Short-term harvesting and log allocation optimisation

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Introduction

Computers are now used routinely in forest management for a wide range of everyday tasks – so much so that the initial resistance is often forgotten. Computer-assisted optimisation of short-term harvesting and log allocation is another example of a new technology being greeted with some suspicion by a skeptical industry. Responses may include "*We've managed just fine in the past without it*" or "*It might be useful for others - but our situation is different.*"

Are the skeptics right? In fact, sometimes they are. In situations where there are only one or two products and one or two customers, most decisions will be straightforward and most trade-offs obvious. However, forestry can be a very complex business. Where there are multiple forests capable of producing multiple products and those products are harvested by multiple contractors and supplied to multiple customers, the sheer logistical considerations are daunting.

Added to this are the greater complexities of the business environment today, with more rigorous internal and external information requirements. Log buyers are operating in an increasingly competitive global economy and have become more demanding in terms of their log supply. In these situations, some form of optimisation becomes a necessity.

Short-term optimisation

The Problem

State Forests of New South Wales owns and manages 85,000 ha of plantations in the Hume region. Traditionally logs in this region were supplied to customers on a *stumpage* basis (ie. customers make their own provision for harvesting and delivery to mills). However logs are increasingly sold on a *delivered* basis (ie. SFNSW organises the harvest and delivery of the logs). This gives SFNSW the opportunity to maximise its profits by making sure that the right log products are cut from the right locations at the right time and supplied to the right customers. It also provides an opportunity for SFNSW to lose potential value should they get their scheduling wrong!

Determining which stands to harvest, which harvesting contractors to allocate to each stand, which mix of log products to cut from each stand, which products to add to in-forest stocks and which to send to each customer has been done manually. The scale and complexity means that it takes a great deal of effort to come up with a plan that is feasible, let alone optimal. It was recognised that the situation would worsen, given that:

(a) The harvest volume is going to increase;
(b) they wanted to convert more customers from stumpage to delivered sales;
(c) new and existing log customers were becoming more demanding about their log supply.

- **85,000 ha plantation resource**
- **Harvesting 30,000 cu.m/week**
- **11 main harvesting crews**
- **8-13 major customers per week**
- **Many log products recognised**
- **Haul distances from 1 to over 350 km**
- **Trucks working 22 hours/day, 7 days/week**
- **Delivered sales increasing**

Figure 1. SFNSW Hume Region logistics

Implementation Challenges

Optimisation has been used widely in the forest industry, for applications such as log bucking (eg. MARVL), strategic planning (eg. FOLPI) and primary processing (eg. SAWSIM). Three factors have limited the application of optimisation approaches to short-term planning problems.

(1) Problem formulation and solution – It is difficult to describe the problem to be solved in plain English, let alone set it out in mathematical equations. In addition, no individual has the whole supply chain in their heads. Past attempts to solve the problem generally required a heavily customised "heuristic" approach that did not guarantee an optimal solution, would not necessarily work in every situation, and in practice seldom found a use beyond the lab. Forest Research has had a long history in Operations Research and forestry software (eg. Garcia 1984, Cossens 1992, Murphy 1998, Laroze 1999) and had worked on optimisation approaches to this particular problem. However, the complexity of SFNSW's Hume business required adaptation and extension to Forest Research's model.

(2) Data requirements - Optimisation at this level requires up-to-date and accurate data from many areas of the value chain, including customer log orders and prices, locations of stands and current log stocks, harvesting crew productivity and harvesting costs and log transportation costs. Often this data simply doesn't exist, or it is out-dated, too aggregated or too hard to extract from other systems.

SFNSW has a systems strategy in place, and has invested in implementing these systems and ensuring that they are embedded within business processes, so are kept up to date. We had to take into account the fact that these systems are still evolving.

(3) Organisational requirements – a project of this nature requires a significant investment to be made. We carried out an audit of manual scheduling as a basis for constructing a business case for SFNSW. Traditionally supply chain issues have straddled internal functional boundaries within organisations, which has hampered progress. There are many business process changes and change management issues to be dealt with.

Achievements to-date

The initial focus of the project was on the user requirements and preparation of functional requirements specifications. A prototype system was then built over a six-month development period and is currently being tested using actual data updated weekly. Atlas Cruiser has been used to analyse existing MARVL inventory data to generate yields for each Harvest Unit under alternative cutting patterns. These Harvest Units are based on aggregations of 'patches' that were identified for harvesting in the first year of the tactical plan.

