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Assoc. Prof. Barbara Ozarska, Project Leader, The University of Melbourne, Department of Forest and Ecosystem Science

*co-authors/
contributors/
collaborators*

Dr Mex Peki, Benson Gusamo, Peter Edwin, PNG University of Technology

Justin Sapi, Charles Tsiritsi, Steven Wilfred Komut, Timber and Forestry Training College

Mathias Niangu, Frank Asok, Nigel Baro, Benjamin Vali, PNG Forest Research Institute

Gerry Harris, The University of Melbourne, Department of Forest and Ecosystem Science

approved by

Mr Tony Bartlett, Research Program Manager for Forestry, ACIAR

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Contents

1 Acknowledgments	5
2 Executive summary	8
3 Background	10
4 Objectives	12
5 Methodology	14
5.1 Objective 1: To explore the development of products and designs based on solid wood and veneers	14
5.2 Objective 2: To examine the potential for value chains integrating advanced processing with production of timber in smallholder agroforestry systems and community-managed secondary forests	21
5.3 Objective 3: To enhance capacity in timber processing training, education and R&D	22
6 Achievements against activities and outputs/milestones	25
7 Key results and discussion	30
7.1 Capacity building in PNG timber processing, training, education and research	30
7.2 Investigation of properties and processing characteristics of PNG timbers	34
7.3 Potential markets for PNG lesser-known timbers	36
7.4 Woodcarving in Bumbu settlement: A preliminary study into the market potential of PNG woodcarvings	36
7.5 Treatment of utility posts and poles for rural communities in PNG	37
7.6 Linking local communities to the wood processing industry	38
7.7 Utilisation of PNG commercial hardwoods for parquetry product	40
8 Impacts	41
8.1 Scientific impacts – now and in 5 years	41
8.2 Capacity impacts – now and in 5 years	42
8.3 Community impacts – now and in 5 years	43
8.4 Communication and dissemination activities	45
9 Conclusions and recommendations	48
9.1 Conclusions	48
9.2 Recommendations	48
10 References	50
10.1 References cited in report	50
10.2 List of publications produced by project	50

11	Appendixes	53
11.1	Appendix 1: List of projects undertaken by PNG UniTech Forestry Students related to wood science and wood processing	53
11.2	Appendix 2: List of equipment purchased for the PNG partners	54

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List of abbreviations used in the Report

ACIAR	Australian Centre for International Agricultural Research
BUC	Bulolo University College
CCA	copper chrome arsenate
EWPA	Engineered Wood Products Association of Australasia
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
ITTO	International Timber Trade Organization
K	PNG Kina
MOE	modulus of elasticity
MOR	modulus of rupture
PETT	Pre-employment Technical Training
PNG	Papua New Guinea
PNG FRI	PNG Forest Research Institute
PNG FIA	PNG Forest Industry Association
PNG FP	PNG Forest Products Ltd
PNGFA	PNG Forest Authority
PNG	Papua New Guinea
TFTC	Timber and Forestry Training Centre
UniTech	PNG University of Technology
UoM	The University of Melbourne

2 Executive summary

Historically, the forest industry in Papua New Guinea has been based predominantly on log exports. Since 1997, log output has averaged 1.9 million m³ per annum, rising to 2.3 million m³ in 2005. This makes PNG the second largest exporter of round logs in the world to markets in China, Japan, Korea and Taiwan (ITTO, 2005).

In 2005, the PNG Ministry of Forests, in the National Policy on Downstream Processing of Forest Products, recognised the need for a major escalation of domestic processing. The Minister indicated a desire to promote the development of a sizeable and sustainable industry based on both primary and secondary processing, including large integrated processors producing plywood, veneer, sawn timber, furniture/joinery and other value-added products. A significant constraint to the achievement of the PNG government vision outlined above was the limited capacity in research, training and education related to timber processing and manufacturing. Hence this ACIAR project was developed with the aim of providing the foundation for a more extensive and more sophisticated domestic timber processing industry in PNG.

The key achievement of the project has been in the building of capacity in PNG wood processing. PNG partners involved in the project included education, research and training institutions as well as industry organisations and companies. The members of these organisations have formed a well-built cohesive network with a strong culture of collaborative work during research activities, training and technology transfer. The collaborative approach between the project participants has blossomed over the years, demonstrated by an increase in networking and joint problem solving.

Extensive training was provided in Australia to PNG project members on wood bending, drying and furniture manufacturing.

In order to enhance knowledge in wood processing, the "Train the Trainers" program was developed and conducted with a diverse range of courses from well-credentialed Australian trainers.

Furthermore, a proposal to develop a National Diploma and an Advanced Diploma in Wood Processing and Products at TFTC was put forward in order to complement the pre-employment technical training currently offered in courses such as wood technology, harvesting training, sawmilling, saw doctoring, small sawmilling, wood machining and furniture manufacturing. Australian and PNG project partners jointly developed the program. The diploma courses are due to commence in 2013.

A commendable example of positive outcomes from the project is the increase in the number of final year students at PNG UniTech, Forestry Department who are interested in wood processing and wood products subjects. During 2010 and 2011, fifteen students selected wood-related topics for their research projects in comparison with only three (on average) in the previous years. Knowledge and experience the students gained while working on the research projects will hopefully inspire them to pursue a career in the wood processing sector.

A significant achievement has also been the upgrading of research, training and educational facilities at PNG UniTech, TFTC and PNG FRI. This includes: purchasing of important equipment and laboratory instruments for the three PNG organisations according to their priorities (e.g. solar kiln installed at PNG UniTech, laboratory kiln at PNG FRI, wood bending equipment at TFTC), purchasing and donation of more than 300 books, journals and professional magazines for the partners' libraries and the acquisition of manuals, technical specifications, publications, training and teaching materials. The value of this activity is particularly appreciated by TFTC where there were no training materials available for trainees in the library prior to project commencement.

A number of individual research projects were initiated early in the project in order to fulfil the requirements of the project objectives. Each research project was undertaken on a collaborative basis by teams involving both PNG and Australian experts in the relevant research areas. The results of some of those projects have been reported in research reports and published papers.

Investigation of processing characteristics of hardwood timbers from secondary forest in PNG addressed the lack of knowledge on the wide range of timber species in PNG, their properties and their potential uses commercially. One of the outputs of this study is the development of a template for evaluating various wood properties and processing characteristics that the industry can rely upon when processing hardwood species. The project also established initial data on the characteristics of secondary forest timber, to which additional information obtained from further research can be easily added. The knowledge of the technological attributes will be used as guidance for industry, forest growers and marketing specialists on the species suitability for various products, service conditions and markets.

The Wood Database on PNG species has been developed to collect data and information on properties, processing characteristics and potential uses of 292 PNG timber species. The database will be useful to scientists and stakeholders involved in developing downstream wood processing in PNG.

The study on market potential for PNG timbers identified the species that could be used as substitutes for highly marketable timbers in various parts of the world.

Links with local communities have been developed through the "Houswin Project", which aimed to build, test and design with local materials and local skills in order to support the development of sustainable micro-economies within PNG. The project provided a basis for future work on developing new sustainable (cultural, economic and environmental) housing for PNG rural and urban communities for both domestic and corporate (mining) needs.

The project participants believe that the project established a foundation for developing a downstream wood processing industry in PNG, which will provide an opportunity to realise greater value and potential for wood utilisation by the production of wood products and, consequently, further reduce the dependence of the industry on log exports and the associated significant loss of wood values.

3 Background

The forestry industry contributes significantly to the PNG economy, impacting the country's gross domestic product and formal employment rate (and its associated benefits). The forest industry also benefits many remote communities.

In 2005, the export of forest products represented 4.7 percent (or K476.3 million) of the value of all exports from PNG (K10,147.5 million), making forest products the largest non-mineral export from PNG in terms of value (Price Waterhouse Coopers, 2006).

The forest industry has predominantly been based on log exports. Since 1997, log output has stabilised at an average of 1.9 million m³ per annum, rising to 2.3 million m³ in 2005. This makes PNG the second largest exporter of round logs in the world, with most of its logs going to China, Japan, Korea and Taiwan (ITTO, 2005).

The timber industry provides jobs to some 9,000 people (FIA, 2006), and brings tangible development services to rural communities, where the government services are unreachable.

The importance of developing domestic downstream wood processing has been recognised after amendment to the Forestry Act 1991 on "The National Forestry Development Guidelines" by the National Forest Board. This policy framework was issued by the Minister for Forests and endorsed by the National Executive Council during September 1993. The policy established an implementation guide for aspects covered in the new Forestry Act, especially in terms of sustainable production, domestic processing, forest revenue, training and localisation, review of existing projects, forest resource acquisition and allocation and sustainable development (Food and Agriculture Organization, 2005).

The PNG Forest Authority in conjunction with the National Forestry Development Guidelines (1993) formulated a policy on the downstream processing of forest products with the objective to maximise value of the harvested timber as well as technology transfer. The implementation of this policy has a potential to provide a significant contribution towards the government's export-driven recovery strategy.

Currently, the wood processing sector in PNG is very small, with only a few companies involved in processing and exporting sawn timber, veneer, plywood, wood chips, furniture and other products. In 2005, the PNG Ministry of Forests, in the National Policy on Downstream Processing of Forest Products, recognised the need for a major escalation of domestic processing, and indicated a desire to promote the development of a substantial sustainable industry based on both primary and secondary processing, including large integrated processors producing plywood, veneer, sawn timber, furniture/joinery and other value-added products.

As a major employer and located strategically in rural areas, the timber industry is well placed to contribute to national development, given appropriate conditions to ensure its security and viability. It is possible, therefore, to envisage a major national industry based substantially on smallholder agroforestry plantings and community-based management of secondary forests. In particular, if coupled with a significant domestic processing industry, PNG's forest industries could become a much larger contributor to the national economy than the current log export industry.

The development of value-added downstream timber processing capabilities would provide great benefits and opportunities to PNG through economic growth and social improvements to local communities. Through the establishment of wood production companies, both large and small, significant employment opportunities would be created for the local population, especially among rural communities.

Achievement of national goals in this area requires a higher level of sophistication, and enhanced training, education and R&D capacity.

In 2006, during this ACIAR Project development phase, a significant constraint to the achievement of the PNG government vision outlined above was the limited capacity in research, training and education related to timber processing and manufacturing:

- The Forest Products research program was re-established at PNGFRI in 2001 (after some 10 years in abeyance), but its activities were limited due to lack of researchers skilled in wood products and wood processing and lack of research equipment.
- Training in timber processing and manufacturing was offered by the Timber and Forestry Training College (attached to UniTech) which has quite good basic facilities but the training courses provided urgently required updating to include new processing technologies to the curriculum, greater collaboration with PNG FRI, expanding options for furniture manufacture, and upgrading of staff skills and qualifications.
- The University of Technology (Forestry Department), currently the only undergraduate and post-graduate forestry institution in PNG, had little focus on timber processing.

In an increasingly global marketplace, the sector must produce competitive, quality products and services. Its future prosperity depends upon the continued development of new products and technologies and most importantly, the education of a highly knowledgeable and skilled workforce.

ACIAR recognised that a major upgrading of capacity in research, education, and industry training is essential to meet the needs of a diverse and competitive processing industry. Therefore, this three year project was developed with the major focus on enhancing training, education and R&D capacity in PNG wood processing sector.

4 Objectives

The aim of this project was to provide the foundation for a more extensive and more sophisticated domestic timber processing industry in PNG. Underpinning objectives were:

Objective 1: To explore the development of products and designs based on solid wood and veneers

Activities:

- Formation of the Project Steering Committee.
- Literature Review aiming to collect the following data: types of species, and volumes being produced, as well as their long-term availability; types of products being produced and their destination markets; lesser known species, available in large volumes and potentially utilisable; comparative advantages of PNG wood products in relation to currently available products on international markets.
- Investigation of market potential for various products, in particular through discussions with local and Australian industry.
- Development of sawing and drying techniques for high value added wood products. This will involve the development of optimum sawing procedures and drying schedules required to reduce the moisture content of different tropical species to the required level for various applications without drying defects.
- Development of value-added manufacturing methods for PNG timbers. This will include:
 - Gluing timbers for various high value wood products for a wide range of climatic conditions, in particular, laminating small sizes components into large dimension panels.
 - Various options for jointing various timber species including mechanical jointing.
 - Machining parameters: planning, routing, turning and sanding.
 - Finishing methods for both indoor and outdoor applications.
 - Investigation into wood bending methods applicable to PNG species. This will involve the examination of the effect of heating conditions, initial wood moisture content, quality and cross-sectional size on bending. New designs for various wood products using bent wood components will be developed.
 - Development of new applications of veneers in a range of novel products for both structural and appearance uses. This will involve investigation of optimal veneer production methods and the suitability of various timber species for veneers and veneered products.
 - Development of a range of simple designs and products based on “ready to assembly” components and construction methods for domestic markets. These products should be affordable to local communities and easy to transport.
- Development, testing and promotion of a range of new designs for both appearance and structural products for both domestic and export markets based on novel processing and manufacturing methods applicable to PNG timbers.

