occurrence dates and event attributes on groups of events. For example, the occurrence dates of a user-selected group of events can be moved forward or backward by a user-specified number of years.

### *Financial Analysis*

The Financial Analysis component computes the financial consequences of a schedule of events using user-defined products, costs and revenues. Outputs are cash flows, Net Present Value at user-defined interest rates and base date, and Internal Rate of Return. This component provides the basic information necessary for forest analysts to carry out sensitivity analyses to test economic parameters as well as undertake forest asset valuation exercises.

### *Data Export and Reporting*

All information displayed in PLYRS is available for export and a number of utilities are available throughout the system to assist the user in filtering and selecting the information of interest. Resources data, management information and the results of simulation and financial analysis may be readily extracted and passed into standard presentation packages, (eg. Microsoft Word, Microsoft Excel) or into other management information systems such as GIS. This enables the user to invoke the power of those packages for reporting and further analysis.

**Summary**

PLYRS is an easy to use, open and flexible plantation management system that allows plantation managers to rapidly evaluate the effect of applying various silvicultural treatments and harvesting plans on the wood and cash flows from a selected area of plantation. Its principle use is to assist plantation managers in the preparation of detailed harvesting plans that are consistent with an organisation's long term management goals and commitments.

Although the current version of PLYRS is based on the biometry used in the South East of South Australia, PLYRS forms the basis of a system that can be readily adapted to the management of other plantation species.

PLYRS was developed as a new system, which allowed the developers to address the deficiencies inherent in many plantation management systems in use in Australia. In particular, PLYRS is a seamlessly integrated single system, is easy to use and was designed for ease of maintenance and further development.

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# Decision support software tools for pine plantations

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**Abstract**

Software tools that link silviculture, wood quality and grading of structural timber are being developed to support the managers of Queensland's commercial pine estate. The tools allow the evaluation of alternative silvicultural scenarios, in terms of internal rate of return and net present value. This paper describes the decision support project that will bring together software tools that grade sawn timber outputs from a conversion model, assign revenues, link to costs associated with a specific silvicultural scenario, and finally generate internal rates of return and net present values. These software tools provide a powerful decision support system that will pass on significant benefits to plantation managers. They will capture several decades of research to maximise the benefits to forest growers and processors by linking silviculture, wood quality and grading of structural timber.

**Introduction**

Efficient and appropriate management of commercial plantations is a primary goal for forestry organisations. Recently, this goal has become focused on the production of total volume at shortened rotation lengths, however an equally important issue is the impact of reduced rotation lengths on the quality of the timber produced.

A decision support system (DSS) that would allow the managers of commercial plantations to test a range of silvicultural scenarios and evaluate changes in internal rate of return, as well as taking into account impacts on wood properties, would be a valuable tool. The Cooperative Research Centre for Sustainable Production Forestry, the Queensland Department of Primary Industries (QDPI) – Forestry and the Queensland Forestry Research Institute (QFRI) are involved in a DSS project to achieve these aims.

The project is focussed on slash pine (*Pinus elliottii* var. *elliottii)*, Caribbean pine (*P. caribaea* var. *hondurensis*), their $F_1$ interspecific hybrid, as well as hoop pine (*Araucaria cunninghamii*). These are the main plantation taxa grown in Queensland, with the $F_1$ hybrid now deployed across the main plantation estate in south-east Queensland. The grower of these plantations, QDPI – Forestry, will be the primary user of the DSS (Catchpoole *et al.* 2001).

The purpose of the DSS is to allow forestry managers to evaluate alternative plantation scenarios in terms of internal rate of return prior to implementation. This could include altering the stocking, average site index and rotation length, as well as evaluating changes in graded timber recovery by overlaying wood property and branch models. In addition, the DSS can be used to evaluate the performance of clones, in terms of branch

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and wood properties, prior to commercial planting. These decisions are supported at the operational, strategic and estate level. Such a DSS requires stand growth models, detailed log description data, a conversion model to saw the timber, branch architecture and wood property models, grading rules, and then grading software to assign structural grades to the timber. The economic criteria of internal rate of return and net present values are used to evaluate each scenario, and relate these properties to a particular silvicultural scenario.

The DSS is currently being developed and an initial version will be completed in late 2003. This paper describes the DSS and discusses its benefits to managers of commercial pine plantations in Queensland. The DSS consists of several components that could be used individually or integrated to form a powerful DSS.

