Reducing transport costs through optimised transport planning: a case study using the FastTRUCK software tool

Abstract

The Australian forestry industry currently spends over one million dollars per day in transporting wood from coupes to mills. Until recently, investigating and implementing strategies to reduce these costs had received limited attention from industry, despite international examples illustrating the potential for significant cost savings. To address this problem, researchers working collaboratively with industry partners developed the FastTRUCK software tool to support improved transport planning. This paper reports on a case study using this software tool and illustrates the potential to reduce transport related costs through optimised transport planning. This case study reports on the approaches used to develop the software and to stimulate increased interest from industry partners in optimised transport planning. The paper analyses the results of using FastTRUCK with one of the case study participants and highlights the capacity of the software to support optimal fleet management approaches tailored company circumstances.

Keywords Logistics, Transportation, Forestry, Supply Chain, Optimisation

1 Introduction

Transportation from harvest areas to mills accounts for 18-25% of the operational costs in forestry supply chains in Australia (Brown, 2012). Similar costs have been reported in other countries: 36% in Canada (Audy et al. 2012); 25 - 50% in the southern United States (Mendel et al. 2006); 30 - 40% in Sweden (Andersson et al. 2008); and more than 45% in Chile (Weintraub et al. 1996). With the costs of transport at such high levels, reducing these costs should be a priority area of study for the forestry industry.

In Australia, research undertaken by the Cooperative Research Centre for Forestry (CRCF) highlighted a lack of a coordinated approach to transport planning and logistics within forestry industry supply chains (Ghaffariyan et al. 2011). Other work by the CRCF reports transport costs of over one million dollars per day for freighting harvested wood to mills (Acuna 2011). Consequently, the need for cost reductions was apparent from these localized studies in addition to the above international studies. Consequently the need to address transport logistics and planning were identified as key research areas for Australian industry by the CRCF. However, from the outset it was also recognized that considerable effort would be required to persuade Australian forestry industry partners of this opportunity and of the benefits of optimized transport planning and logistics.

From an international perspective a variety of approaches to optimising transport efficiency, planning and logistics which result in cost-reductions for transport are identified. The review of decision support systems in vehicle routing problems for timber transportation by Audy et al.(2012) reports on three operational approaches. Firstly in Chile, a computerised system called ASICAM has been in use since 1990. ASICAM is a simulation system embedded with a heuristic solver which produces a complete transport schedule for one day for more than 100 trucks within a few minutes (Epstein et al. 2007) and has reduced transportation costs by between 10% and 20% (Weintraub et al. 1996). Secondly in Finland, the EPO system was developed by VTT Information Technology to deal with all stages from strategic to operational planning (Palmgren et al. 2004). In 2002, the EPO system was replaced by the KUORMA route planning system, which has been reported to save 5% of the total transportation costs for one of the major companies in Finland (Savola et al. 2004). Finally, in Sweden, Skog Forsk developed a system called Flow Opt (Forsburg et al. 2005) that integrates Geospatial Information System (GIS) data, supply chain information, and uses a heuristic approach based on a “Tabu” search algorithm to optimise vehicle routing with similar savings to those generated of ASICAM and EPO. Hence, with improved transport planning cost reductions can be achieved.

Significantly, when researching Australian forestry industry transport and logistics chains (Acuna 2011) it became evident that although Australian companies were aware of this evidence, they were reticent to invest in these systems and remained sceptical of the benefits that might accrue within an Australian setting. As a result, in developing the research approach the CRCF researchers recognised the importance of the strong industry engagement in the tool development to ensure that interest and confidence in the benefits of optimised transport planning were stimulated. As this paper highlights the approach to collaborative engagement with forestry industry partners has been a critical success factor in acceptance and use of the FastTRUCK software tool.

The case study presented in this paper details the approaches used to both develop the software and to stimulate increased interest from industry partners in optimised transport planning and in particular the potential of centralised transport dispatch and management. In detailing these approaches, the paper focuses on three components. Firstly, the development of a domain model of existing transport planning to support visualisation by industry partners of the challenges in optimising planning along their logistics chains. Secondly, leveraging this domain model and combining it with an iterative systems development approach to generate the key software requirements for the tool. Thirdly, modelling the software architecture for FastTRUCK and encoding a scheduling algorithm in combination with a simulated annealing algorithm as part of the software tool’s implementation. The paper then reports on analysis of the results of using FastTRUCK with one of the case study participants and highlights the capacity of the software to support optimal fleet management approaches tailored to individual company circumstances. Moving forward, FastTRUCK has already received industry support for ‘live trials’ with analysis and reporting of the results of these trials anticipated within the next 12-18 months. It is anticipated that these live trials will deliver tangible transport cost savings to the Australian Forestry Industry of up to 10% per day.