- Promotion of designs and products to industry, through the Forest Industries Association and through the training programs of the Timber and Forestry Training College.

Objective 2: To examine the potential for value chains integrating advanced processing with production of timber in smallholder agroforestry systems and community-managed secondary forests

Activities:

- Analysis of current value chains linking community forestry with processing and manufacturing.
- Development of concepts for new value chains linking communities with the processing, manufacture and marketing of wood-based products resulting from novel technologies and designs for both export market and domestic uses (in particular for rural communities). This will include industry-smallholder partnerships. This activity would draw on other work, including project documents and reports from other ACIAR projects, e.g. on agroforestry systems, community-based management of secondary forests, and portable sawmilling.

Objective 3: To enhance capacity in timber processing training, education and R&D

Activities:

- Development of training programs and education materials to accommodate the industry demand and to accommodate the development of novel technologies, production methods and new products.
- Extensive FRI participation in the project, and training programs for FRI staff.

5 Methodology

5.1 Objective 1: To explore the development of products and designs based on solid wood and veneers

5.1.1 Formation of the Project Steering Committee and Research Teams

The Project Steering Committee

At the outset of the project the Project Steering Committee was formed, consisting of representatives from the project partner organisations and industry.

Originally, Dr Ruth Turia was the Chair of the Committee until she resigned from PNG UniTech. Dr Mex Peki (UniTech) was then nominated to the Chair position.

Terms of reference were developed for the Committee to ensure that the project objectives would be completed on time and within the budget. A strategy for the project coordination was developed to enable frequent, efficient and open discussions between the project team members.

The Steering Committee members met approximately every 6–11 months (depending on the availability of the Committee members) to discuss and review the project.

A logo was developed to give the project its own identity and to facilitate internet communication and distribution of information. The logo is provided in Figure 1 below:



Figure 1: Project logo

Formation of Research Teams

The project team selected eight major research projects to be undertaken on a collaborative basis. The projects were well aligned with the ACIAR project milestones.

Collaborative research teams were formed for the projects involving both PNG and Australian experts in the relevant areas of research. Each team was made responsible for the development of the project methodology, conducting the research program and reporting.

The list of the projects and a short summary on their aims are as follows:

Project 1: Drying PNG timbers

Team members: Gerry Harris – leader (UoM), Mex Peki (UniTech), Frank Asok (FRI), Baleng Lagep (TFTC), Steven Komut (TFTC).

Project aim: To investigate drying stresses, dimensional changes and drying schedules for selected PNG timbers. Eight species were selected for the study. The outputs of the project are presented in Section 7.1.1.

Project 2: Potential speciality timber markets for PNG lesser-known hardwoods

Team members: Barbara Ozarska – leader (UoM), Trevor Galgal (UniTech), Steven Wilfred, Mathew Wundamani (TFTC), Nigel Baro (FRI).

Project aims:

- Investigation of furniture export requirements for undeveloped countries with the focus on certification and chain of custody (*completed and reported*).
- A review of forest certification in PNG (*completed and reported*).
- Survey of current markets for PNG lesser known species: questionnaires were developed and circulated to all research members for comments (*completed and reported*).
- Market potential for PNG timbers and products: a review of the European markets demand for imported timbers and products is in progress (*completed and reported*).

Project 3: Mechanical properties of some lesser used species

Team members: Barbara Ozarska – leader (UoM), Trevor Galgal, Mex Peki (UniTech), K. Ramute (TFTC), Mathias Niangu, Nigel Baro (FRI).

Project aim: Testing of mechanical properties of lesser used species.

Selected mechanical properties of 10 species were completed by Peter Edwin as part of his Masters thesis at the University of Melbourne.

Project 4: Market potential of PNG carvings in developed countries

Team members: Barbra Ozarska – leader (UoM), Trevor Galgal, Mex Peki (UniTech), K. Ramute (TFTC), Nigel Baro (FRI).

Project aim: A final year forestry student, Ms Dorcas Ling (UniTech) was engaged to carry out research to determine which species are currently used for making carvings. A survey questionnaire was developed by Mr Nigel Baro and Mr Trevor Galgal and circulated to team members for comments.

The interview questionnaire comprised of three sections:

1. Background information about the carvers, which included names, age group and what province they came from.
2. General information on the carvings, the main species used, substitute species, carving products, the skills and tools used.
3. Market information, what customers they target, their preferences when buying carvings, the availability of wood resources and what challenges are faced when marketing their carvings.

At the end of each interview, the woodcarvers also had the opportunity to raise their concerns of the challenges faced in marketing their carving products. Data collected from the field were analysed using descriptive statistical tools such as mean, frequency, mode and percentages. The survey was completed and the results documented in the report:

- Baro, N. 2011. Wood carving in Bumbu Settlement. A preliminary study of market potential on PNG wood carvings. ACIAR Research report (16pp).

Project 5: Preservative treatments of PNG timbers and bamboos

Team members: Benson Gusamo – leader (UniTech), Mex Peki (UniTech), Geoffrey Bayak (TFTC), Mathias Niangu (FRI).

Project aims:

- To investigate treatability/permeability of selected PNG timbers, test correlation between basic density, solution uptake and dry salt retention.
- To conduct durability tests.

TFTC made arrangements with PNG Forest Products and Australian preservative companies to supply treatment chemicals for the research. Chemicals needed for this project included: copper chromium arsenate (CCA), alkaline copper quaternary (ACQ), and borax.

Several studies were undertaken and completed and reported:

- Gusamo, B. and Tulo R. 2011. Tar oil vs time of immersion treatment of pine poles: a simple technique applicable for rural communities of PNG. ACIAR Research report (9pp).
- Gusamo, B. and Moroma G. 2011. An examination of the effect of re-wetting seasoned woods at different times against diffusion of Boron-Fluoride-Chromium-Arsenate Salt in dip treatment. ACIAR Research report (27pp).
- Gusamo, B. 2011. Chemical and non-chemical processes of controlling sapstain and mould fungal growths on freshly cut plantation pines, Bulolo, Papua New Guinea. ACIAR Research report (7pp).
- Gusamo, B. 2011. Fluid flow pathways of two *Araucaria* spp. and their variation in permeability to chemical preservative treatment. ACIAR Research report (5pp).

Project 6: Designing sustainable housing prototypes using timber and bamboo species

Team members: David O'Brien – leader (UoM Architecture), Benson Gusamo (UniTech), Lus Pora (TFTC), Mathias Niangu (FRI).

Project aim: To design low-cost houses specifically targeting low-income earning families in urban settlements and in rural communities. The details of this activity are provided in the Section 5.2.1.

In addition, a study was carried out by Trevor Galgal (UniTech) in order to:

- Examine the potential market of low-cost weatherboards from *Castanopsis acuminatissima* processed using a hand axe in Lae urban settlements.
- Identify possible links between rural weatherboard producers in Finschhafen and urban settlements through a proposed value chain.

The study was completed and documented in the report "Forest-based small-scale processing of *Castanopsis* weatherboards for the local market. A value chain link for rural forest based communities".

Project 7: Wood staining with synthetic or natural dyes

Team members: Prof. J. Akande – leader (UniTech), (*replaced by Charles Tsiritsi, TFTC*), Lus Pora (TFTC), Mathias Niangu, Frank Asok, Nigel Baro (FRI).

Project aim: To investigate the use of natural dyes for various products.

Due to problems with frequent staff changes in the project team this project did not undertake any activities.

Project 8: Parquetry Making

Team members: Benson Gusamo – leader (UniTech), Barbara Ozarska (UoM), Andrew Kasa, Charles Tsiritsi (TFTC), Frank Asok (FRI).

Project aim: To investigate the potential for the manufacture of parquetry in PNG.

A study was undertaken with the aim of studying methods of further processing waste sawn pieces of timber from local premium hardwoods and investigating their potential application for parquetry product making. Four locally grown hardwoods were selected for the study: Rosewood (*Pterocarpus indicus* Willd.), Taun (*Pometia pinnata* Forst.), Kwila (*Intsia bijuga* Kunkze.) and an exotic Teak (*Tectona grandis* L.f.). The study was completed and documented in the report "Trial experiment on utilisation of PNG commercial hardwoods for parquetry product".

In addition, a study was conducted at TFTC pursued by Steven Komut and co-workers at the joinery and furniture section. Four native hardwood timber species namely *Intsia bijuga*, *Pterocarpus indicus*, *Anisoptera thurifera* and *Hernandia ovigera* were used to produce parquetry. The patterns used to form the parquetry were *square on square*, *single herringbone* and *basket weave*. The machinability of timbers, gluing characteristics, application of coatings and the final product performance were assessed.

5.1.2 Detailed analysis of market potential for various products, in particular through the literature review and discussions with local and Australian Industry

The assessment of market potential for various PNG timbers and products was undertaken through the following studies:

Forces determining the pattern of production and trade and prospects for small scale timber producers in PNG

Through the collaboration with the project FST/2004/06, managed by Prof. Keenan (UoM), the report "The state of play of tropical hardwoods" was made available for the use of this project. This document examined two issues. Firstly, it discussed the main forces that are currently shaping the production and trade of tropical hardwoods at the global and sometimes regional and country level. Secondly, recommendations were presented as to how small scale timber producers and community managed forests in PNG can establish viable enterprises.

The study provided sound background information for the assessment of market potential for PNG timbers and products undertaken within this project.

Potential markets for lesser-known PNG species

Morgan Le Guludec from the University of Nantes in France completed an internship at the University of Melbourne in 2010 under the supervision of Assoc. Prof. Barbara Ozarska. Morgan examined PNG timbers and their potential for substitution for large world timber markets in Africa, South America and Asia.

The study included:

- An overview of PNG forests and the timber trade.
- Examination of the criteria for successful market penetration.

- Two different methods were used to compare the PNG timbers to international timbers, the “Researcher” approach and the “Salesman” approach.

The “Researcher” method involved finding potential markets for lesser-known timber species based just on their physical and mechanical properties. Timbers were divided into four groups: major exportable hardwoods, commercial hardwoods, minor hardwoods and softwoods, and their properties and characteristics were listed in an excel spreadsheet. There were two reasons for using this method. First, to look for timbers with the largest final end-use; this result provided an idea about timbers with export potential. Second, to make a quick comparison between the end-use range of the lesser-known species and the most-used species in order to search for possible substitutes.

The “Salesman” approach was used to find out which species dominate the international tropical timber market. For this, the ITTO website was used as a reliable source of information and statistics on the volumes of the most exportable tropical timbers in the world. The properties of these timbers were then compared with the properties of PNG timbers by grouping together the timbers with similar characteristics. This provided a basis for identifying which PNG timbers could be substitutes for most commercial timbers in the world.

Furniture exports requirements for undeveloped countries

Maria Rosario Poblete, a student of the Master of Ecosystem Science at the University of Melbourne, explored the area of trade policy and the implications on export requirements for undeveloped countries. The study examined some of the barriers that can inadvertently be created through trade policies, tariffs, phytosanitary requirements and certification requirements of various countries and the import of timber products.

A review of timber certification in PNG

The review was undertaken by the final year student, Peter Zeng, at PNG UniTech. The study aimed to gather data and information on the current certification systems used in PNG. However, problems were encountered in collecting the information from some government departments and timber companies.

5.1.3 Development of sawing and drying techniques for high value added wood products

This activity involved three major tasks:

1. sawing and grading PNG timbers
2. drying techniques for PNG timber
3. investigation of properties and processing characteristics of PNG timbers.

Sawing and grading of PNG timbers

The activity on sawing PNG timbers was not undertaken because the PNG project partners identified that numerous studies have been carried out in PNG on sawing, in particular portable sawmilling, by various organisations and donors. It was also revealed that the current timber grading rules are used by timber companies and training organisations and the development of new rules was not required.

Drying methods for PNG timbers

The development of drying schedules and methods for PNG species was recognised as a very important project activity. The following research plan was developed:

- A timber drying research team was formed to undertake research on drying stresses, dimensional changes and drying schedules for selected PNG timbers.
- Timber species proposed for the study were:
 - *Instia bijuga*
 - *Pometia pinnata*
 - *Pterocarpus indicus*
 - *Dracontomelon dao*
 - *Vitex cofassus*
 - *Endospermum medullosum*
 - *Octomeles sumatrana*
 - *Alstonia scholaris*
 - *Anisoptera thurifera*.
- Rough sawn timbers for drying experiments were collected and air dried at TFTC.
- A template for developing drying schedules was developed. However, research on drying schedules for PNG species has not been undertaken due to lack of available suitable drying facilities. An existing kiln at TFTC remained out of order due to lack of spare parts since the project started. The project provided money to purchase the spare parts overseas but unfortunately the kiln was not repaired before the project was completed.
- Two brand new kilns were purchased using the project budget money:
 - Conventional laboratory kiln for FRI. Unfortunately, the kiln was not operational until the project was completed due to FRI delays in arranging electrical connections to the kiln.
 - Solar kiln for UniTech. The delivery of the kiln was delayed as the UniTech team had difficulties in obtaining management approval for a site on which the kiln was going to be placed. The kiln is now installed and fully operational; it is used for research, teaching undergraduate and postgraduate students and will be used for training in the future.
- A comprehensive training on wood drying was provided to the project partners in Lae and in Australia (see Section 5.3.1).

