production process at the Maryborough plant is more or less similar to the one at Gunns in Brisbane. However, another production line that utilises radiofrequency curing was being installed at the time of the visit to supplement the existing production line.

Cambered beams with depths ranging from 120-160mm and thickness of 38,40,65,85,115mm and lengths of up to 15 metres are manufactured at the Maryborough plant, and are generally graded for both aesthetic and structural properties or solely for structural properties. For example Grade A- Beams are for exposed applications where appearance qualities are significant, Grade B- Beams could be painted and exposed to weather conditions, and Grade C-Beams are only for structural applications where appearance qualities are not significant.

Besides using hardwood species for beams production at the Maryborough plant, softwood species such as *Arauria cunninghamii* Ait. ex D.Don (hoop pine) is also used to produce Pine beams and square posts.

The production process for the Pine beams involve finger jointing short pieces of 70mm and 90mm and thickness of both 35 and 45mm, and edge gluing to a depth of 140-290mm or deeper and lengths up to 12 metres using RF adhesive. In this way off-cuts or waste from Pine mills can be utilised for high value products such as floor joists, lintels, veranda plates, rafters and, when double laminated for bearers or as a suitable replacement for kiln dried pine or laminated veneer lumber.

Also, by face laminating the finger jointed pieces, square posts of section size 90 x 90mm and 115 x 115mm can be produced. The length of these can be up to 12 metres. Hyne and Son recommend treatment of the posts with LOSP and coating with a primer as the posts are for exterior applications, and could be claimed to be suitable replacements for Copper Chrome Arsenic (CCA) treated poles.

In general, there were strict quality control procedures for beam manufacture and the Hyne and Son Maryborough plant has achieved a third party product certification.

One important development at Hyne and Son is the use of characteristic stiffness of the beam as the rating system rather than the traditional F rating which is based on beam ultimate breaking strength. F ratings have always referred to solid timber and not to manufactured products such as Glulam beams. The use of stiffness values is based on the fact that the majority of laminated timber are used in situations where deflection is the critical design criteria.

An issue of general concern in promotion of glu-laminated beams is the lack of education for designers who intend to work with timber and adequate market for producers. However, provided a suitable adhesive is used in the laminated beam construction there is an overall potential for application of the product in niche structural markets, especially in harsh environments such as swimming pools or in corrosive environments, where for instance, metal gantry cranes corrode or become magnetised.

Value adding using adhesive to produce appearance products such as bench tops and curved beams was observed by the author at company in Brisbane called Springwood beams. The company concentrates on production of solid timber benchtops(Plate 8) and

curved beams for the national market utilising local species such as *Tristania conferta* (brush box) and *Callitris* endlicheri (Parl.) F.M.Bail (black cypress pine) as well as imported South East Asian timbers and *Pterocarpus indica* Willd (Papua New Guinea Rose wood). The timber is purchased from merchants and/or sawmillers. High quality items are produced by the company and there is increasing demand for decorative products such as laminated timber kitchen bench tops, bar tops and stair treads. Some of the increase in demand is related to use of exotic species such as the Papua New Guinea Rose wood.

Most of the production of bench tops at Springwood beams is of standard size 200 mm-1200mm wide, 35mm deep and average length ranging from 0.9m to 5.4m. The bench tops produced are curved or straight. Adhesive commonly used is RF which is applied to the edges of dressed timber; the glued assembly is placed on a rig, covered with tarpaulin and cured by heat generated by a gas burner.

Further use of adhesives for value adding on solid wood for appearance product was also observed at another company called 3-Door manufacturer in Brisbane where approximately 140$m^3$ of E. *obliqua* (messmate) and some *E.pilularis* (blackbutt) is used per annum for the production of wooden kitchen cupboard doors.

The production process for the doors involves sawing the planks to specified sizes, edge-gluing using Poly vinyl Acetate (PVA) cross link adhesive for low density species or epoxy resin when high density species are used. Curing of the adhesive is by radio frequency.

### 3.3.2 WESTERN AUSTRALIA- RECONSTITUTED WOOD PRODUCTS

#### 3.3.2.1 Medium Density Fibre Board (MDF).

The MDF plant located at Welshpool in Western Australia is owned by Westralian Forest Industries Limited (WESFI). Generally the wood resource utilised by the plant is obtained from forests managed by Conservation and Land management(CALM), and consists of at least 90% *Pinus pinaster* Ait (maritime pine) thinnings and the rest *Pinus*

*radiata* D.Don (Monterey pine). Common log diameter is 35cm. Sizes smaller than 7cm diameter are not used because such sizes break easily during the debarking operation.

MDF production at Welshpool is by conventional manufacturing methods and is largely automated.

At the plant, logs are mechanically debarked and transferred to a chipper for production of chips. The chips are then steamed at pressure of 8-9 bar and refined in "Sunds" refiner. Resin is injected into the refined fibre as it is transferred to the drier. The fibres are dried at a temperature of 68-75°c at the exit end. The dried fibre is pre-pressed before final pressing in a multi-daylight press at pressures of up to 200 bar and temperature 180-200°c. Production is 50-60% standard boards, produced essentially using urea formaldehyde adhesive and the rest comprise of High Moisture Resistance (HMR) boards for which a combination of urea and melamine formaldehyde adhesive is used.