2 A domain model for Australian forestry transport planning

Researchers in the Cooperative Research Centre for Forestry (CRCF) recognised from the outset of the research, significant opportunities existed for transport cost reduction evidenced by international studies. These researchers also recognised that the Australian Forestry industry, while aware of the evidence around cost reduction, remained sceptical of the applicability to the Australian context. As a result, it was recognised that an important first step for engagement with the industry would be to develop a conceptual model of the "transport planning" domain.

In developing this domain model researchers worked collaboratively with six of the largest forestry companies in Australia and a number of their logistics chain partners, over a period of 18-months, to examine their existing transport logistics and transport planning approaches. The companies were: Elders Forestry, Hancock Victoria Plantations (HVP), Forests New South Wales (FNSW), Forestry Tasmania, Australian Blue Gum Plantations (ABP), and Gunns. The logistics partners included one of the largest road transport dispatching company, Asset Logistics. In collaboration with Elders Forestry, one of Australia's largest hardwood plantation forestry managers, an initial study was conducted to evaluate the required level of receiving capacity at a proposed woodchip terminal in Western Australia. This project helped CRCF researchers develop the first prototype of the FastTRUCK system which proved to be a valuable tool in garnering early support whilst also returning practical benefits. For example, it was used for evaluating the level of infrastructure at port (Acuna 2011), saving Elders at least one million dollars in port infrastructure costs (Australian Department of Innovation 2010).

From this research it quickly became evident that the standard industry approach to addressing transport planning issues were conducted by each individual company rather than through a cooperative or integrated approach. It was also evident that the common practice amongst haulage contractors was to operate within a decentralised transport planning system. This has resulted in very limited coordination across the truck fleets used. These approaches appear to have evolved organically and partially as a result of the fact that many haulage operators are small or medium sized businesses servicing a single forestry company. The lack of coordinated planning has been an obstacle to recognition of the potential for performance gains and cost savings from resource pooling and centralised planning.

A specific company example representative of this approach is Forestry Tasmania (FT). FT is primarily a 'forestry growth and resource management' company that has traditionally outsourced transportation of its wood to its customers via a fee-for-service closed tendering process for minimum three year periods. FT incurs costs when it pays haulage contractors to move agreed wood volumes. FT's yearly wood volume in 2011 was 1,515,597 tonnes of wood. From publicly available figures, transportation cost FT $29,722,976 to employ 27 haulage contractors, using 44 haulage contracts, to service 31 harvesting contractors, who in turn, own 44 harvesting contracts. In 2011 the haulage contractors used 144 trucks, in the 27 haulage contracts, to transport FT's wood. An analysis of the transport planning revealed that the approach relied heavily on these haulage and harvesting contracts.

Following a series of detailed discussions with key industry stakeholders and participants in the CRCF, a domain model focused on transport planning tasks, interconnections in planning tasks, timing of occurrence, and informational accuracy requirements, was articulated and verified with all stakeholders. This domain model (Figure. 1) formed the basis for key requirements generation for the FastTRUCK software tool.

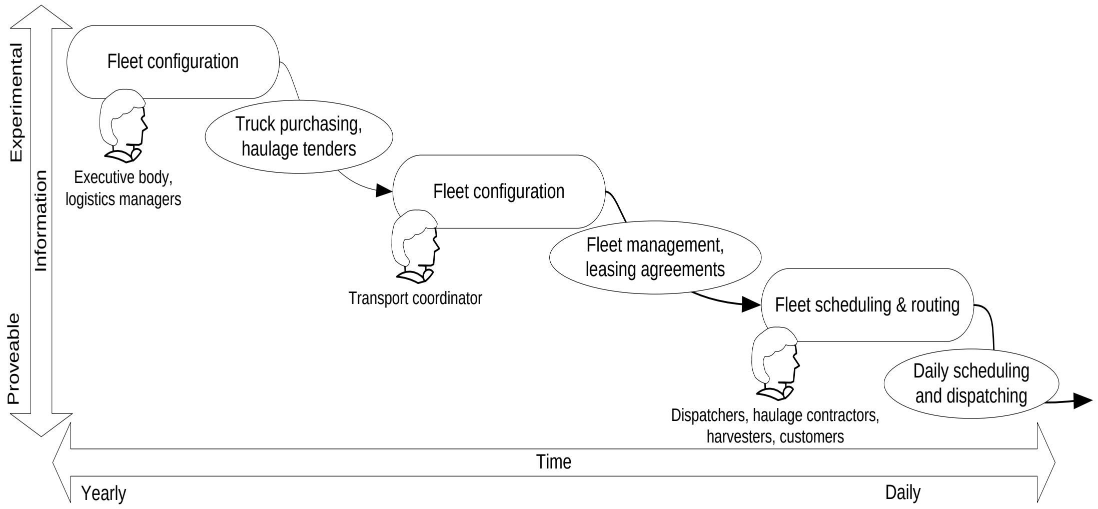

Figure. 1 *Domain Model of existing transport planning*

This domain model of transport planning supports conceptualisation of the tasks along the "planning spectrum." The needs of different stakeholders for informational accuracy are highlighted at different stages along the domain model's time horizon. Planning tasks occur at various stages, leading to distinct planning outputs which become the inputs for the next stage. This domain model represents the decision making ranges: from a yearly outlook to a daily, and up to the minute outlook, with the decision makers and outputs identified at each stage.