## Components of the DSS

The DSS will consist of external data/models, custom built computer software tools, branch models, wood property models, and grading rules (Figure 1). A software tool called STEPS (Software Tools for Evaluating Plantation Scenarios) has already been developed as part of the DSS. It provides a user-friendly interface to test a range of silvicultural scenarios and is one component of the whole DSS. The STEPS software can be used as a stand-alone product, which requires inputs such as growth models and user specified data, or as a component of the whole DSS to generate outputs such as log size distributions for the conversion software. The conversion software will saw the logs into boards and pass the board details, such as board dimensions, to the grading software. The grading software will require a set of grading rules, and branch and wood property models to assign grades to a collection of boards. The distribution of grades assigned to the boards would then be returned to the STEPS software where internal rates of return and net present values will be determined.

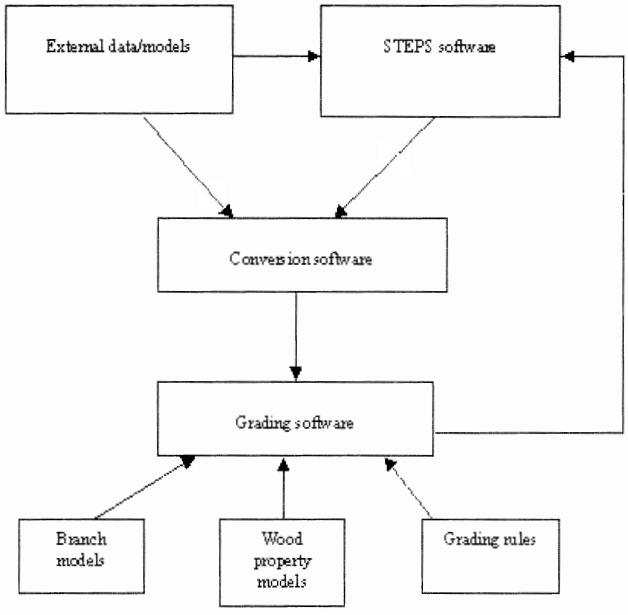
## External data and models

These are not part of the DSS itself, but are essential sources of information that are required as inputs to the DSS. These include the stand yield predictions produced by QDPI – Forestry's WEEDS/PLYSIM system (Catchpoole *et al.* 2001) and the cost and price information that are input by the user to operate STEPS. Furthermore, external data such as customised sawing patterns and taper data are required in the conversion software.

## STEPS

STEPS (Software Tools for Evaluating Plantation Scenarios) has been developed in Microsoft Excel and uses Visual Basic programming to carry out a series of calculations. It requires user-specified inputs such as a range of establishment costs and fixed annual costs, as well as specific growth data that are input from a file. The user can also alter parameters such as site index, thinning age, clearfall age, pruning strategies and stocking levels. This allows the user to evaluate silvicultural scenarios by varying any of these parameters as well as the cost and prices. STEPS is currently being used by QDPI – Forestry as a stand-alone software tool to assist

**Figure 1: Structure of the silvicultural decision support system.**




plantation managers in the decision-making process for evaluating a range of silvicultural scenarios in terms of internal rate of return and net present value.

STEPS is a powerful software tool that deals with both direct and commercial regimes in a single workbook. It displays only the worksheets that are relevant to the data that are input. For example, when direct regime data are input, any worksheets relating to thinning information are not visible to the user. This helps make STEPS an efficient and user-friendly software tool.

Functionality of STEPS includes:

- Economic evaluation of a standard (benchmark) silvicultural regime using internal rate of return (IRR) and net present value (NPV).
- Simultaneous comparison of three alternative regimes with a benchmark.
- Production of either average stand estimates, tree size distributions, or log size distributions (if stem merchandising is requested).
- Provision of feedback from the grading software to STEPS for evaluating economic returns using graded recovery of sawn products.

## The conversion software

The conversion software will enable users to simulate the sawing of logs into specific products, choosing from a range of sawing patterns. The conversion software will produce a virtual collection of boards, with associated dimensions and the within-tree position of each board. Win-EPIFN (Leban *et al.* 1999; Meredieu *et al.* 1999) and AUTOSAW (Todoroki 1996) are well-documented examples of conversion software. QFRI are currently investigating the purchase of off-the-shelf conversion software, rather than develop this component of the DSS in-house.