Investigation of properties and processing characteristics of PNG timbers.

This study was undertaken by a Masters student at the University of Melbourne, Mr Peter Edwin, who was awarded the John Allwright Fellowship by ACIAR.

The thesis entitled “Investigation of processing characteristics of hardwood timbers from secondary forest in PNG” aimed to:

- Develop a template for assessment of wood properties and processing characteristics for timbers from the secondary forest.
- Assess selected properties of commercial PNG species from secondary forest according to the appropriate test methods.
- Select appropriate test methods suitable to PNG's conditions.

Peter Edwin successfully completed the thesis in 2011.

In addition, a Wood Database on PNG species has been developed by Benjamin Vali of PNG FRI. This includes all historical data and covers 292 species. The project is ongoing.

5.1.4 Development of value-added manufacturing methods for PNG timbers

A Project Meeting was held on 13 August 2009 in Lae with the aim of discussing the priorities for various technologies and products that should be researched and developed within the project. A detailed plan was developed and documented in the report "Summary Report on The Project Visit to PNG 10–15 August 2009". A workshop for the project partners was held on 15 November 2009 to brainstorm the proposed plan.

A strategy for development of centralised timber processing facilities was developed by Mr Paul Aoae (TFTC) and Trevor Galgal (UniTech) and documented in the report "Domestic processing in PNG: Linking major logging companies with small and medium wood processing entrepreneurs".

Wood bending technology was identified as the most suitable and effective value-added method for the adoption by the PNG timber industry as it promotes efficient use of timber and a significant reduction of waste. Therefore, a research project "Bending of PNG timbers" was developed in addition to the eight research projects described in Section 5.1.1.

The team members were: Barbara Ozarska – leader (UoM), Paul Aoae (*replaced by Steven Komut, TFTC*), Peter Edwin (UniTech).

The aim of the project was to develop a methodology for assessing bending characteristics of PNG hardwoods when subjected to steam heating and create an information system that supports effective decision-making in selecting suitable species for commercial bentwood fabrication.

It was agreed that the steam bending equipment should be located at TFTC and used to train the industry in wood bending techniques and to conduct research on bending characteristics of PNG species. The equipment was constructed in 2010 by a local PNG engineering workshop according to the specification developed by the UoM team. The equipment included:

- Two steaming boxes connected to a boiler, which was the steam source for the plasticisation process.
- The hydraulic bending machine, metal straps and bending forms.

Mr Paul Aoae (TFTC) conducted a study titled "Bending characteristics of *Pometia pinnata* and *Anthocephalus chinensis* as influenced by steaming length (time), moisture content and timber size" as his Postgraduate Diploma thesis at UniTech. He was trained at UoM on wood bending procedures.

Five logs from each species were flat-sawn to produce 240 samples with 32 mm x 32 mm cross sections. The samples were prepared according to criteria for wood bending available in research specifications. Each specimen was bent until failure or breakage occurred. The radius of curvature at which the first failure occurred was recorded for each sample.

Unfortunately, Mr Aoae's employment at TFTC ended on 31 December 2010 and he did not complete the study. Mr Steven Komut (TFTC) continued with the bending project at that time. Preliminary studies were undertaken but not completed due to technical problems with the equipment and lengthy delays in making the plant operational.

5.1.5 Development, testing and promotion of a wide range of new designs for both appearance and structural products based on various processing and manufacturing methods applicable to PNG timbers

Designs for appearance products

As explained above, the research on bending attributes of PNG timbers was delayed, which resulted in a lack of data on bending abilities of PNG timbers. Therefore, the development of new designs for appearance products could not be undertaken.

Designs for structural products

Dr Mex Peki of PNG UniTech and the project leader, Dr Barbara Ozarska (UoM) initiated a project on designing houses for local communities. The Architecture, Building and Planning Department of UoM and PNG UniTech were brought on board to design houses suitable for PNG rural and settlement conditions.

As this activity is closely linked with the Objective 2 its details are described in Section 5.2.1 below.

5.2 Objective 2: To examine the potential for value chains integrating advanced processing with production of timber in smallholder agroforestry systems and community-managed secondary forests

5.2.1 Development of concepts for new value chains linking communities with the processing, manufacture and marketing of wood-based products resulting from the developed technologies and designs

In order to link rural communities and urban markets through wood processing into wood products, a sub-project was developed involving PNG UniTech (Faculty of Forestry and Faculty of Architecture) and UoM (Faculty of Architecture, Building and Planning). The project aimed to design low-cost kit homes specifically targeting low-income earning families in urban settlements. The following methodology was developed:

“Rural communities will process and package the building materials which will be supplied to the urban settlements for the construction of houses. In return, this activity will provide revenue for rural communities which can be used to purchase corrugated roofing and other materials to build permanent quality houses in the rural villages. The team of architects from the University of Melbourne and UniTech will design low-cost sustainable houses for both rural communities and urban settlements.”

Dr David O'Brien, Hamish Hill, Grant Divall and Allison Stout from the University of Melbourne undertook the building component, which was run through an Architectural Design Studio with Masters of Architecture and Landscape students. Project organisation in Lae was coordinated by Trevor Galgal and Dr Mex Peki at the University of Technology, Lae. The activity was overviewed by Dr Barbara Ozarska, the project leader.

A reconnaissance visit by the Australia–PNG team to rural Serongko villages in Finschhafen and Bumbu Settlement in Lae was conducted between 16 and 18 of March, 2010 in order to identify the possibility of designing a low-cost quality house that is also

culturally, socially, and environmentally sustainable in each respective location. The outputs of the visits were:

- Serongko village: The visit helped the researchers to gain some insight into the lives and living patterns of the people in this village. They were able to inspect and document five houses, draw up a village site plan and ask questions of the residents in regards to how they lived in their homes.
- Bumbu settlement: The researchers were able to see different houses in the settlement. They inspected and documented six houses and gained understanding on the style of living in the houses and the village.

Following the visit, the "Community Pavilion and Water Tank Project" was developed as a case study in building and designing with local skills and materials. The project was titled *Hauswin* after an informal type of public building, a traditional tropical wind house where local people get together. The project involved the design and construction of two pavilions: one was located in Serongko village and the other at Bumbu settlement.

Planning and preparation for the construction of pavilions was carried out as a group activity in December of 2010.

The construction work was conducted by a team consisting of Australian and PNG students and lecturers. The Australian team had 15 students and three lecturers, and the PNG team involved six students and one lecturer from the Faculty of Architecture, and four students and two lecturers from the Faculty of Forestry.

Students were divided into groups in order to identify and record various patterns in the two sites visited. The overall aim was to undertake and complete a social map of the communities visited (i.e. rural and urban settlement). The groups recorded patterns in:

- connections
- constructions
- living
- meaning
- site.

Local people were actively involved in the preparation of timber components and in constructing the pavilions. The pavilions were built to include water tanks so that communities would have access to clean drinking water.

The team members also designed new, easy to build constructions (houses, toilets, kitchens) for Bumbu settlement incorporating some wood products and recycled materials. This also allowed researchers to study the feasibility of such an activity to continue once the ACIAR project ends.

5.3 Objective 3: To enhance capacity in timber processing training, education and R&D

5.3.1 Development of training programs and education materials

The training program included:

A. Training in Australia

Extensive training was provided in Australia to PNG project members on wood bending, drying and furniture manufacturing.

- One TFTC training instructor was trained at UoM on wood bending (1 week – June 2009).
- Two TFTC drying instructors were trained in wood drying at Timber Training Centre at Creswick in June 2010 (2 weeks).
- Six trainees completed training on wood drying and furniture manufacturing in June 2011 (2 weeks). This training was possible through a successful application to the Crawford Fund, which co-funded the training course with the ACIAR project money.

B. Train the Trainers program

In order to enhance the knowledge of the training instructors at TFTC a "Train the Trainers" program was developed. The following courses were provided:

- Basics of wood science and wood quality
- Wood sawing and sawn products
- Veneer and plywood production and products
- Decorative wood veneers
- Wood composites
- Wood drying
- Wood treatment and wood durability, including termites treatment
- Requirements for high quality wood products
- OH&S in timber industry
- Machinery and wood machining in furniture manufacturing
- Furniture manufacturing process
- Production planning and furniture factory layouts
- Basics of wood finishing
- Timber in buildings
- Life Cycle Analysis and carbon in wood products.

The training consisted of both theoretical and practical sessions at TFTC, Lae, and PNG Forest Products, Bulolo.

C. Development of National Diploma and Advanced Diploma in Wood Processing & Products

A program for *National Diploma and Advanced Diploma in Wood Processing & Products* was developed by UoM in a close consultation with the PNG partners. The program was presented to PNG FIA Board in May 2011 and was enthusiastically supported by the Board members and industry representatives. The program was then submitted to the University Degree Assessment Committee for approval. The Diploma program was approved and will commence in 2013.

D. Revision and development of PNG tertiary education program in forest products

This activity was highly dependent on PNG UniTech needs and requirements to revise the existing education program. Although the UniTech team members have recognised the importance of this activity, an approval was not provided at that point in time from UniTech

Management to agree to this program. Therefore, this activity was not able to be undertaken.

An effort was made to increase interest of undergraduate students at UniTech in forest products industries. A list of research topics on wood processing and manufacturing was developed by Dr Barbara Ozarska for the final year students, as part of the fulfilment of their undergraduate degree in Forestry. Dr Ozarska also presented a seminar to the students on "Opportunities in Forestry and Forest Products". Dr Mex Peki, Benson Gusamo and Peter Edwin, lecturers at UniTech, promoted wood related research to the students. As the result, several research projects related to wood processing were undertaken by students (see Section 7.1.3).

5.3.2 Extensive FRI participation in the project, and training programs for FRI staff

An inventory of research equipment at FRI was completed. A list of equipment to be repaired was prepared and quotations from engineering experts were requested. It was found that the majority of the items were antiquated and the cost of repairs prohibitive.

Various laboratory instruments and equipment were purchased by the UoM team in Australia and transported to FRI, and the two other partner organisations (TFTC and UniTech).

FRI staff attended all the "Train the Trainers" courses, two researchers were trained in Australia and "in-house" training on wood drying was provided to FRI team members.

6 Achievements against activities and outputs/milestones

Objective 1: To explore the development of products and designs based on solid wood and veneers (Table 1)

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Formation of the Project Steering Committee	Project Steering Committee formed and responsibilities assigned. (PC + A)	Yr1: m1-2	<i>Completed.</i> Project Steering Committee was formed consisting of representatives from the project partner organisations and industry.
1.2	Detailed analysis of market potential for various products, in particular through the literature review and discussions with local and Australian Industry.	Wood species to be included in the project selected, wood products currently being produced in PNG identified & their key destination markets. (PC)	Yr1: m 2-5	<i>Completed.</i> The selection of wood species to be included in the project was a part of a Masters study by Peter Edwin, who was awarded JAF. Survey was undertaken (interviews and questionnaires) to identify species which are available for downstream processing on a sustainable basis and to identify their current markets. The results were presented in the Masters thesis.
New opportunities for PNG wood products identified on both domestic and overseas markets. (PC + A)		Y1: m4-7 and on-going.	<i>Completed.</i> Market research studies for PNG timber and products, including carvings, were undertaken by the Australia–PNG team. A report “Furniture export requirements for undeveloped countries” was written by a Masters student at UoM. A review of timber certification in PNG was completed by the final year UniTech student. Opportunities for PNG products in Europe were investigated by the UoM team and a report written.	
Current industry capabilities evaluated. (PC +A)		Y1: m4-7	<i>Completed.</i> The evaluation of the industry capabilities was undertaken in Morobe Province and the results reported.	
Industry development strategies identified (PC + A)		Y1: m9	<i>Completed.</i> A strategic paper “A Vision of forestry and forest industries in PNG” was developed (see Appendix 3).	