The yearly planning tasks are usually conducted by a company's executive committee, and may involve logistics managers, deciding on a transport fleet's configuration. The fleet configuration usually means different things to the different companies involved in the logistics chain. For a company that is "vertically integrated", usually it means deciding on fleet maintenance cycles and the purchase of new trucks. For companies that are "horizontally integrated", it usually means they have outsourced the transportation of their wood to external haulage contractors. This approach is common in Australia, and means that fleet configuration tends to refer to the design of tenders or contracts linking haulage of wood supply to meet demand for wood at pulp and saw mills.

Following the steps in Figure. 1 because fleet configuration has often largely been fixed, the next stage considers how monthly and daily plans can be best made to utilise the fleet for demands over these specific time-periods. This is usually done by translating the whole year's supply and demand information, into a monthly, weekly and daily setting of harvester cutting instructions. These instructions may be adjusted up or down to accommodate unforseen changes in demand/supply arising as a result of over or under supply delivery resulting from factors including truck break downs or changes in weather conditions. In these circumstances, the transport coordinator is responsible for managing any changes required in wood supply and transport planning including changes to harvester cutting-instructions and truck fleet coordination. This can be an involved process for the transport coordinator because they have to evaluate which trucks need to be in which specific depots across their geographical area and to communicate and coordinate this information to the truck drivers. Many of these drivers will have contracts from multiple companies and thus have a range of competing priorities that have to be managed dynamically. These drivers also want to have a degree of certainty about the use of their services as they are also frequently independent contractors.

Unsurprisingly, time spent planning is directly related to the "informational accuracy" requirements of the planner (Figure. 1 - the vertical axis). These requirements will vary depending on where along the domain model a planner is operating. For example, in developing a fleet configuration, the planner will need to base their approach on projected forecasts of demand often based on historical supply and demand information from previous years. In these circumstances, the degree of uncertainty is relatively high when compared to monthly, weekly or daily information that are based on exact supply and demand information. Whereas when scheduling trucks to particular destinations the information accuracy requirements are high and tend to display a good match to the actual planning requirements at this stage.

On the basis of the domain model that was developed collaboratively with industry stakeholders, considerable support was generated for further work to be conducted by the CRCF team to identify the software requirements for an optimised planning tool that would support individual planning tasks for individual companies whilst also supporting integration of these into a whole of logistic chain visualisation. The aim of the tool being to support companies in understanding and investigating the impacts of transport decisions within their operations on other supply chain partners.

3 Systems development and software requirements

Building on the domain model presented above, the research team deployed an iterative systems development approach involving detailed interaction with industry partners to identify the key software requirements for the transport planning tool to be developed. Through these interactions it rapidly became evident that any software tool developed would need to fulfill and balance a wide range of requirements across different implementation areas including from within the forestry industry, amongst system users, and also from a software development perspective to ensure scaleability.

At the broadest level, the iterative approach used involved a "ground up" approach to systems development and requirements analysis (Pressman 2000). This approach ensured that important concepts and key requirements were generated directly from industry and evaluated through multi-disciplinary expertise within the research team covering forestry, logistics and computer science. Using the domain model as a reference point for interaction it was possible to focus on key requirements for validation, modelling, optimisation, and programming in the tool.

Ensuring the range of information reporting requirements from the highly accurate 'operational' daily scheduling operations, through to the more experimental long term 'strategic' modelling tasks could be addressed emerged as an important requirement. Simultaneously, it was evident that another key requirement was to ensure the tool could support visualisation of the logistics chain in order that widespread acceptance and support from industry stakeholders could be maintained.

While investigating the transport planning challenges from the perspectives of a number of different forestry stakeholders was useful, it also posed a "standardisation" problem in terms of how to ensure the domain model whilst generic captured all key elements of transport planning within individual companies. To overcome this challenge the domain model developed, adopted the approach advocated by Arango (1994) such that the domain model forms the starting point for understanding how system components function and inter-relate.