At the plant there is a developed quality control system and a laboratory for continuous assessing of the board's properties. Daily average production is approximately $300m^3$ and the products from the plant find wide application in furniture, mouldings or bench tops for kitchen cabinets.

3.3.2.2 Veneer and Plymill

At Kewdale, Western Australia, a mill owned by Westralian Forest Industries Limited (WESFI) produces veneer from *P. pinaster* (maritime pine) logs by a rotary peeling process and a by-product of the peeling process such as core of the logs is used for production of packaging timber and wood chips. Also, at the plant small amounts of *E. diversicolor* (karri) and *E. marginata* (jarrah) billets supplied by Conservation and Land Management (CALM) sawmills are processed by slicing after initially softening the billets by steaming.

Generally the thickness of veneer produced at the plant range from 1 mm to 3.2 mm.

The freshly produced veneers are dried at temperature of 150°c in a double deck single pass steam-heated "Hildebrand" drier operating at feed speed of 2.3-8.5 metres per minute to attain a moisture content of 5-6%. The veneers are then graded into one of four or five different grades.

Final veneer recovery from a rotary peeled log is approximately 60%. The author was able to note that the veneer peeling process at the Kewdale plant may require upgrading to improve recovery. One way to achieve this may involve stabilising and reducing vibration during peeling through a additional mechanism for holding the log firmly and preventing possible veneer breakages and the increasing recovery.

Plywood is also produced at the site by laying veneers coated with Poly Vinyl Acetate (PVA) or urea formaldehyde adhesive and heat-pressing the veneers using pressures of approximately 1170 kPa. In some cases phenolic overlays (paper impregnated with phenolic resin) are applied onto the surface of some structural plywood that are designated for formwork.

It is of interest to note that currently in Australia the market for appearance-grade plywood has been dominated by Asian producers. It is hoped, however, that the market for structural plywood will still be maintained by Australian producers mainly because the quality of veneers obtained from South East Asian timber species may still need more investigations to confirm their suitability for use in manufacture of structural plywood that is compatible to Australian standard 2269(1979).

At the Kewdale plant it was also noted that *E. marginata* (jarrah) and *E. diversicolor* (karri) as well as an extensive array of imported South East Asian veneers are used as overlays on particle boards and medium density fibre boards brought from WESFI's other plants to produce veneered boards. The veneered boards range in size from approximately 2400mm xl200mm to 2400mm x 1800mm.

3.3.2.3 Particle Board Plant

The particle board mill at Bunbury, Western Australia owned by WESFI is said to be the largest in the southern hemisphere. Approximately 200,000m$^3$ of particle board is produced per annum.

The logs utilised by the plant are obtained within the radius of 100-150 km from the plant, the majority of which are products of thinnings from forests managed by Conservation and Land Management (CALM) and a small proportion from private plantations. The total annual plant intake of 300,000-500,000m$^3$ comprise of 90% *P.radiata* (Monterey pine) and 10% *P.pinaster* (maritime pine).

It was interesting to learn that about two years ago, the plant utilised 85% logs and 15% wood residues in the form of chips, sawdust, shaving and trimmings from the manufactured boards as raw materials for particle board manufacture. Now up to 30% wood residues and 70% of logs are being utilised. Clearly there is increased efficiency in utilising wood residues for production of a higher value product. In this way maximum utilisation of wood resources is achieved.

At the Bunbury mill site, logs are debarked and the bark shredded. Some of the bark is either sold for gardening or burnt to produce supplementary heat for the plant. From the debarked logs flakes of 0.38 mm thick are produced.

The flakes are dried at a temperature of 120°c to attain a moisture content of 4% before blending with resin. Plain boards are manufactured using urea formaldehyde resin, but high moisture resistant (HMR) boards by a combination of melamine and urea formaldehyde resin. The HMR boards are identified by a blue dye that is added to the particles during the resin application stage.

The boards are heat pressed in a 7 level multi-daylight press at pressures of up to 255 bar and temp 195-210°c. They are finally air cooled, trimmed and graded. Final average board width is approximately 2.6m and average length 7.2m.

In general the Bunbury plant is automated and quality control is practiced during manufacture by periodic sampling and conduct of test tests on board properties such as screw holding and glue bond strengths as well as board swelling properties to ensure that the boards satisfy the relevant Australian standards.

Approximately 15% of the boards manufactured at the Bunbury plant is exported, 25% used locally in Western Australia and 65% sent to the eastern states of Australia.

Also, at the Bunbury site there are four melamine presses and a paper impregnating plant. It is here that melamine-paper overlaid particle boards are produced. The specially imported papers which depict appearance characteristics of different wood species as well as different colours are treated using urea or melamine adhesive at the site. The treated papers are then used by the company for manufacture of melamine-paper overlaid particle boards.

# SECTION 4

# 4.0 RESEARCH

## 4.1 CONSERVATION AND LAND MANAGEMENT (CALM) - WOOD UTILISATION RESEARCH CENTRE, HARVEY, WESTERN AUSTRALIA

CALM wood utilisation research centre in Harvey was set up to address the issues relating to the emerging timber resource and the associated problems of its utilisation. The centre was previously an old softwood sawmill owned by CALM. It was closed in 1982 and the mill was then restructured to handle regrowth hardwood. It now has horizontal band saw, a frame saw and circular resaw bench and a docker.

The centre is now a registered research agency with three scientists, one production manager, three workers for making saleable products to the general public as well as performing contract jobs such as drying for clients.