Much of the data required could be imported from existing systems (eg. current stocks from Artlis (Meynink et al 2004), haulage distances from GIS). Some information must still be entered manually, although there is scope to automate more of the data handling.

Figures 2 and 3 give an indication of the types of report available from a scenario.

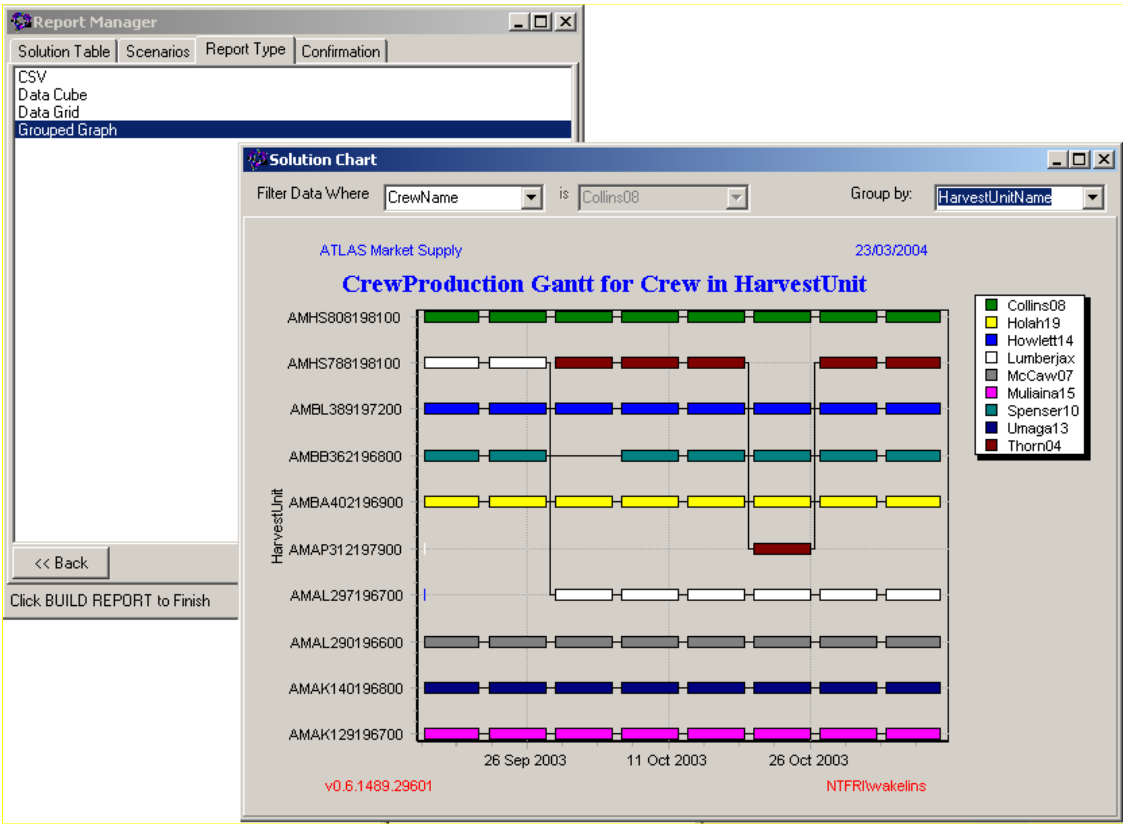

Figure 2. Reporting – tabular reports can be grouped, sorted, and summed or averaged on screen in a data grid or exported to spreadsheets. Solutions can also be graphed – in this case crew location decisions are displayed in a Gantt chart. These decisions can be left to the Optimiser or pre-empted using constraints.