1.3	Development of sawing and drying techniques for high value added wood products.	<p>Optimal sawing schedules and timber grading rules developed. (PC + A)</p> <p>Drying schedules developed. (PC + A)</p> <p>Study on physical, structural & processing properties of the major and lesser known PNG timbers completed. (PC + A).</p>	<p>Y1: m9 till Y.2: m3</p> <p>Y1: m9 till Y.3: m3</p> <p>Y1: m9 till Y3: m12</p>	<p>This activity was not undertaken as the PNG project partners identified that numerous studies have been undertaken in PNG on sawing, in particular portable sawmilling, and that the current grading rules are still used for training and by industry.</p> <p>A comprehensive training on wood drying was provided to the project partners in Lae and the template for developing drying schedules was made available. However, research on drying schedules for PNG species has not been undertaken due to lack of available suitable drying facilities (see Section 5.1.3).</p> <p><i>Completed.</i> The major part of this study has been completed within the Masters thesis by Peter Edwin. The study provides protocols for the assessment of properties and technological attributes of the major and lesser known PNG species. In addition, a data base on the PNG species has been developed by FRI team.</p>
1.4	Development of value-added manufacturing methods for PNG timbers.	<p>Plan for developing various technologies and products completed. (PC + A)</p> <p>Workshop to brainstorm the proposed plan completed. (PC + A)</p> <p>Assessment and development of required infrastructure completed (PC + A)</p>	<p>Y2: m1-2</p> <p>Y2: m3</p> <p>Y2: m-6</p>	<p><i>Completed.</i> The action plan was developed and documented in the Report 3 "Summary Report on The Project Visit to PNG 10–15 August 2009".</p> <p>As above.</p> <p><i>Completed.</i> Strategy for development of centralised timber processing facilities "Timber Processing Model" was developed by Mr Paul Aoa, TFTC and Trevor Galgal, UniTech.</p> <p>Wood bending technology was identified as most suitable and effective value-added method for the adoption by the PNG timber industry. Wood bending equipment was constructed but limited studies were undertaken on bending properties of PNG species due to technical problems with the equipment and due to termination of employment of the key TFTC staff member who was conducting the study.</p>

1.5	Development, testing and promotion of a wide range of new designs for both appearance and structural products based on various processing and manufacturing methods applicable to PNG timbers.	<p>Design Team formed. (PC + A)</p> <p>Program to involve local communities in design & production developed. (PC + A)</p> <p>New products developed. (PC + A)</p>	<p>Y2: m3</p> <p>Y2: m3-4</p> <p>Y2: m4 on going</p>	<p>Design Team was formed consisting of researchers and students from the Faculty of Architecture (UoM and UniTech).</p> <p>A program was developed aiming to design and construct culturally, economically, environmentally sustainable houses for rural and urban communities in PNG.</p> <p>New designs for structural products were developed but the development of designs for appearance products was not undertaken due to lack of data on bending properties of PNG timber.</p>
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Objective 2: To examine the potential for value chains integrating advanced processing with production of timber in smallholder agroforestry systems and community-managed secondary forests (Table 2)

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Analysis of current value chains linking community forestry with processing and manufacturing	<p>Synergies with other ACIAR projects developed. (PC + A)</p> <p>Current links between community forestry and timber industries analysed. (PC + A)</p>	<p>Y1: m5-9</p> <p>Y1: m5-9</p>	<p>Discussions were carried out with the team members of the project FST/2006/06 to exchange information on the projects progress. However, no collaborative activities were undertaken mainly due to different focuses of the two projects.</p> <p><i>Completed.</i> Report was written by Mr Paul Aoa, TFTC, "Domestic Processing in PNG: Linking major logging companies with small and medium wood processing entrepreneurs".</p>
2.2	Development of concepts for new value chains linking communities with the processing, manufacture and marketing of wood-based products resulting from the developed technologies and designs.	<p>Options developed for new value chains linking village communities with the timber industry and marketing of wood products. (PC+A)</p> <p>Training to members of village communities provided. (PC+A)</p> <p>Village communities involved in producing some components and products. (PC+A)</p>	<p>Y2: m1-6</p> <p>Y2: m6-9</p> <p>Y2: m6 - on going</p>	<p><i>Completed.</i></p> <p>This activity was focused on designing and constructing low-cost housing suitable for PNG using timber from the community forests (see the Act.1.5).</p> <p>In order to link rural communities and urban markets through wood processing into wood products, a case-study was developed involving researchers and students from PNG UniTech and UoM where a timber pavilion was designed as an example of a construction affordable to low-income earning families in urban settlements and villages. Two pavilions were built involving local people.</p> <p>The team members also designed easy to build constructions (houses, toilets, kitchen, etc) incorporating some wood products and recycled materials.</p>

PC = partner country, A = Australia

Objective 3: To enhance capacity in timber processing training, education and R&D (Table 3)

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Development of training programs and education materials	<p>Selected PNG project members trained in Australia. (A)</p> <p>PNG training program revised and developed. (PC+A)</p> <p>PNG education program revised and developed. (PC+A)</p>	<p>Y1: m9</p> <p>Y1: m9 till Y2: m6, & on-going.</p> <p>Y1: m9 till Y2: m6, & on-going.</p>	<p><i>Completed.</i> Extensive training was provided to the PNG project members in Australia on wood bending, drying and furniture manufacturing. An application to the Crawford Fund was successful which allowed training 6 people in Australia.</p> <p>In order to enhance the knowledge of the training instructors at TFTC a "Train the Trainers" program was developed. 8 courses were completed:</p> <p><i>Completed.</i> Program for <i>National Diploma and Advanced Diploma in Wood Processing & Products</i> was developed by UoM in a close consultation with the PNG partners. The program was approved by PNG FIA Board and the University Degree Assessment Committee and will commence in 2013</p> <p><i>Deferred.</i> This activity is dependent on PNG UniTech needs and requirements to revise the existing education program. Although the UniTech team members have recognised the importance of this activity, an approval is awaited from UniTech Management .</p>
3.2	Extensive FRI participation in the project, and training programs for FRI staff.	<p>Research laboratories and equipment modified and improved. (PC+A)</p> <p>Appropriate training programs on new technologies and products provided for FRI staff. (PC+A)</p>	<p>Y1: m10 till Y3 m6.</p> <p>Y2: m6-12</p>	<p>An inventory of research equipment was completed. It was found that the majority of the items were too old and the repair costs too high.</p> <p>Various laboratory instruments and equipment were purchased for FRI, TFTC and UniTech.</p> <p>A new Wood Drying Kiln, specifically designed and constructed for FRI, was purchased for research studies on drying PNG species.</p> <p>FRI staff attended all "Train the Trainers" courses, two researchers were trained in Australia and "in-house" training on wood drying was provided to FRI team members.</p>

PC = partner country, A = Australia

7 Key results and discussion

7.1 Capacity building in PNG timber processing, training, education and research

The key achievement of the project has been in the building of capacity in PNG wood processing. PNG partners involved in the project included education, research and training institutions as well as industry organisations and companies. The members of these organisations have formed a well-built cohesive network with a strong culture of collaborative work during research activities, training and technology transfer. The collaborative approach between the project participants has blossomed over the years, demonstrated by an increase in networking and joint problem solving.

This is a valuable achievement of the project – taking into account that for many years PNG research, teaching and training in wood processing was neglected by the government, which resulted in a limited capacity to assist the industry in its development.

The key achievements in the building of capacity in research, training and education are described below.

7.1.1 Research capacity

A number of individual research projects were initiated early in the project in order to fulfil the requirements of the principal project objectives. Each research project was undertaken on a collaborative basis by teams involving both PNG and Australian experts in the relevant research areas. The results of some of those projects have been reported in research reports and published papers.

Outputs of the research projects, listed in Table 4, include a diverse range of benefits, including research studies, training courses and purchase of equipment. The details of the key outputs are provided in the subsequent sections of this chapter.

Table 4: Summary of major outputs of research projects

Project	Outputs
1. Drying schedules for PNG timbers	<ul style="list-style-type: none"> • Training on wood drying in Australia (8 people) • “Train the trainers” course in PNG • Training for PNG FRI staff • Equipment purchased including laboratory scale kiln for PNG FRI, solar kiln for UniTech and laboratory instruments such as moisture meters and temperature and humidity data loggers • No research undertaken as kiln at TFTC was out of order during the term of the project • Research to be continued
2. Potential specialty timber markets for lesser-known	<ul style="list-style-type: none"> • Report completed “Furniture export requirements for undeveloped countries”

hardwoods	<ul style="list-style-type: none"> • Report completed “Opportunities for PNG products in Europe” • Review of forest certification in PNG • Report “The state of play of tropical hardwoods” (ACIAR Project FST/2004/061)
3. Mechanical properties of some lesser-used species	<ul style="list-style-type: none"> • Masters thesis completed by Peter Edwin “Investigation of processing characteristics of hardwood timbers from secondary forest in PNG” • Database on PNG species being developed by PNG FRI
4. Market potential for PNG carvings in developed countries	<ul style="list-style-type: none"> • Survey of woodcarvers undertaken • TFTC initiative to introduce training in wood carving and support marketing of PNG carvings
5. Preservative treatments on PNG timbers	<ul style="list-style-type: none"> • Breakdown of vac-pressure plants at TFTC and BUC delayed the research • Lab-scale vac-pressure plant at PNG FRI repaired after the project was completed • Dip diffusion plant designed for construction at TFTC • UniTech research studies <ol style="list-style-type: none"> a) Tar-oil absorption vs time in immersion treatment of pine poles b) An examination of the effect of steaming on the treatability of high density refractory timbers of PNG <i>Instia bijuga</i> and <i>Vitex coffasus</i> c) An effect of re-wetting of dressed sawn boards against diffusion of BFCA salt in dip treatment d) Preliminary study on the natural durability of some selected lesser used species
6. Designing sustainable housing prototypes using timber and bamboo species	<ul style="list-style-type: none"> • Case study completed: Timber pavilions were designed as an example of a construction affordable to low-income families in urban settlements and villages • Visits to villages were conducted followed by development of building designs
7. Wood staining with synthetic or natural dyes	<ul style="list-style-type: none"> • Literature review • Methodology • Timber collected for experiments • Project to be continued
8. Parquetry making	<ul style="list-style-type: none"> • Project 1: Native species rosewood, kwila and taun and locally grown teak (UniTech)

	<ul style="list-style-type: none"> • Project 2: Native species rosewood, kwila, mersawa and hernandia (TFTC) • Assessment of machinability, glueability, finishing and appearance
9. New technologies: Wood bending	<ul style="list-style-type: none"> • Bending equipment constructed and installed at TFTC • Literature review • Methodology • Research on bending PNG species to be continued.

Although not all of the project tasks are fully completed, due primarily to lack of equipment and frequent staff changes, the team members have gained valuable experience in collaborative research work.

7.1.2 Training capacity

Extensive training was provided to nine PNG project members in Australia on wood bending, drying and furniture manufacturing.

An application submitted by the project leader to the Crawford Fund was successful and allowed for the training of six PNG project members (from TFTC, UniTech and PNG FRI) in Australia (Figure 2)



Figure 2: Trainees of the Crawford Fund in Melbourne

In order to enhance knowledge in wood processing, the “Train the Trainers” program was developed and conducted with a diverse range of courses from well-credentialed Australian trainers. The courses were well attended by PNG project members, including technical staff from the industry (Figure 3).

Furthermore, a proposal to develop a National Diploma and an Advanced Diploma in Wood Processing and Products at TFTC was put forward in order to complement the pre-employment technical training (PETT) currently offered in courses such as wood technology, harvesting training, sawmilling, saw doctoring, small sawmilling, wood machining and furniture manufacturing. Australian and PNG project partners jointly developed the program. It will be offered as a two year National Diploma and a one year

National Advanced Diploma in Wood Processing and Products under the National Qualification Framework (NQF). Both courses are due to commence in 2013.



Figure 3: PNG team members participating in training courses

7.1.3 Education capacity

Two young researchers involved in the project were awarded John Allwright Fellowships to undertake Masters study at the University of Melbourne:

- Mr Peter Edwin, former staff member at TFTC, who successfully completed his Masters degree in 2011. The topic of his thesis was “Investigating processing characteristics of hardwood timbers from secondary forest in PNG”. After the completion of his degree, Peter Edwin was appointed a lecturer at the Faculty of Forestry at PNG UniTech.
- Mr Trevor Galgal, a researcher at PNG UniTech, commenced his Masters study in 2011 on “Life Cycle Energy of timber drying in PNG and Australia”. The study is due to be completed in July 2013.

A commendable example of positive outcomes from the project is the increase in the number of final year students at PNG UniTech, Forestry Department who are interested in

wood processing and wood products subjects. During 2010 and 2011, fifteen students selected wood-related topics for their research projects in comparison with only three (on average) in the previous years.

The students were supervised by lecturers from PNG UniTech with guidance and support provided by the project leader, Assoc. Prof. Barbara Ozarska.

The list of projects is provided in Appendix 1.

Knowledge and experience the students gained while working on the research projects will hopefully inspire them to pursue a career in the wood processing sector.