It was interesting to note that the committee of management of the centre includes a person from the Forest Industry Federation of Western Australia who represents the industry's direct interest.

At the moment, the main thrust for research is small log utilisation for various products and development of drying schedules and systems.

Successful research outcomes at the centre include development of a suitable sprinkler watering regime for logs in the log yard. It was establishing that a regular watering regime of 15 minutes and 105 minutes of non-watering, throughout the year, is adequate for maintaining a moist surface on the logs. The quantity of water used in this research was a function of size of the log yard, number of sprinklers and power of the water pump. Moreover, economy of water usage was achieved by placing the logs over wood chips. This facilitated percolation of water from the sprinklers through the wood chips and into a drain, and subsequently into the main reservoir. Therefore water is re-circulated to avoid wastage. The results of the research is important with regard to reducing extend of end splitting in logs due to excessive drying at the ends.

One of the products developed by the Harvey research centre is Valwood, made by edge laminating narrow 10 mm thick boards to form wider pieces which are subsequently face laminated. Depending on the designated end use of the product, the adhesive used is either urea or resorcinol formaldehyde.

The timber for Valwood production is obtained from sawing small diameter logs to produce the narrow 10 mm boards. After kiln drying, the boards are planed on four sides and graded into three grades, namely good, medium and poor and edge laminated. Subsequently the poor grade timber is placed between the good and medium quality timber and pressed. The final product normally has the good grade timber on the face, poor grade in the core and medium grade at the back (Plate 9) and can be used for manufacture of table tops, indoor or outdoor furniture. Maximum size of Valwood produced at the centre is 2.4 metes long x 900mm wide mainly due to the press size at the centre.

Several species have been tried for Valwood manufacture. These include Tasmanian *Acacia melanoxylan* R.Bir (blackwood), *E.obliqua* (messmate) and *E. regnans* (mountain ash). Also, research is underway to determine movement characteristics of Valwood under conditions of high humidity, low humidity and cyclic humidity. It is expected that the stability of Valwood is superior to that of solid wood. In addition, there is on-going research on finishes and wood fillers for use on Valwood product.

Currently the centre is seeking applications from potential Valwood producers to acquire licence for production of Valwood. Valwood's retail price of $5,000 per $m^3$ is considered appropriate and may be well received by the market.

Other successful research programs at the Harvey research center include solar kiln drying of timber (Plate 10). CALM solar kilns are made of a double soft shell of soft inflatable ultra violet resistant plastic which, in turn, forms an insulated solar collector. Stacks of timber in the kiln are covered by a patented blanket. The doors are velcro-sealed, and can be fastened or unfastened easily. Controlled air inside the kiln can be separately heated and humidified according to the requirements of the different drying

stages of the timber being dried. Also, fans blow air through the stacks thus ensuring an even drying of the timber. The fans and the curtain filters can be adjusted, and the fogger water sprays would contribute to minimisation of splitting or checking. Commercially, the kilns can be used as pre-driers particularly in order to reduce the period of normal air drying.

Other on-going research at the centre include investigation on the association of gum veins with borer(*triyphocaria-Genus*) particularly in timber that have a marked quantity of gum veins such as *E.calophylla* (marri).

## 4.2 QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRY - FOREST SERVICE

In Queensland the department of Primary Industry-Forest service is currently researching development of suitable drying schedules for refractory species and high temperature drying of other Queensland Eucalypts. Research is also under way on radial sawing to relieve stresses in regrowth *E.pilularis* (blackbutt).

## 4.3 TIMBER RESEARCH AND DEVELOPMENT ADVISORY COUNCIL OF QUEENSLAND (TRADAC)

TRADAC has coordinated and funded certain research activities with regard to hardwoods. For example fire and sound testing of timber framed walls, development of timber floor systems and heavy decking systems, and use of sawmill residue in building products.

## 4.4 PRIVATE RESEARCH

It was evident during the study tour that some wood product companies conduct their own research activities to enhance their product's properties. For example, through intensive researching Bunnings in Western Australia have developed their own brand of Resorcinol formaldehyde adhesive that is appropriate for gluing *E. marginata* (jarrah) timber. This adhesive is now being widely used by several hardwood industries in the

country for finger jointing and laminated beam production. Also, Bunnings research and development team are currently investigating the possibility of high humidity treatment at the end of the kiln drying run to help solve some shrinkage problems for *E. marginata* (jarrah), and are seeking to solve the problem of movement of timber in service as result of differential shrinkage.

At WESFI's medium density fibre board and particle board plants there is on-going collaborative research with a resin manufacturing company on ways for improving the performance of board products manufactured using the resin and associated additives obtained from the resin manufacturer.

## 4.5 CSIRO ADHESIVE RESEARCH

The author was privileged to visit the CSIRO adhesive research centre in Melbourne. Recent developments in adhesive research at the centre have involved seeking ways for successful gluing of high density, difficult to glue timbers such as *E.pilularis* (blackbutt). This species has a hot water extractive that could affect the gelation time for Resorcinol formaldehyde/Phenol formaldehyde resin and cause poor quality bonding. The adhesive research centre is experimenting with and developing a new brand of Phenol Formaldehyde adhesive to counteract the effect of extractives such as found in *E.pilularis*(blackbutt) and for gluing timber with high moisture contents. In particular, for plywood manufacture, adhesives that can be used at higher moisture content of say 12% would lead to significant cost saving since most veneer are normally glued at 5% moisture content, and the adhesive so developed, could be used on certain wood containing wet and dry pockets.