## Branch models

The purpose of the branch models are to characterise

the branch architecture including branch stub diameter, and branch position for each branch in the tree, and relate this to knot size and distribution for individual boards. Combined with distributions of tree size, the branch models will be used in the grading software to assign grades to the sawn timber. Considerable research has been undertaken in modelling these parameters in radiata pine (*Pinus radiata)* (Pont *et al.* 1999) and black spruce (*Picea mariana*) (Lemieux *et al.* 2001). Similar models for slash pine (*Pinus elliottii* var. *elliottii)*, Caribbean pine (*P. caribaea* var. *hondurensis*), their $F_1$ interspecific hybrid, and hoop pine (*Araucaria cunninghamii*) grown in Queensland are not available and are being developed to support this project.

**Wood property models**

The wood property models will be used to relate the strength and stiffness of mechanically stress-graded Queensland grown pine timber to visible defects and measurable wood quality parameters.

Models for density distribution (Tian and Cown 1996) and location of pith for the whole tree, as well as the modulus of elasticity (MOE), modulus of rupture (MOR), air dry density (ADD), knot area ratio (KAR) (Grant *et al.* 1984), slope of grain (SOG) (Tian *et al.* 1995), and distance to pith for individual boards will be developed. Combined with distributions of tree size, the wood property models will be used in the grading software to assign grades to the sawn timber.

**Grading rules**

The grading of timber involves the sorting of products into groups with similar characteristics or properties (Boughton 1994). For appearance grading this involves setting criteria based on the visual appearance of the timber, and for structural grading involves setting criteria based on strength and stiffness.

The standards for visual grading (Standards 2001) and machine stress grading (Standards 1997) will be adhered to when setting the grading rules in the DSS. The standards and rules associated with timber grading will certainly change over time, and possibly throughout the development of the DSS. Therefore, it is important that the grading software be sufficiently flexible to facilitate the adoption of these changes throughout the development of the DSS.

**Grading software**

The grading software will use the branch models, the wood property models, the grading rules and the conversion software to establish a profile of wood and branch properties across each board. Based on these models, and the within-tree position of each board, the grading software will apply the user-specified grading rules to assign a grade to each board. The graded board information will then be passed onto STEPS so that graded recovery and IRRs and NPVs can be determined.

**Application**

The decision support system described will provide a flexible platform to QDPI – Forestry to assist them in making decisions regarding the wood quality and grade recovery for particular silvicultural regimes in their commercial pine plantations. In addition, the DSS can be used to evaluate the performance of clones, in terms of branch and wood properties, prior to deployment in commercial planting. Using their own stand growth models for particular locations, they will be able to assess the internal rate of return and net present value of stands with different site indices, different clearfall ages, or stands with different revenues assigned for specific products. The relationships between wood properties and grade recovery can also be analysed and related to a specific silvicultural regime.

**Acknowledgments**

The authors wish to acknowledge the on-going support from the CRC for Sustainable Production Forestry and QDPI – Forestry throughout this project. Drs. Kevin Harding and Mark Lewty (QFRI) provided useful comments on a draft manuscript.

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# Modeling with Woodstock: An Australian case study

**Moira Finn**

## Introduction

*Woodstock* forest modeling software, developed by Canadian company, Remsoft Inc. has gained wider recognition in New Zealand and Australia in recent years as public and private sector organizations have begun adopting the software to model estate and natural forests, and radiata pine and eucalypt species. Tasmanian forestry company, North Forest Products (NFP) has had two licenses for *Woodstock* since 1997 and uses the software to develop long-term harvest schedules for eucalypt tree farms and native forests. NFP has also put Woodstock to work optimizing the Net Present Value (NPV) of its forest estate within an overall program of sustainable management.

## New applications

In 2001, NFP was purchased by Tasmania-based forest products company, Gunns Ltd. The take-over made the combined business Australia's largest exporter of wood chips, with annual sales of an estimated A$500-million.

The merger of the two large land owners also presented new opportunities for applying *Woodstock*, a Windows-based software that can accommodate simulation, linear programming (optimization) and random simulation using the same model format. The first new application was to integrate the forest records for the existing and new Gunns' businesses, and then to rebuild *Woodstock* models to incorporate the larger land base. This was

**Figure 1: Woodstock syntax lets users define inputs, outputs and actions using their own terms.**