Apart from the achievements in research, training and education described above, an important output of the project has been the purchase of books, journals and professional magazines for the TFTC, UniTech and FRI libraries and the acquisition of manuals, technical specifications, publications, training and teaching materials. The value of this activity is particularly appreciated by TFTC where there were no training materials available for trainees in the library prior to project commencement. Similarly, the library in PNG UniTech had only a limited number of books and publications on wood science and technology subjects. In total, about 200 books and manuals were purchased for TFTC UniTech and FRI libraries. Many publications and manuals, as well as teaching and training materials, were also provided in electronic form for TFTC, UniTech and FRI staff members.

In addition, the project leader initiated a donation of 120 books from the Creswick library at the Department of Forest and Ecosystem Science (UoM) to the PNG UniTech library at the Faculty of Forestry.

The TFTC, UniTech and FRI libraries are widely available not only to students, trainees, lecturers and researchers but also to industry members.

A significant achievement has also been in upgrading research, training and educational facilities at PNG UniTech, TFTC and PNG FRI. Important equipment and laboratory instruments were purchased by the UoM team and delivered to the three PNG organisations according to their priorities (e.g. solar kiln installed at PNG UniTech, laboratory kiln at PNG FRI, wood bending equipment at TFTC). The list of the equipment purchased is provided in Appendix 2).

7.2 Investigation of properties and processing characteristics of PNG timbers

Peter Edwin was successfully awarded a Master of Wood Science in 2011 for his thesis entitled "Investigation of processing characteristics of hardwood timbers from secondary forest in PNG". His study was funded by John Allwright Fellowship, ACIAR.

The thesis addressed the lack of knowledge on the wide range of timber species in PNG, their properties and their potential uses commercially.

The fundamental aspects of wood properties and their influence on the wood processing industry were presented. Important issues of the forest industry were highlighted: the forest as a source of raw material, history of the forestry industry, status of the PNG wood processing industry, the prospects of plantation development and finally a review of the properties of hardwood timber. The study culminated with investigation of the properties of hardwood timber of PNG.

One of the outputs of this study is the development of a template for evaluating various wood properties and processing characteristics that the industry can rely upon when processing hardwood species. The project also established initial data on the characteristics of secondary forest timber, to which additional information obtained from further research can be easily added. The knowledge of the technological attributes will be used as guidance for industry, forest growers and marketing specialists on the species suitability for various products, service conditions and markets.

By providing readily available information to the local forest communities, this project will enhance the effective use of the available hardwoods, which should provide both social and economic benefits.

The summary of the major outcomes of the study are provided below:

Development of template suitable in PNG environment

Since this study is the first of its kind in cataloguing the technical information for the forest industry in PNG, some of the standards revised in this study were adopted as elementary testing methods for testing of PNG timber species. Templates for the assessment of wood properties and processing characteristics from the secondary forest were developed as the standard protocols, which can be easily adopted by the timber industry in PNG. The templates include saw doctoring, sawmilling, timber drying, timber machining, wood jointing and gluing, and wood coating.

PNG hardwood timbers (200 commercial timbers) have the potential to draw attention toward their use in engineered wood products. However, the fundamental wood properties have never been studied and developed in order to make the vital information accessible. Therefore, cataloguing of wood properties of commercial and lesser-known timbers that were assessed and evaluated in this study will create a window of opportunities for utilisation of these timber species.

Importance of effective data recording system

Results from the field visits undertaken during the study revealed that a proper recording system to be used by wood processors with respect to what type of timber is milled and what volume is produced from individual timber species is lacking. This was observed across all of the visited timber millers whose records of mixed volume were inconsistent and confusing. It was not possible to accurately determine which specific species were milled and the volume of production per week or month. It is evident that there is no effective recording system in place and as a result problems arise for timber companies and portable operators to market their products. Thus, this study recommended that proper recording systems be developed by wood processors to identify future market demands and that a strategic plan for harvesting of new timber species also be developed.

Updated technical information provides opportunity for state of the art technology

The challenge faced by timber processors is the need for technology transfer and for enhanced technical knowledge about processing timber products and value adding. It was observed that the industry's inability to adapt to new state-of-the-art technology was linked to the lack of efficient and timely technical information about the species. Therefore, updating information on technological attributes of individual species will increase the number of potential uses of the timbers. At the same time, availability of this information will attract appropriate technical facilities and equipment suitable for processing and manufacturing timber products.

The results of the study were displayed on a poster presented at the IUFRO International Conference in Lisbon in July 2012:

- Edwin, P. 2012. Investigation of processing characteristics of hardwood timbers from secondary forest in PNG. Poster at IUFRO Division 5 International Conference, Lisbon, Portugal, July 2012.

Three manuscripts are currently in preparation for international journal publication.

7.3 Potential markets for PNG lesser-known timbers

The study was undertaken by Morgan Le Guludec from the University of Nantes, France, within his internship at the UoM, which examined PNG timbers and their potential for substitution for large world timber markets in Africa, South America and Asia. Two different methods were used to compare the PNG timbers to international timbers, the “Researcher” approach and the “Salesman” approach, as described in Section 5.1.2.

Key results of this study were:

- The use of the two different methods allowed the identification of PNG timbers with good characteristics that could make them competitive in international markets.
- The main timber characteristics, which are important at the international trade, are colour, density and the availability.
- The two different methods of comparing PNG timbers resulted in different results, or different lists of timber species, depending upon the approach used in the analysis.
- The study demonstrated the applicability of lesser-known PNG timbers for international markets.
- The PNG forests and timbers are well known to the PNG population; the only barrier for a profitable trade is a lack of their promotion.

This study identified PNG species that could be used as substitutes for highly marketable timbers in various parts of the world. The information provided in the study report can be used as a guide to appearance product and furniture producers interested in manufacturing products for international markets.

7.4 Woodcarving in Bumbu settlement: A preliminary study into the market potential of PNG woodcarvings

A survey of wood carvers living within the Bumbu Urban Settlement was conducted under the leadership of Nigel Baro, a researcher from the PNG FRI.

The main research questions of the survey were:

1. What are the key inputs and outputs of woodcarving?
2. Has the practice of woodcarving been passed on to younger generation of wood carvers or is it gradually dying out?
3. What main wood species are used in making carvings?
4. What constraints do woodcarvers face in the local markets?

Key results of the study were:

- Wood carving is a traditional and cultural aspect of communities in PNG.
- Durability of the wood is a key criterion when selecting wood for carving.
- The size of the carving is the main factor when setting a price.
- The role of making carvings is mainly restricted to the male population.

- Wood carving provides an important income stream at a household and community level.

The main wood species used in carvings are rosewood, kwila, milky pine and black ebony. The natural durability of a wood is the main criterion these woodcarvers look for when selecting wood for carving.

The wood resource within the Bumbu settlement is scarce and very limited. The size of the woodcarving is the major contributing factor when pricing their woodcarvings.

From this survey finding, an average income of 8,100 Kina, can be generated annually from the carving sales. Carving products are of great importance to most of these families living in the urban settlement (Figure 4).

For the sustainability of woodcarving trade there is a need for sustained, long-term management of the main wood species used for carvings through domestication and use of alternative wood species. Value adding to the wood like appropriate drying, polishing and painting of the wood would increase chances of the carving being sold at higher prices. Story boards figure woodcarvings with an information kit or a story relating to the carved products are usually sold at a higher price than the carvings without a story.

The results of his study provided insight into the drivers behind the choices carvers make in terms of materials and carving attributes. The survey also pointed out the importance in carving as an income generator for families and a way to alleviate poverty and facilitate economic growth.



Figure 4: Woodcarvers selling their carving at Boroko Food World, Port Moresby

7.5 Treatment of utility posts and poles for rural communities in PNG

Wood is a prime raw material used in many rural communities for various end uses in PNG. The demand for wood is increasing dramatically due to rural population growth. Native timbers are used extensively and pines (conifers) are cultivated in woodlots as alternative raw materials to meet basic needs (utility poles/posts for building construction, fencing, deckings, parks, horticulture and landscaping uses). The species of interest are *Aracuaria cunninghamii* Aiton D. Don (hoop pine) and *Pinus caribaea* Morelet (pinus). Untreated pines used in rural applications deteriorate immediately in service due to low natural durability. To enhance durability in non-durable timbers, an effective preservative treatment of timber is required.

A timber treatment study was undertaken by Benson Gusamo and Robin Tulo at Bululo University College, UniTech, with the aim to recommend a simple method for the treatment of utility posts and poles that could be used by rural communities of PNG.

This study examined the hot- and cold-bath process using tar-oil creosote for treatment of pine (pinus and hoop pine) to investigate whether solution uptake and retention increases proportionally with dip time so that a recommendation as to the suitability of the technique for application in PNG rural communities could be made.

The pine species examined were treatable materials. Wholly submerged samples showed fair preservative distribution. Hot- and cold-bath treatment is simple and requires the use of basic equipment/materials. It can be concluded that this technique is suitable for application in rural communities of PNG for treating utility pine poles/posts to extend the service life of materials and alleviate the problem of their low durability.

The study was published in the International Wood Protection Proceedings:

- Gusamo, B.K. and Tulo, R. 2012. Tar-oil uptake vs time in immersion treatment of short pine posts: A simple technique applicable to rural communities of PNG. International Research Group on Wood Protection. IRG/WP 12-40608. pp. 1–10.

7.6 Linking local communities to the wood processing industry

As described in Section 5.2, the “Houswin Project” was undertaken jointly by researchers from PNG UniTech (Faculty of Forestry and Faculty of Architecture) and the Faculty of Architecture, UoM. The “Community Pavilion and Water Tank Project” was developed and completed as a case study in building and designing with local skills in materials (Figure 5).

The project outputs were:

- The production of zines – Small hand-drawn magazines produced on photocopies, which were easy to read, had many simple diagrams and were able to be mass-produced with minimal technology.
- Construction of HausWin website – www.hauswin2010.blogspot.com
- Construction of two pavilions in each community site visited (Finschhafen and Bumbu) for fresh water collection and community use.

Because PNG is an exporter of timber, though much of the wealth this creates is lost to local communities, the team wanted to test if the rural communities could export their own sustainably harvested timber to urban communities and at the same time see if the income this created could be used to purchase industrialised materials such as corrugated roofing and water tanks.

The researchers were able to test the constructability of the local axe-milled wood in Selongko Village. The harvested wood was very green and extremely hard. While this has its benefits in regards to durability, it made it difficult to build the pavilion quickly and efficiently. The wood was bowed and difficult to nail together because it was green and not kiln dried. The pieces of wood were also not cut to exactly the same lengths, so time was spent at the construction site cutting everything to a standard size for constructability. While these are not major problems, they do diminish the possibility of an efficient pre-fabrication model whereby the village could be expected to pre-fabricate housing that would be shipped to Lae or elsewhere in the province. These problems can be overcome by training village people in timber preparation and fabrication of building components.

The key achievements of this project were:

- The “Community Pavilion and Water Tank Project” was developed as a case study in building and designing with local skills and materials.

- The project provided the communities with fresh water, shelter and community hubs.
- Architectural solutions and pre-fabrication of building materials are now better understood.
- The project established several longer-term case studies that can be revisited by the collaborative team.

In summary, this project was a success in that it tested the previously established local connections, developed numerous architectural ideas within the villages and brought to the team's attention the realities of pre-fabrication of building materials by remote villages. The physical act of building and designing the pavilions with the villages and settlements allowed for these structures to act as long-term case studies as well as give back to the villages by providing potable drinking water. This process has also allowed for a better understanding of the reality associated with building sustainable micro-economies within PNG.

It should be pointed out that the team involved in this study was successful in obtaining funding from the Australian High Commission in Port Moresby (HOMDAG grant) to extend the existing relationship with the Bumbu community to complete a community development exercise.



Figure 5: Involving local people in Hauswin project in Serongko village

This joint project between the Bumbu settlement community and Australia–PNG researchers and students has a development agenda – addressing limited access to fundamental health hardware in a marginalised community in Lae through developing new community ablutions facilities.

7.7 Utilisation of PNG commercial hardwoods for parquetry product

Research was conducted to investigate the potential of developing the production of parquetry in PNG based on further processing of waste sawn pieces of timber from local premium hardwoods. Four timber species were used in the study: rosewood, teak, kwila and taun. The study revealed that the species are suitable for the production of parquetry products and can provide the opportunity to increase their end use domestically and for export markets (Figure 6).

The results of this study provided the following recommendations on parquetry making:

1. Sharp tools are required for cutting or machining medium to high density timbers, e.g. kwila, to minimise split, tear or rough ends at the corners of wood specimens.
2. Kiln dried timber at <15% moisture content is desirable to avoid in service shrinkage and movement in high humidity environments.
3. Water-resistant adhesives are recommended for application in parquetry floor construction to avoid unnecessary moisture ingress reacting with the glue line, which would significantly reduce the bond strength.
4. Other hardwoods and lesser-known timbers with distinct wood characteristics e.g. colour and figure, and non-timber species can be considered as an ideal raw material for parquetry product.
5. Awareness and dissemination of information on the end use and marketability of this product is necessary to boost downstream processing and diversify timber products and timber industry in PNG.