## 4.6 CSIRO - WOOD TECHNOLOGY RESEARCH GROUP

The research activities in this group was observed by the author during the tour. The group is involved in various research activities such log conversion, development of models for wood drying, wood drying by dielectric heating, glass log technology involving x-rays to identify internal log characteristics, and a host of other wood technology projects.

## SECTION 5

# 5.0 GENERAL REMARKS AND IMPLICATIONS FOR REGROWTH ASH TYPE EUCALYPTS.

For effective utilisation of wood from forests, resource security is necessary. Currently, uncertain resource security is a disincentive in most states in Australia, Victoria included. Most investors have the notion of, "Why develop new methods and infrastructure when resource is being systematically removed?". It is, however, necessary to note that with a decreasing log supply there will always be a need for value adding or profit adding. Thus, the fewer logs will be highly valued.

During the study tour the author observed significant quantity of residue logs in form of live or dead trees left in coupes. However, with the newly introduced integrated logging practice such as in Western Australia, the residue logs could be readily used in other products that are not necessarily derived from sawlogs, for example particle board, chip board and medium density fibre board. Moreover, there is a growing shortage of sources of high quality wood fibre and this would mean utilisation of even lower grade wood material for the production of the mentioned products. Some companies have realised this need; for example, WESFI forests in Western Australia has recently acquired a chip-harvester that will produce chips at logging sites, thus utilising log residues for production of wood chips at coupes. Such a move could be suitably adopted in coupes of Ash-type Eucalypts such as *E. regnans* (mountain ash) and *E. delegantensis* (alpine ash) in Victoria and Tasmania where log residues exist.

Log yard management at sawmills is an important function which require addressing. Logs need to be segregated in terms of lengths, species and grades to facilitate efficient sawmill production runs. Also, the research outcome in Western Australia regarding suitable watering regime for logs in a log yard could be introduced with some modification for Ash-type Eucalypts with a view to economising water usage and reducing the extent of end splits attributed to lack of watering at ends of logs.

At some of the sawmills visited, the author was able to note the general low level of recovery and at least 30% of the mill input turned up as waste material. However, it is necessary to note that this waste material can provide significant cost-saving for energy in those mills that utilise waste for fuel in boilers. The use of mill waste in energy production in the dry kilns will reduce the drying costs substantially and this has various spin-offs such as lowering the price of sawn dried timber. Alternatively the waste could be sold to pulp and paper manufacturers rather than burnt in an incinerator where no use is made of heat energy produced. Also, wood waste finds ready markets in the mulch and landscape spheres.

After observing utilisation of other species, it became apparent to the author that one of the keys to maximum utilisation of the regrowth Ash-type forest resource would lie in the use of adhesives for increasing the value of the resource for such products as chip boards, particle boards, plywood, laminated veneer lumber (lvl), Valwood, oriented strand boards and medium density fibre boards. In this way log residues currently left in the forest coupes could be utilised.

It was observed during the tour that sawmills, timber laminating plants and board manufacturing plants have gone a long way to achieving Quality Accreditation through a third party certification. Such a move is encouraged for regrowth Ash-type eucalypt timber processing plants. Certification assures designers and builders of the product quality. This has its own spin-offs such as increasing the market share of the product. In addition, it is necessary to note that automation of the manufacturing practice may lead to effective quality control and is more likely to lead to increased designer and specifier confidence in timber products being manufactured. Automation has the possibility of reducing human judgemental errors. Where automation is impractical, quality control should be encouraged during processing of the regrowth Ash-type Eucalypts through training and re-training the work force on all quality matters regarding the product. This would lead to specifier and designer confidence regarding reliability of the product.

Machine stress grading for structural regrowth hardwood timber products may be necessary to avoid errors due to the subjective nature of human visual grading. However,

at the moment, there is no price differential between machine stress-graded products and visual-stress graded products. This may need to be addressed. Also desirable is the development of a machine for visual grading that would be suitable particularly for appearance grade timber.

Also, it is necessary to note that where defects such as knots etc have been removed during manufacture of engineered wood material such as glued laminated beams and where good fitting joints have been achieved using a reliable adhesive, design value of the manufactured material would be expected to markedly improve. Also, when designing using regrowth Ash-type Eucalypt timber, use of modulus of elasticity (moe) values where deflection values count more than rupture values in an application may need to be encouraged.

In addition, it would seem appropriate that those lighter regrowth hardwood species with modulus of elasticity values equivalent to Pine species like *P. radiata* (Monterey pine) could be used as a "sandwich" product between the denser and stronger pieces so as to improve the design values of the product. This would lead to added confidence in specifying the product for structural application. Research may be necessary to investigate the possibility of bonding hardwood species with different characteristics to form such a sandwich.

For effective promotion of products manufactured from Ash-type Eucalypts, it may be necessary to target where the product-appeal to the community at large lies and where other competing products have difficulties with acceptance. The perceived increase in incidence of asthma associated with carpet flooring is a living example.

In general, it is important to appreciate some of the strength, appearance and durability attributes of hardwood timber and use these for the advantage of regrowth hardwood timber species such as *E.regnans* (mountain ash). Such a move would affect the attitude of designers and specifiers who may require specific features that appeal to a given design function.