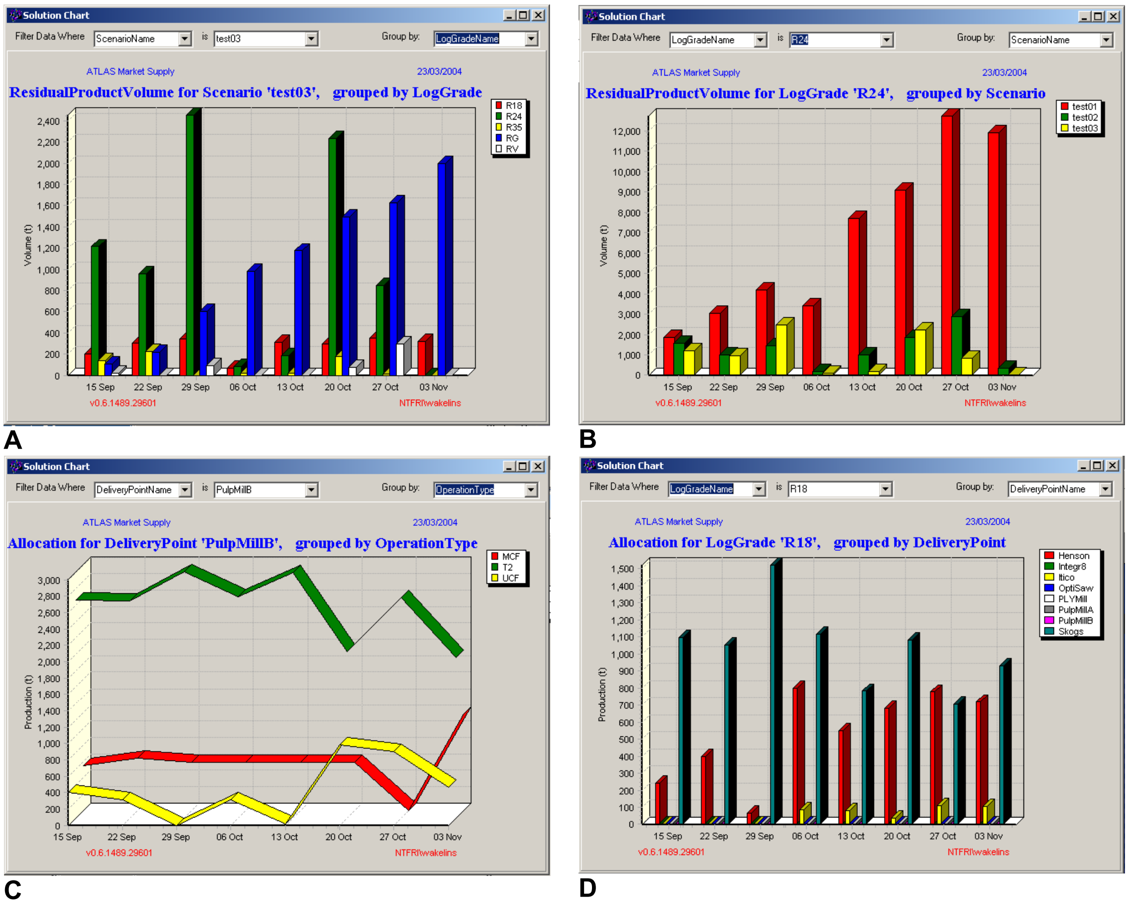

*Figure 3. The report writer includes charting functionality, for examination of production, allocation and stocks. Almost any combination of variables can be graphed and/or constrained within the system. Chart **A** shows weekly closing stocks aggregated by broad log grade. Stocks of Pulp logs gradually accumulate over the eight weeks because a minimum stock requirement of 2000 m3 was set for week eight. **B** shows the stock for a particular grade (R24) under three different scenarios. In **C**, the supply of pulp logs to a particular customer is shown by source – initially the mill is supplied mostly from first thinnings, but this drops away to be replaced firstly by unthinned clearfell and then by mature clearfell. **D** shows the allocation to customers for a particular grade (R18).*

Conclusions

While any organisation that buys and sells logs could make use of the functionality contained with the Atlas Market Supply Prototype, it may not add much value in situations where:

- Logs are sold solely on a 'run-of-bush' stumpage basis.
- The logs supplied are uniform in quality and value.
- There are few customers, with similar haul distances and/or insignificant transport costs.
- Customers are easily satisfied, with no negative consequences from failing to deliver to specification and on time.
- The forest owner is not concerned with maximising the return from their operations.
- Data describing the resource harvest operations and orders are not available, or are out-dated.

We see Atlas Market Supply as an example of practical delivery of a science-based solution. It is business-need driven - the aim is not to solve a theoretical problem, but to deliver an integrated solution that will make a real difference in the business.

References

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