The accumulation of residual wastes, which are often discarded or burnt in the processing mills, could be solved by developing new products, such as parquetry, to maximise utilisation of timber and increase revenue. Merchantable logs with short boles that are rejected from milling and left on the forest landing can be hauled and milled for parquetry, which requires short pieces of wood.



Figure 6: Research on the production parquetry flooring using PNG species

8 Impacts

8.1 Scientific impacts – now and in 5 years

The project focused on capacity building in the key PNG institutions involved in the project through enhanced research, training and education. Lack of research facilities (equipment and instruments) and research personnel who could carry out the project research activities resulted in delays in completing the majority of research milestones. Consequently, a number of the planned scientific outputs of the project are incomplete. However, the major outputs from the project have been drawn together and published in the following book: Ozarska, B. 2012. Increasing downstream value adding in PNG's forest and wood products industry. Summary of the project outputs. Allenby Press, Camberwell, Australia. 129pp.

The major impacts were derived from the following studies:

1. Masters thesis "Investigation of Processing Characteristics of Hardwood Timbers from Secondary Forest in PNG":

This research project investigated the fundamental aspects of wood properties of PNG species and examined processing characteristics of these species.

As stated in Section 7.2, one of the outcomes of this study was the development of a template for evaluating various wood properties and processing characteristics of hardwood timbers. The study also established initial data on the characteristics of secondary forest timbers, to which additional information obtained from further research can be easily added.

Physical properties assessed were: density, permeability, natural durability and shrinkage properties. Mechanical properties included modulus of rupture (MOR) and modulus of elasticity (MOE). The study also investigated the durability of PNG timbers. Changes due to the in-ground exposure were observed in the microstructure of the examined hardwood timber. This study provided the opportunity to visualise the cell wall layers of hardwood timber. A valuable finding of the study was that white rot belonging to basidiomycetes and soft rot of ascomycetes were indicative decay fungi that caused damage to the secondary cell walls.

Data and information on properties of PNG timbers available in the scientific literature relates mainly to old-growth timbers from primary forests. Little published data is available on the properties and processing characteristics of timbers from secondary forests, which creates problems for the suppliers of raw material and particularly for the wood processing industry. The results of this project revealed that:

- only two species: *Diospyros spp.* (Ebony) and *Dracontemelon dao* (Walnut) from the secondary forest possessed higher densities than those found in the primary forest. This could be the result of inherent variability factors found in the wood anatomical structure.
- MOR values in the secondary growth species were lower than those of the primary forest, yet the MOE values for some species proved to be higher than the primary timber. There was also clear indication that MOR and MOE values vary significantly between and within the timber species.

The integration of the data and information developed within this study will form a valuable wood properties database for PNG hardwood timbers. It is also envisaged that the availability of such technical data will facilitate the process of technological advancement in processing and manufacturing of hardwood timbers. For example, the flexural strength properties (MOR) and stiffness exhibited by MOE are vital for timber

grading specification and timber design values. These engineering values will become useful to scientists, engineers, architects, builders and construction managers.

The project's research studies on the assessment of secondary forest timbers provide valuable information to scientific communities around the world and to wood processing industry in PNG. The findings of the study are to be published in international journals to make them available to the wider international scientific community.

2. The Wood Database on PNG species developed by FRI has significant scientific value as it collects data and information on properties, processing characteristics and potential uses of 292 PNG timber species. The database will be useful to scientists and stakeholders involved in developing downstream wood processing in PNG.
3. Although the research studies on preservative treatment of PNG timbers and the utilisation of various species for parquetry flooring or building products do not have innovative scientific elements, the research methodologies applied in these studies will provide a valuable tool for similar studies which could be undertaken in other developing countries. The study on dip diffusion treatment of poles and posts in rural communities was published in the International Wood Protection Proceedings, and the study on processing and laminating of balsa wood as an insulation board for ceiling construction in buildings has been recently accepted for publication in the *African Journal of Agricultural Research*.
4. An innovative market research methodology was developed within the study on potential international markets for PNG timbers. The novelty of this study was in proposing two different methods to compare the PNG timbers to international timbers, the "Researcher" approach and the "Salesman" approach (see Section 7.3). The use of the two different methods allowed the identification of PNG timbers with appropriate characteristics to make them competitive in international markets. A manuscript for publication in an international journal is being prepared so that the method can be made available to other researchers around the world.

8.2 Capacity impacts – now and in 5 years

It is believed that the project has provided considerable assistance to the PNG government in implementing the policy on the development of the downstream wood processing industry. A strong foundation was built for research, teaching and training in wood processing for the PNG timber sector through the establishment of a cohesive network with a strong culture of collaboration (Figure 7).





Figure 7: Strong collaboration was developed within the project

Improved networking between organisations was an integral part of this project and was achieved through an active involvement of team members from all partner organisations in the project activities.

Significant benefits were achieved by the purchase of materials and equipment and the up-skilling PNG employees and researchers.

Long-term improvement of the industry is likely to be achieved by the development of the TFTC Diploma courses and the intake of students into those courses.

The experience gained by the participants within the project has prepared them for future collaborative work and established strong linkages and friendships, which are likely to continue after the project's completion. In fact, this long-term collaboration has already been demonstrated through various collaborative activities undertaken by the project participants. For example:

- Several students from UniTech are working on their research projects in collaboration with PNG FRI and TFTC. Research equipment and facilities, as well as technical and scientific support, are provided to the students by experienced staff members of these institutions.
- Lecturers and researchers from UniTech and PNG FRI will be providing lectures on various subjects for the National Diploma in Wood Processing and Products at TFTC.

It is believed that the strong collaborative culture developed within the project will provide sustainable long-term capacity improvements in the PNG wood processing industry.

8.3 Community impacts – now and in 5 years

Several community impacts have been emerged:

- Links with local communities have been developed through the “Houswin Project”, which aimed to build, test and design with local materials and local skills in order to support the development of sustainable micro-economies within PNG.

The Hauswin project took place in two settlements. In both locations the people are economically disadvantaged but retain strong cultural links and family ties. The houses in Serongko are basic with timber frames and thatched roofs. In Bumbu they are built from salvaged scrap. Most importantly, the residents of both communities access unsuitable water sources resulting in chronic illness. Effort is also spent trying to keep the houses dry, as they require a lot of maintenance. The issue of clean water supplies is particularly important. “Hauswins” built in each community provide shelter and a source of fresh drinking water.

The project involved Selongko and Bumbu communities in collaboration with PNG and Australian researchers and students. This activity was a new experience to the communities that will never be forgotten. The villages were actively engaged in preparing timber components and in building, assembling and decorating the community pavilions and water tanks. The people were open and welcoming to the project team and happy to show how they live, how they build their houses, and tell stories on their tradition and beliefs. This allowed the team to understand better the needs and wishes of the local people in regards to their housing, their jobs and their communities.

Marginalised communities are not familiar with making decisions about their environments and their shelter. In many circumstances they have had few or no choices. The process of talking, designing and then building together opens up many opportunities for a more useful dialogue, which then enriches the ideas, processes and outcomes for the next project.

The project provided a basis for future work on developing new sustainable (cultural, economic and environmental) housing for PNG rural and urban communities for both domestic and corporate (mining) needs.

- Woodcarvings have always been a part of most traditions and cultures of rural communities in PNG. Carving products are important to most of the families living in the urban settlement. Results from this study, at a community level, clearly shows that woodcarvings have the potential to sustain livelihoods, alleviate poverty and facilitate economic growth. Selling of woodcarvings can generate significant income for the carvers' families. A proposal was developed within the project to establish a carving centre at TFTC that will train young carvers so that the skill and tradition is passed on to future generations. This initiative will provide significant community impacts.
- The study of the properties of PNG timbers will assist local producers engage in small-scale wood processing. The technical data will be widely disseminated through education and training institutions and can be also used by the PNGFA to facilitate formulation of policy in the areas of resource management, allocation and development, and wood products marketing. Thus, the outcome of this study will have a significant impact on the people of PNG.
- The research study on low cost preservative treatment of PNG species has the potential to increase the durability of houses. This will benefit local communities in both rural and urban settlements.
- The project developed a sound groundwork for developing efficient training programs for the timber industry. The project's achievements towards enhancing training is an effective tool for empowering the PNG community to support a sustainable downstream wood processing industry in PNG.
- It is envisaged that there will be significant community benefits arising from a stronger forest industry sector, associated with increased employment opportunities in the developed wood processing industry and an increase in the communities' incomes associated with increased demand for timbers.

8.3.1 Economic impacts

No measurable economic impacts of the project can be identified at this stage as its major achievements are in building capacity in the industry. However, some tangible economic impacts can be expected if the downstream wood processing industry is further developed.

The promotion of downstream processing activities of the forest industries in PNG is important, encouraging a range of new opportunities such as production of a wider range

of wood products for domestic and international markets. The availability of technical information for hardwood timbers suitable for processing, provided by this project, will assist in further expanding the industry.

The enhanced capacity in research, training and education developed within the project, is likely to provide both social and economic benefits.

8.3.2 Social impacts

Rural PNGns can benefit in processing their own timber using low cost methods incorporated with traditional knowledge. The project undertaken by the Australia–PNG team involved rural and urban communities building community pavilions and water tanks using local skills and materials. This activity provided a totally new and memorable experience to the local communities through the collaborative work with Australian and PNG researchers and students.

Social advantages of training and development of skills undertaken within the project are obvious – there are many benefits in having a skilled and dedicated work force.

Female participation in the project was about 5% of total stakeholders (the project staff, university staff, training school staff, industrial participants), with several females actively participating in research and training. In general terms, women played a very minor role in the project. This indicates that in future a stronger focus should be placed on encouraging women to increase their roles in the PNG wood industry, in particular with design, quality control, research and training.

Further research is still required to analyse the value chains that will benefit the rural forest communities who are the true custodians of PNG's forest resources.

8.3.3 Environmental impacts

The project established a foundation for developing a downstream wood processing industry in PNG, which will provide an opportunity to realise greater value and potential for wood utilisation by the production of wood products and, consequently, further reducing the dependence of the industry on logs exports and the associated significant loss of wood values.

The demand for wood certification and wood product labelling is noticeably increasing internationally. New legislation has been developed and implemented in Australia, Europe and the United States to ensure that no wood or wood products derived from illegal sources can be imported into those countries.

If the PNG government and industry follow international environmental policies there will be multiple opportunities for the PNG timber industry to promote their products as eco-friendly certified products in international markets.

8.4 Communication and dissemination activities

A summary of the major communication and dissemination activities is provided below:

Major Project Meetings

1. The project commencement workshop was held on 8 November 2008 in Lae attended by the participating project organisations and invited guests including land owners, sawmillers and furniture companies. The agenda of the workshop included the description of the project objectives, methodology and expected outcomes, a training session on major topics relating to high value wood processing and product development, and a general discussion on expectations and potential benefits of the project to PNG.
2. The Steering Committee meetings were held every six months to discuss the project progress, staff requirements, financial issues, equipment and training.
3. Regular project team meetings were held in PNG every six months during the project term to: review the project progress; discuss important matters related to the nine research projects undertaken by collaborative research teams; discuss the training program, equipment and financial issues; and to discuss future activities. Research members from the project partner organisations attended the meetings.
4. A meeting with the PNG Forest Authority was held on 10 August 2009 in Port Moresby and attended by the project leaders, Barbara Ozarska and Peter Vinden (UoM), Mr Kanawi Pouru (Managing Director), Dr Ruth Turia (Director of Forest Planning) and other senior managers of Forest Policy and Planning Directorate. The aim of the meeting was to discuss PNG strategies for the development of the timber industry and how the ACIAR project can assist in achieving government goals in the development of downstream wood processing. Mr Pouru highlighted the importance of integration of training and education, a need for developing a State Marketing Enterprise and a utilisation strategy for lesser known wood species.
5. Three meetings between the project leader and Mr Bob Tate, Managing Director of PNG FIA, were held. Major topics discussed were: PNG timber processing strategy, markets for lesser known species, development of PNG timber treatment standards and priorities for timber industry training, the project progress, major problems and opportunities for the project and for the industry as a whole.
6. A meeting was held with PNG project stakeholders and Tony Bartlett (ACIAR Forestry Research Program Manager) on 18–19 April 2011. The aim of the meeting was to discuss and recommend priorities for future ACIAR forestry research in PNG.
7. The project leader held two meetings with Dr Ruth Turia, Director of Forestry Planning, PNG FA in Port Moresby to discuss the project progress and the government policy on developing the downstream wood processing industry.