Another issue of concern regarding utilisation of Ash-type Eucalypts include some of the inherent characteristics of the timber. Often characteristics such as knots or gum veins have been termed defects or faults. Such characteristics, however, can be used to the advantage of the timber by regarding them as peculiar timber characteristics. Moreover when knots or gum veins are adequately polished or finished they show a distinctive or attractive feature of the timber.

# SECTION 6

# 6.0 RECOMMENDATIONS FOR FURTHER RESEARCH

## 6.1 DIFFERENTIAL SHRINKAGE OF REGROWTH EUCALYPT GLULAM BEAMS

As laminates in a glue laminated beam may have different shrinkage attributes due to the inherent characteristics of each of the laminates, it is necessary to investigate the effect of the differential shrinkage of the laminates in a glue laminated hardwood beam manufactured using regrowth Eucalypts.

## 6.2 HIGH TEMPERATURE DRYING OF ASH - TYPE EUCALYPTS

This investigation may be conducted on timber that has attained fibre saturation point following application of existing drying schedules. The object of such investigation would be to determine potential drying stresses following application of a higher dry bulb temperature. Studies on high temperature drying of *E. marginata* conducted by Bunnings in Western Australia may need to be correlated with studies on Ash-type Eucalypts like *E. regnans* (mountain ash) which has different properties to *E. marginata.*

## 6.3 INVESTIGATION ON POSSIBILITY OF AUTOMATION OF QUALITY CONTROL PROCEDURES DURING PROCESSING OF REGROWTH EUCALYPT TIMBER

Although automated quality control is common world wide in some softwood mills, it may be necessary to investigate such a system with regard to regrowth Eucalypt timber production. Such investigation would be necessary in order to ultimately eliminate human errors during quality monitoring of naturally regenerated regrowth Eucalypt timber. Also, the object of such investigation may be to determine the human and machine interface.

## 6.4 INVESTIGATION OF POSSIBILITY OF GLUING DIFFERENT HARDWOOD SPECIES TO FORM A SINGLE PRODUCT

It is necessary to determine the possibility for gluing different species to produce a single product. For example by placing weaker or difficult to glue species between stronger species.

## 6.5 INVESTIGATION ON USE OF HIGH STRAIN, THIN KERF SAWS FOR MILLING ASH-TYPE EUCALYPTS

As sawlog volumes are constantly being reduced due to the restricted supply from the forests the need to reduce saw kerf by using high strain thinner saws in order to increase recovery warrants investigation. Results from such investigations may also lead to a consistent quality of sawn timber in terms of sawing variation along a piece of timber.

## 6.6 INVESTIGATION ON EFFECT OF LONG TERM EXPOSURE UNDER VARIOUS ENVIRONMENTAL CONDITIONS OF ISOCYNATE AND EPOXY BONDED REGROWTH EUCALYPT TIMBER

The lack of data on long term durability of Isocynate and Epoxy adhesive bonded timber products provides the need for carrying out such an investigation in order to facilitate their wide use in Australia.

## SECTION 7

# 7.0 REFERENCES

Dinwoodie, J.M., 1982; Timber, its structure, properties and utilisation 6th edition.

Knight, R.A.G,1968; The efficiency of adhesives in wood, Bulletin No 38 (fourth edition), London.

Australian Standard 1720.1-1988; Timber Structures Code Part 1: Design methods, Standards Australia.