Field visits

1. Visits to Omsis and Wampit villages were made in August 2009 by the Australian and PNG researchers to meet local people living in PNG villages and to see typical village houses. The visits involved:
 - meeting with Habitat for Humanity
 - visits to local villages: Malahang, just outside of Lae, Gobari in the Nawaeb district and a village called Munum in the Huon District.
2. Several visits to selected timber processing and manufacturing companies in Lae and Bulolo and small landowners were undertaken by the project team to develop an understanding of the current major issues and strategic directions of PNG forestry and timber sectors.
3. The team of researchers, Dr. David O'Brien, Hamish Hill and Allison Stout, from the Faculty of Architecture (UoM) spent five days in PNG on 15–19 March 2010 to establish local connections and to develop ideas for their future research on the design and construction of houses for local villages and settlements. The team,

accompanied by PNG researchers from UniTech, Trevor Galgal and Dr Mex Peki, visited Serongko Village and Bumbu Settlement: The researchers were able to see different houses in the settlement. They inspected and documented six houses and gained understanding on the style of living in the houses and the village.

4. A visit to Cloudy Bay Timber Processing Company in Port Moresby was made by Dr Barbara Ozarska on 24 April 2010 to make the company aware of the ACIAR project and to discuss possible collaboration. The company managers expressed interest in the project, in particular the training courses, research on drying, timber treatment and lesser known PNG timbers.
5. A visit to Yallu Village, Morobe Province, was made by the FRI team on 25–27 August 2010 and 11–13 March, 2011, to identify potential lesser known timber species within the Yalu area that could be used in wood mechanical testing to obtain data for the Database on PNG timbers and to carry out an inventory on the volume of the selected species.
6. Visits to wood carving communities in Port Moresby were made on 28 April–02 May, 2011 to undertake a value chain study of PNG woodcarvings. The aim of the visits was to identify the main actors or organisations in the commercialisation chain of woodcarvings, from the input provider, to the collector, right through to the final buyer.
7. A brainstorming workshop was held on 17 August 2011 at TFTC with the theme *Linking forestry and wood products training to local mining communities*. A total of 15 participants representing the training and education sector, mining companies, local rural people and social stakeholders, vocational teachers and researchers attended the meeting. The meeting included presentations of research papers and discussions on how forestry and wood products training could be linked to communities affected by mining. Various options were analysed for linking rural forest communities with domestic downstream processing. It was proposed that a collaborative program should be developed with the aim of assisting village communities in the construction of low cost, easy to assembly houses and various wood products for their own uses, which would improve the standard of living in rural communities. This would also include training of local people from the mining site and interested neighbouring communities.

Following the meeting a proposal was developed and submitted to Ok Tedi Mining Limited. Further discussions have been held and the program is yet to be finalised.

9 Conclusions and recommendations

9.1 Conclusions

Since ACIAR identified the need and supported the development of a project to assist the PNG forest and wood products industry (in 2007), significant advances have been made within the project FST/2006/120 "Increasing downstream value-adding in PNG's forest and wood products industry". The partners have developed the project by formal research studies but also by informal discussion, lateral thinking, taking small risks and experimenting. These activities have enabled the overall project to be successful not only in the pre-set benchmarks but also in the "soft areas" of breaking down barriers between groups and developing networks and friendships. The funding supported initiatives such as the capacity building for effective research, education and training, assessment methods for properties and processing characteristics of PNG timbers, more efficient production processes, as well as designing affordable houses for rural communities and urban settlements.

During the preparation for the Final Project Review, the assessment of the project achievements against its milestones was undertaken, which revealed that some tasks have not been finalised and further work is necessary. These shortcomings have been outside of the control of the Project Steering Committee and the project leader; for example lack of infrastructure, delays in repairing essential equipment, personnel changes and a variation in some activities due to decisions of bureaucratic nature. These incomplete activities are still important and it would be desirable for them to be carried out in the future. Given the challenges faced by this three year project in getting technical equipment installed and operating in PNG, it would be preferable for a future project to be a minimum of four years duration.

PNG partners involved in the project included education, research and training institutions as well as industry organisations and companies. The members of these organisations have formed a cohesive network with a strong culture of collaboration.

The experience gained by the participants within the project will prepare them for future collaborative work and will establish strong linkages which will continue after the project is completed.

The project participants will be well prepared for technology transfer, training and consultancy roles in downstream wood processing and product development in the future.

It is now time to cement the project outcomes with stronger foundations and move on to the next stage. Hence the need to identify and document the priorities that need to be addressed in future research studies and the development of an appropriate budget to enable the momentum built to date by the enthusiasm of all partners to continue into the next phase.

9.2 Recommendations

On request of the project leader, a brainstorming meeting was held by the PNG project partners on 11 July at UniTech, Lae, to identify the priorities in wood processing for the new ACIAR value chain project. As a result of the meeting a list of the priorities was developed.

The priorities for future R&D in wood processing in PNG, which are listed in this document, have been identified by the current project's partners according to their

knowledge of PNG timber sector's needs and in concurrence with the government strategies.

The priorities listed below demonstrate the PNG partners' views and ideas.

Future R&D priorities for PNG wood processing:

1. Enhancing skills in wood processing through various levels of training courses (e.g. providing expert support to the new Diploma and Advanced Diploma Courses developed within the current ACIAR project).
2. Developing a comprehensive R&D program at FRI, UniTech and TFTC based on the framework established within the current project, with focus on:
 - engineered wood products
 - timber drying using solar energy (environmental benefits)
 - utilisation of waste products from timber processing/ waste products for bioenergy
 - timber durability, with a strong focus on the use of environmentally friendly treatment methods for decay and termite control.
3. Design for durability: design and construction of houses for longer-term performance ("design life"). This will assist in fighting common statements such as "Why would you use timber, which does not last; use steel".
4. Linking rural communities with the wood processing sector using the foundation developed within the current project. Discussions have been initiated and are in progress with Ok Tedi Mining Limited & Morobe Mining Joint Venture through the Community Affairs Program to develop a collaborative program with the aim of assisting village communities in the construction of low cost, easy to assembly houses and various wood products for their own uses which would improve the standard of living in rural communities. This program could become a part of the new ACIAR project. The above mining companies are willing to provide funding for this initiative.
5. Promoting environmental properties of timber through the Life Cycle Analysis of a range of products (e.g. typical houses) made from different material types.
6. Analysing business options for developing furniture production in PNG for domestic and export markets. Why has the furniture industry has not yet been developed? Can PNG become another Vietnam in furniture manufacturing? (Business and technical issues, infrastructure and market knowledge should be taken into account).
7. Developing best-practice wood processing systems for community processing and for different community scenarios.
8. Capacity building in sawmills in view of the implementation of forest certification.
9. Providing support to the industry in developing wood processing standards (e.g. seasoning, treatment plant standards).

10 References

10.1 References cited in report

- Eddowes, P.J. 1977. Commercial timbers of PNG, Hebamo Press, PNG.
- FAO 2005. Forest products annual market review 2005–2006, Food and Agriculture Organization of the United Nations, Rome.
- ITTO 2005. Status of tropical forest management. ITTO Report.
- PNGFA 1991. Forestry Act 1991. Government of PNG, Port Moresby.
- PNGFA 1993. The National forestry development guidelines of PNG. PNG Forest Authority, Port Moresby.
- PNGFA 1996. The National forest development plan. PNGFA, Hohola, Port Moresby.
- PNGFIA 2005. Export statistics of log and sawn wood products from 2003–2005, PNG Forest Industry Association, Port Moresby.
- PNGFIA 2006. Trade statistics up to August 2004. www.FIAPNG.com (accessed October 2006).
- PNGFIA 2007. Annual report of forest industries news., PNG Forest Industry Association, Port Moresby.
- Prince, H. 1976. "Trade of tropical forest wood products", *International Trade*, Edward Arnold (Publishers) Ltd, Manchester, pp. 177–184.
- Price Waterhouse Coopers 2006. Economic analysis and potential of PNG Forest Industry. PNG Forest Industry Association.

10.2 List of publications produced by project

Project Documents

- Project proposal FST/2006/120.
- Annual Report No 1: 1 June 2008 – 31 May 2009.
- Annual Report No 2: 1 June 2009 – 31 May 2010.
- Minutes of several Project Steering Committee Meetings and 6 monthly progress reports.
- Ozarska, B., Vinden, P., Harris, G. 2009. Project commencement visit to PNG and recommendations on improvements in PNG downstream processing forest and wood products industry. Research Report on ACIAR project: Increasing downstream value adding in PNG forest and wood products industry. 71 pp.
- Ozarska, B., Vinden, P., Galgal, T., Aoae, P. 2009. Summary report on the project visit to PNG, 10–15 August 2009. 29 pp.

Project Major Reports

- 1 Aoae, P. and Galgal, T. 2009. Timber processing model for domestic processing in PNG: Linking major logging companies with small and medium wood processing entrepreneurs. TFTC. 6pp.
- 2 Galgal, T. 2009. Forest-based small-scale processing of *Castanopsis* weatherboards for the local market. Paper presented at the 6th Huon Seminar held at the PNG University of Technology, Lae, 24–27 August 2009.
- 3 Gusamo, B. and Zeng, P. 2009. A Review on forest certification concept in PNG and its impact on timber processing industry and timber product marketing. PNG University of Technology.
- 4 Aoae, P. 2009. Bending characteristics of *Pometia pinnata* Forst. f. and *Anthocephalus chinensis* (Lamk) Rich as influenced by timber size. A proposal submitted to the Forestry Department of the PNG University of Technology as partial fulfillment of the requirements for the degree of Postgraduate Diploma in Forestry.
- 5 Poblete, M.R. 2010. Furniture exports requirements for undeveloped countries. Research report for Master of Forest and Ecosystem Science. The University of Melbourne. 19pp.
- 6 Grigoriou, J. 2010. The state of play of tropical hardwood. (*written for this project and FST/2004/061*). 28pp.
- 7 Stout, A., O'Brien, D., Hill, H., Galgal, T. and Peki, M. 2010. Summary report on visit to PNG, 15–19 March 2010. Internal Report.
- 8 Stout, A. and O'Brien, D. 2010. Report on the Hauswin Project, PNG 2010. 54pp.
- 9 Le Guludec, M. 2010. Potential markets for lesser known timbers of Papua New Guinea. French Exchange Student. University of Nantes, Internship Report.
- 10 Edwin, P. 2011. Investigation of processing characteristics of hardwood timbers from Secondary Forest in PNG. Masters Degree in Wood Science by Research Thesis. 215pp.
- 11 Gusamo, B. and Tulo R. 2011. Tar oil vs time of immersion treatment of pine poles: a simple technique applicable for rural communities of PNG. 9pp.
- 12 Gusamo, B. and Moroma, G. 2011. An examination of the effect of re-wetting seasoned woods at different times against diffusion of Boron-Fluoride-Chromium-Arsenate Salt in Dip Treatment. 27pp.
- 13 Gusamo, B. 2011. Chemical and non-chemical processes of controlling sapstain and mould fungal growths on freshly cut plantation pines, Bulolo, PNG. 7pp.
- 14 Gusamo, B. 2011. Fluid flow pathways of two *Araucaria* spp. and their variation in permeability to chemical preservative treatment. 5pp.
- 15 Vali, B. 2011. The creation of the database program. Summary report. 2pp.
- 16 Baro, N. 2011. Wood carving in Bumbu Settlement. A preliminary study of market potential for PNG wood carvings. 16pp.
- 17 Gusamo, B. and Tomakala, S. 2011. Trial experiment on utilisation of PNG commercial hardwoods for parquetry product. 7pp.
- 18 Ozarska, B. and Sapi, J. 2011. National Diploma in Wood Processing and Products. Course Outline. 24pp.
- 19 Ozarska, B. 2012. Increasing downstream value adding in PNG's forest and wood products industry. Summary of the project outputs. Book printed by Allenby Press, Camberwell, Australia. 129pp.
- 20 Ozarska, B. 2012. Project Final Report. Report for ACIAR.

Publications in journals and conferences

- 1 Edwin, P. 2009. Developing methodology for assessing technological attributes of PNG's hardwood timbers. Presentation at the Postgraduate Conference, November 2009, Department of Forest and Ecosystem Science, The University of Melbourne.
- 2 Galgal, T. 2009. Forest-based small-scale processing of *Castanopsis* weatherboards for the local market. Paper presented at the 6th Huon Seminar held at the PNG University of Technology, Lae, 24–27 August, 2009.
- 3 Ozarska, B. 2012. Development of value-added industries in South-East Asia and Pacific Region. The University of Melbourne, Burnley Campus Seminar, 10 May 2012.
- 4 Ozarska, B. 2012. Increasing downstream value adding in PNG's forest and wood products industry. Summary of the project outputs. 129pp.
- 5 Gusamo, B.K. and Tulo, R. 2012. Tar-oil uptake vs time in immersion treatment of short pine posts: A simple technique applicable to rural communities of PNG. International Research Group on Wood Protection. IRG/WP 12-40608. pp. 1–10.
- 6 Edwin, P. 2012. Investigation of processing characteristics of hardwood timbers from secondary forest in PNG. Poster at IUFRO Division 5 International Conference, Lisbon, Portugal, July 2012.
- 7 Gusamo, B., Semeli, M. and Ozarska, B. 2012. The study on processing and laminating of balsa wood as an insulation board for ceiling construction in buildings. *African Journal of Agricultural Research* (in review).