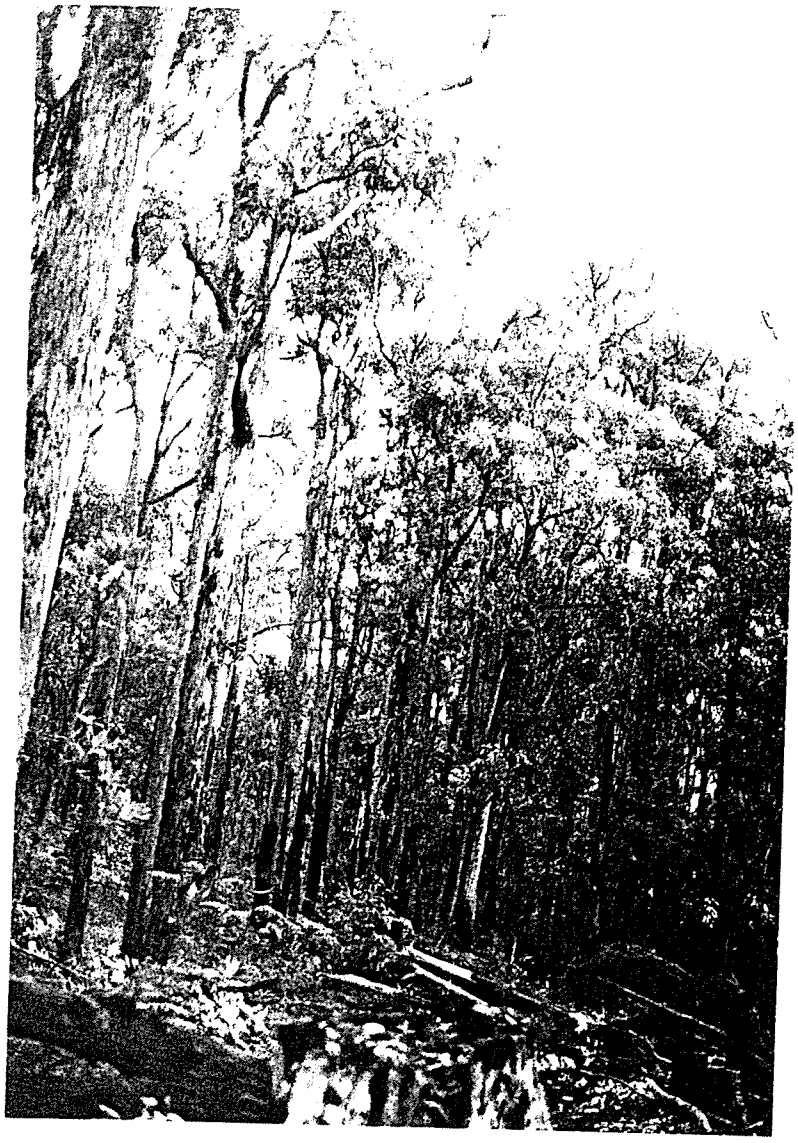

Plate 1 Regrowth jarrah stands

Plate 2 Log residue-jarrah coupes or gaps

Plate 3 Plantation of spotted gum

Plate 4 Logs from plantation of spotted gum

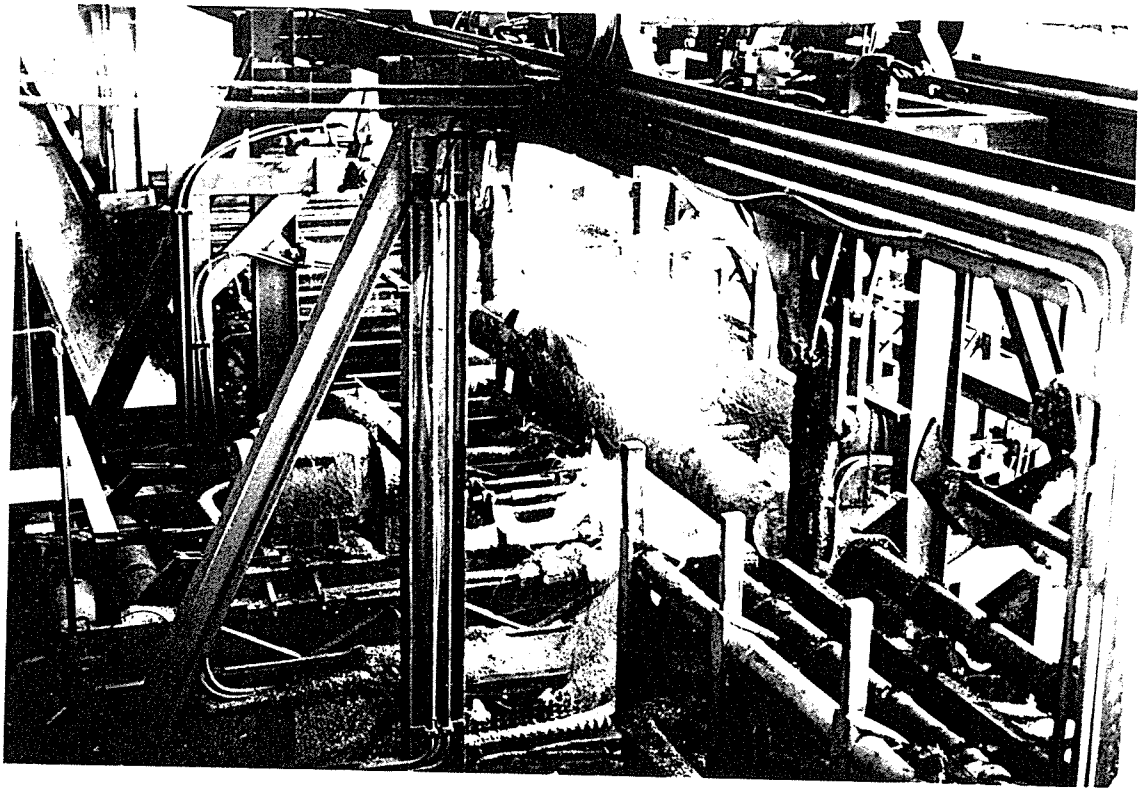

Plate 5 Twin edger sawing regrowth spotted gum

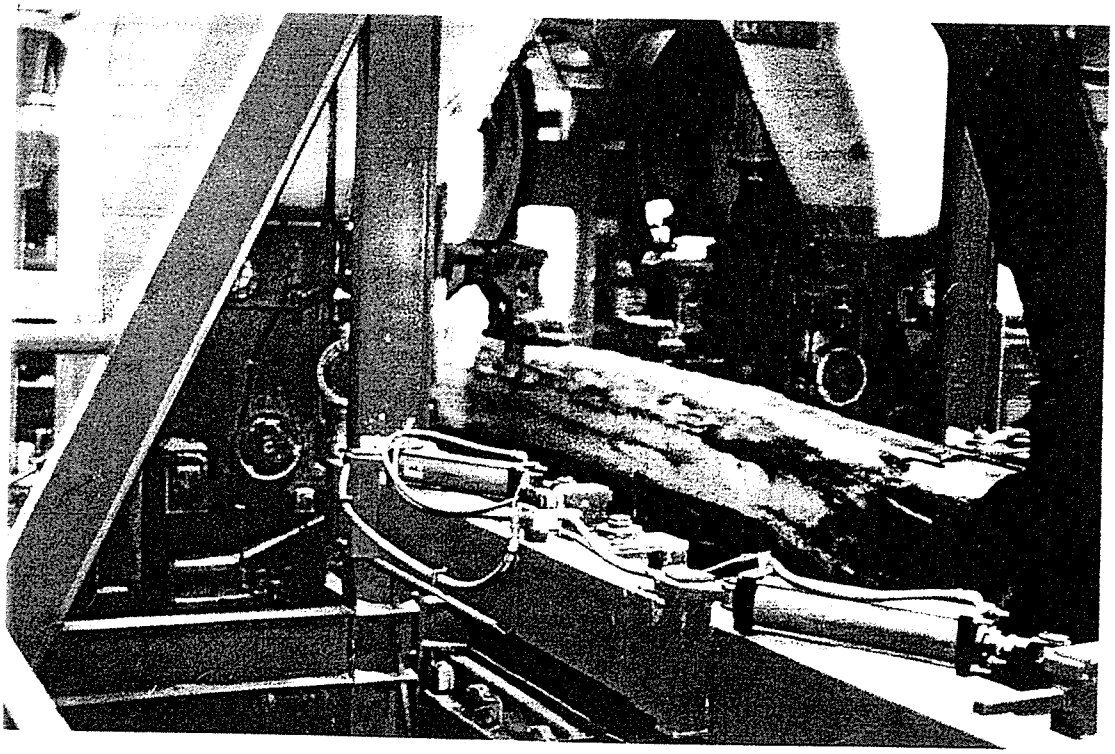

Plate 6 Chipper canter sawing regrowth karri

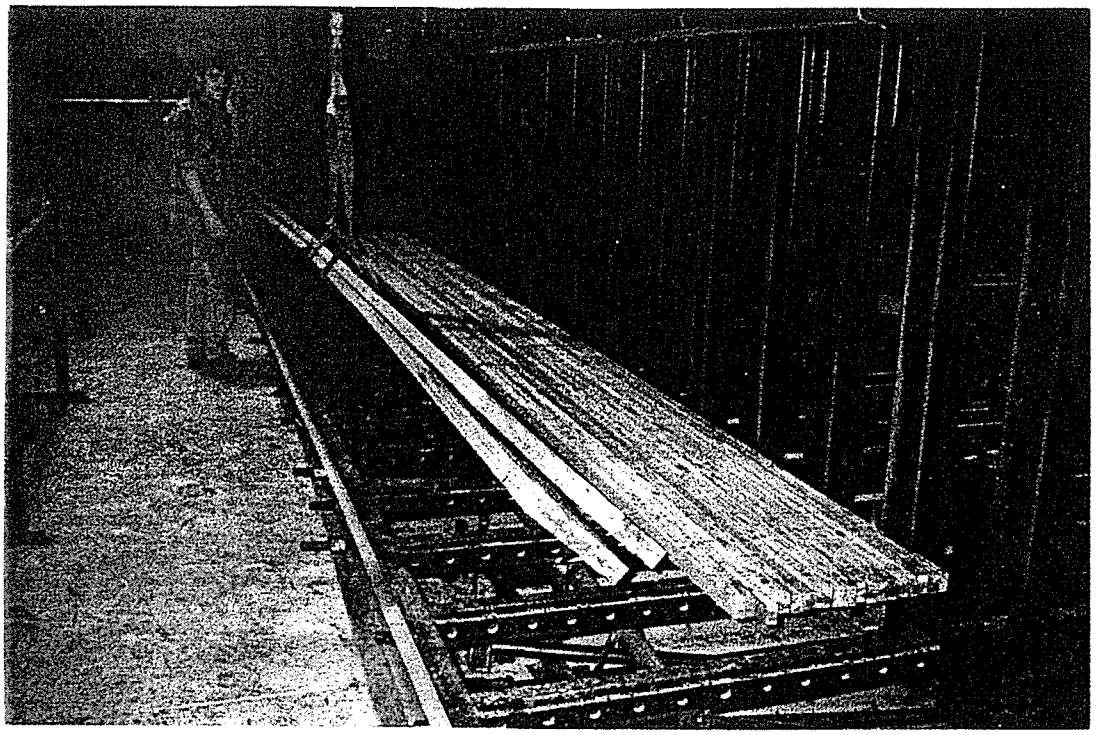

Plate 7 Glue laminated beam production