11 Appendixes

11.1 Appendix 1: List of projects undertaken by PNG UniTech Forestry Students related to wood science and wood processing

- 1 Michelle Anania and Mex Peki (2011) Plant species used in building traditional houses in Selanko village, Finschhafen District.
- 2 Delma Kamasunga and Peter Edwin (2011) Analysis of the current wood recovery rate in furniture production in PNG and identifying scope for the waste reduction and management.
- 3 Augustine Idok, Benson Gusamo and Peter Edwin (2011) Relationship between wood density and gluability of various PNG timbers.
- 4 James Kaselau and Peter Edwin (2011) Investigation into the development of improved recovery of sawn wood for selected PNG hardwood timbers.
- 5 John Moroma and Benson Gusamo (2011) An effect of re-wetting seasoned woods on diffusion of BFCA salt in dip treatment.
- 6 Lucy Sapau and Mex Peki (2011) Provide environmental arguments on the benefits of using timber and timber products as a method of reducing climate change. Compare the benefit with other materials.
- 7 Tanu Daba and Mex Peki (2011) Survey on materials used to build houses in Bumbu Settlement, Lae, Morobe Province.
- 8 Claude Saliou, Peter Edwin and Steven Komut (2011) Determination of minimum radius of curvature for steam bending of PNG lesser known timbers.
- 9 Ivy Kiele and Benson Gusamo (2010) Preliminary study on the natural durability of some selected lesser used species.
- 10 Israel Simon and Benson Gusamo (2010) Effect of steaming on treatment of two refractory species *Instiabijuga* and *Vitex coffasus*.
- 11 Daniel Savinat and Benson Gusamo (2010) Mechanical properties of some plantation species.
- 12 Philomena Leo and Benson Gusamo (2010) Glue bonding strength of *Instiabijuga* and *Vitex coffasus*.
- 13 Dorcas Ling, Mex Peki, Nigel Baro and Trevor Galgal (2010) Carvings [handicrafts] as an economic activity in Bumbu settlements.
- 14 Peter Zeng and Benson Gusamo (2009) Review of timber certification in PNG.
- 15 Rex Wunum, Trevor Galgal and Mex Peki (2009) Recovery rate of traditional weatherboard production in Selanko, Finschhafen.

11.2 Appendix 2: List of equipment purchased for the PNG partners

TFTC

- moisture meters x 2
- humidity and temperature data logger x 2
- humidity and temperature sensor
- chisel for testing veneer bond quality
- wood bending equipment constructed by a local PNG engineering firm
- existing TFTC conventional kiln repairs
- camera (Canon)
- wood sander for samples preparation
- angle grinder
- high pressure spray gun for coating application
- laboratory instruments and materials required for training.

PNG FRI

- moisture meter x 1
- humidity and temperature sensor x 1
- humidity and temperature data logger x 2
- kiln drying chamber, capacity: 0.3 m³/batch, timber stack size: width 0.6 m x depth 1.0 m x height 1.0 m
- computer for database program
- laboratory instruments and materials for testing.

UniTech

- moisture meter x 1
- humidity and temperature sensor x 1
- humidity and temperature data logger x 2
- high precision camera with microscope adjustment
- chisel for testing veneer bond quality
- solar kiln 15m³ built to a specification
- solar panels & accessories
- slide compound Mitre Saw
- 1137 Series digital calipers
- EW-I Series portable electronic balances
- drying oven – 18 L

- laptop computer – Acer note book for laboratory testing work
- 3120 Husqvarna chainsaw
- spring balance (1000–1500 g)
- thickness swelling meter
- increment borer.

Appendix 3: A Vision of Forestry and Forest Industries in PNG

The document below is a chapter from the project report:

Ozarska, B., Vinden, P., Harris, G. 2009. Project commencement visit to PNG and recommendations on improvements in PNG downstream processing forest and wood products industry. 71 pp.

A Vision of forestry and forest industries in PNG

The purpose of establishing a series of vision statements for the PNG forest and forest industries is to articulate the views and visions of as wide a range of stakeholders and interest groups as possible. Recommendations can then be formulated in the light of an agreed vision. There are numerous interest groups involved or affected by the forest industries who may have different objectives and agenda. These interest groups include:

1. the **industries** and the **markets** that they service;
2. **society** (employees, people providing external services including research, education and training providers and people that are affected by the forest industries
3. **institutions** (government, financing institutions, owners).
4. the **international community** that is increasingly vocal and demanding that life cycle attributes of raw materials use, manufacture and disposal are taken into account to reduce dependency on oil but above all reduce the many influences that impact on global warming. The international community is also demanding a sustainable industry in terms of the available forest resources, and markets that also benefit local peoples and that currently may be disadvantaged.

The process being applied in the current project is in essence a mixture of “bottom up” and “top down” determination of the vision statements. The mix is essential. A purely applied top down established vision will miss much of the technical reality of what can be achieved taking into account social, economic and environmental realities. Bottom up planning involving sector stakeholder groups will often appear to target national objectives. However, the inevitable assumptions made may miss national policy objectives.

Inevitably this first report can only review the visions of interest groups in the geographically limited area surrounding Lae. However, distinct visions were articulated from which recommendations can start to be made. The process that will be provided is therefore to articulate a continuing vision that can be updated by a reference group as the project unfolds and adds new interest groups and other geographic regions

Recommendations need a vision of the future role of forest industries in PNG.

Given the potential complexity of implementing recommendations following from the interaction between interest groups, there needs to be a process for the continuing re-evaluation of the vision.

Recommendation 1.

The first recommendation is:

The establishment of a steering group

to represents the interests of all parties. This group was established at a meeting of interested parties at the TIFTC in November 2008 (see chapter 3.4). A whole day meeting was held in which a number of presentations were provided by stakeholders. It was concluded that the Steering Group would meet to fine tune Vision Statements and develop recommendations based on this report.

The following vision statements and recommendations are therefore draft and based on an interpretation of discussions with interest groups. These need further discussion and fine tuning before final recommendations can be articulated.

Recommendation 2.

Discussion of the vision statements with the Minister of Forests.

The Steering Group has directed researchers to meet with the Minister of Forests and his staff. The purpose is to meld vision statements and recommendations so that they are consistency with National policy. This will take place during the second planned visit to PNG.

Vision Statement 1.

Background

PNG has traditionally exported large volumes of raw materials in the form of logs. There is a vision of substituting log exports with the development of forest industries within PNG that services the needs of local people and export value added products.

PNG has a rich supply of tropical hardwoods as well as plantations of hardwoods and softwoods that can form the basis for an expanded domestic forest industry. However, such a development needs to reflect a domestic demand for forest products.

The vision is therefore:

Increasing domestic consumption of forest products; improved, more durable infrastructure, better houses for people and most particularly more affordable houses for rural communities.

Vision Statement 2

Background

Forest (land) ownership in PNG is primarily vested with villages and families. These production forests associated with villages are often mixed with gardening, fruit and vegetable growing and in the Lae region are relatively productive. However, utilisation and

regeneration of these forests tend to be fairly haphazard, based on immediate needs rather than any long term planning.

Any systematic sustainable utilisation of these forests needs village involvement. The benefits of adding value to the raw material also has to accrue to the families and village communities.

Involvement of communities and villages in the development of sustainable forest industries.

Vision Statement 3

Background

PNG has an existing forest products industry. Some of these operations for example the PNG Forest Products Pty Ltd, Bulolo, comprise highly sophisticated vertically integrated forest product complexes of world class standing.

Other companies, for example Lae Builders and Construction Company and Filco Joinery, Lae are small to medium sized enterprises. These enterprises are also well developed and use modern processing technology and engage in value added production of high quality joinery products using high quality tropical hardwood species that are in demand overseas.

At the community level, for example family enterprises based in small villages such as is found in the Oomisis Region, wood processing may involve the use of portable sawmills, low technology treatment processes (for example the BFCA diffusion treatment technology and air drying of sawn timber).

Some centralised drying facilities involving kiln drying and timber marketing has been achieved servicing a number portable sawmills. However, such enterprises are entrepreneurial in nature and often use second hand and fairly old equipment. These initiatives often require an injection of capital.

Some of these low technology (alternative) processing technologies involve for example portable sawmills. The use of such technology can be argued as being "appropriate technology" for community development. However, very often the use of such technology is inappropriate. For example:

The BFCA preservative formulation applied by diffusion is highly toxic and capable of causing health and environmental problems. There needs to be a technical understanding of how treatment is achieved and how treatment success is measured; the EH&S consequences arising from mishandling of the chemicals and the safety equipment that needs to be employed.

Air drying still require a level of understanding of the fundamental properties of wood; the importance of proper filleting patterns and drying stack construction.

Investment in capital equipment such as portable sawmills requires practical skills in saw doctoring OH&S and commercial skills to ensure a viable business.

The vision is therefore:

Integration of research, education and training to provide a range of articulated programs for all levels of skills needed by large, medium and small forest industry enterprises. And an education system that mirrors the requirements of life-time (career) learning.

Vision Statement 4

Background

Visits to the Forestry School, University of Technology, Lae, the Timber and Forestry Training Centre (TFTC) based at Lae and the PNG Forest Research Institute at Lae, all highlighted an enthusiastic and dedicated staff. However, the resources being allocated to forest products research education and training limit their capacity to provide industry and rural community needs. At one time forest products research was very well endowed with research staff, infrastructure and equipment based on bilateral aid funding from Japan. However, since the ending of this aid program virtually no funding has been made available for forest products research. In fact staffing was reported to be reduced to one person. The infrastructure has now been taken over by forest research staff.

The research laboratories were once well endowed with equipment. However, larger items of equipment have been moved out of the Institute and donated to the Timber Industry Training Centre. Nonetheless, the FRI still has infrastructure, (wood treatment plant, drying plant, analytical facilities and a wood science laboratory) that forms the basis for forest products research. More recently the number of staff has increased to 4. However, this is too small a group to function effectively on it's own on behalf of the industry it represents.

The building infrastructure at the University of Lae is of very high quality, (a new building). However, equipment is fairly limited. The teaching of wood science and technology at the University is also severely under resourced. Potentially a staff member was about to be appointed to teach wood science. There are limited courses available for specialisation in forest industries or wood science.

Technical training was better resourced at the Lae Timber Training Centre, although some wood working equipment needs to be upgraded and new technologies established to service industry training needs. The Training Centre was well resourced at one time under bilateral aid from New Zealand. The centre was established in the mid 1970's, and based on the successful model of the Timber Training Centre based in Rotorua. The TFTC in Lae is now under resourced and struggling to maintain existing programs. One very interesting attribute relates to the large proportion of female students. These students are enthusiastic and demonstrate technical skills, ability and determination. It is clear that many of these students could have the ability to articulate into an undergraduate degree if suitable pathways were available. Currently no such pathways exist. The programs available in forest industries, post apprentice training is also very limited. Whilst technically the Timber Training Centre is now part of the University, integration is relatively poorly developed, primarily one suspects because of limited resources rather than a lack of cooperation.

- **Well resourced and centralised research education and training in forest industries that provides pathways for articulated training from apprentices through to undergraduate and postgraduate research programs.**

Visits to local craft and furniture enterprises, for example St Josephs (Lae) highlight that PNG has very gifted craft persons and designers, producing a range of high quality unique furniture. This ability is enhanced through the availability of high quality tropical hardwoods. However, a very general observation is that these items of furniture and craft are sold very cheaply on the local market relative to the high labour input required in their production. There is a shortage of skills associated with enterprise management that needs to be addressed. Similarly there is a shortage of technical skills relating to understanding the technological attributes of wood and its behaviour in the environment. There is a major gap in education and training in forest industries at the interface between University training and the trade training skills provided by the training Centre. The gap arises at the technical management level i.e., middle management, involving enterprise management skills, OH&S, supervision, team leadership skills, communication, marketing, industrial design, manufacturing, plant operation and production. Such training needs a

mix of teaching skills that can be provided by both the Training Centre and University. Successful implementation of a program needs some key elements incorporated into the design of such courses to ensure success. The courses need to take into account the difficulty that some companies have in releasing staff because of the disruption it causes to work flow.

Sources of students are two fold.

1. School leavers who want to do more practical work leading eventually into a management role.
2. Existing industry employees who have shown promise and initiative and need ongoing training to mirror an advancing career in the forest industries.

New education / training initiatives that provide:

- **essential training in enterprise management directed at the forest industries and associated industries,**
- **provide training in value added manufacturing (timber engineering and furniture design and manufacturing**
- **provide equal opportunities for females**
- **provide for the needs of local communities.**