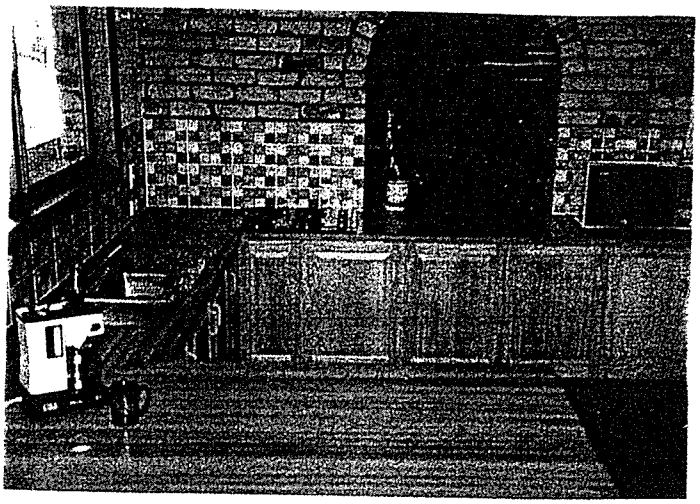

Plate 8 Bench top product

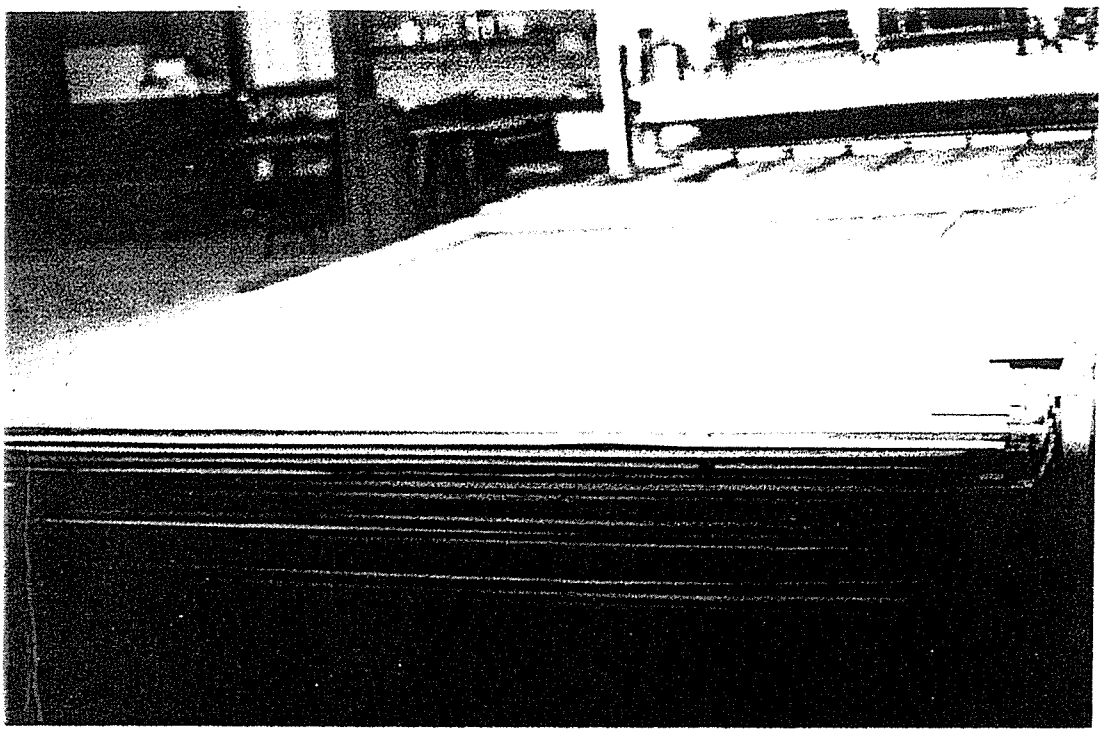

Plate 9 Valwood production and final product

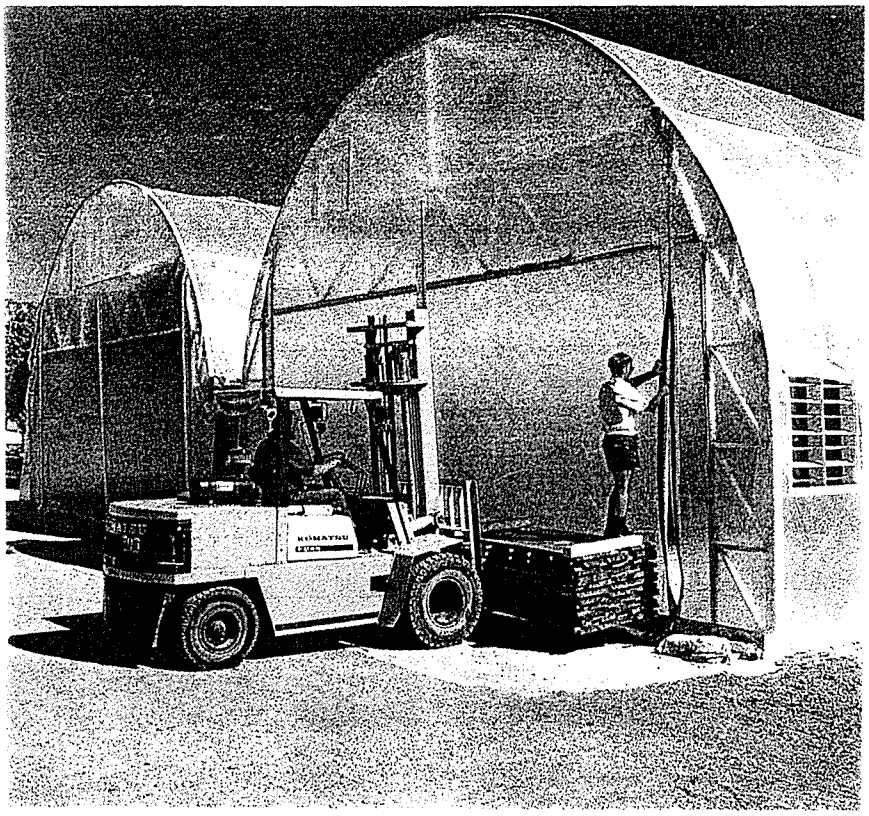

Plate 10 CALM solar kiln