As the systems development work progressed the research team engaged in a further two stages of work: data analysis and classification, to finalise the key requirements and prepare to develop the software architecture for the tool. These stages are commonly used in information and data modelling in order to elucidate domain elements for software systems (Benyon 1996). The data analysis stage examined the domain model to identify: key entities, operations, events, and relationships. The classification stage uncovered information structures characterising classes of these elements. Using this process, it was possible to iteratively interact with industry partners to capture an initial draft of the key requirements. This draft was also validated independently by a broader group of researchers with forestry operations and transport logistics expertise. Following several iterations involving discussion and modification the research team finalised the requirements for the system and maintained widespread support amongst industry partners.

4 Software architecture and the FastTRUCK tool

As a result of the iterative systems development approach, the research team were able to produce a software architecture for the software tool to be developed. This architecture is presented in Figure. 2. Given the focus of the tool it was decided to call it "FastTRUCK" to reflect the focus on improving the performance of trucks along the foresty logistics chain.

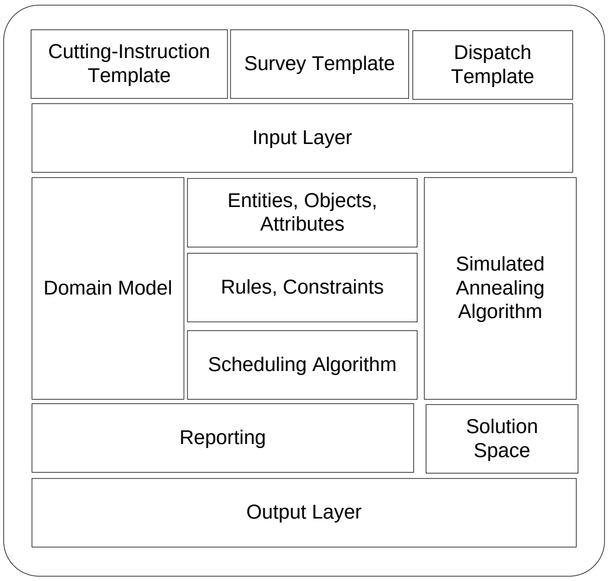

Figure. 2 Software architecture

In essence, the FastTRUCK software tool is designed for use at both operational and strategic levels by forestry companies. Following Robinson (2004) it is a "mode two simulator" developed to support processes for "social change" that occur during the development process and through experimentation with the finished software tool. The logic embedded in Robinson's approach is that simulator users become highly involved during the modelling process and gain benefits from all stages in terms of improved understanding as well as the solutions that can be derived from experimentation with the simulator.

Using FastTRUCK a forestry company can identify and reduce costs across their part of the planning spectrum. This includes daily dispatching of trucks, from harvest locations to mills; haulage contract design; fleet configuration on a monthly basis; fleet configuration on an annual basis; and even the performance of outsourced dispatching operations. FastTRUCK uses actual system data to create truck schedules by a simulation process minimising (or annealing) both the number of trucks required and the waiting times at origins and destinations, while meeting demand at mills. The software utilises a scheduling algorithm in combination with the simulated annealing algorithm.

The "scheduling algorithm" handles the challenges around truck routing between coupes and mills. Through discussions with two of the key stakeholders: Asset Logistics and HVP, it was possible to generate a "metaphor based" scheduling approach. As a result the scheduling algorithm is an abstraction of the current approach used by dispatchers on a daily basis. In summary, this approach involves a number of tasks to plan and produce a "dispatch schedule".

These tasks are:

- review the available trucks in the fleet, their type, capacity, and current location;
- select the next available truck and review its current constraints such as shift length, driver skill, and running costs;
- review the cutting instruction identifying a product, coupe customer mix which fits the truck's constraints;
- schedule the truck to this mix;
- starting from the last known customer, repeat the process for a truck until it's shift length is exhausted, returning it to its home depot.

Drawing on this information FastTRUCK treats a "dispatch schedule" as an instantiation of the domain model for a current set of values in the domain. The simulated annealing algorithm is then used to evaluate the quality of this solution, against the previous solution. A "least cost" objective function is used and this cost is calculated for each schedule and is used as the input into the simulated annealing algorithm. The encoding of this metaphor served various goals in the domain modelling exercise:

- it made it easier to validate the approach through discussion with domain experts as it is a near exact representation, albeit abstracted, of actual dispatcher practices.
- the approach also avoids the risk that some scheduling knowledge is not captured because it is "tacit" or not explicit.
- it made it easier to identify exceptions to scheduling as variations in the results indicates when a dispatcher has deviated from their previously 'conceptualized' approach to scheduling. This means that in analysing the results produced by FastTRUCK it is possible to identify and compare them with any variance in the schedules produced by dispatchers. This also means that, where appropriate useful variance can be encoded and added into the software's fixed algorithm as an exception. The simulated annealing algorithm allows existing transport planning to be modelled such that optimal fleet management approaches can be identified and results tailored to any specific company's requirements. This facility allows FastTRUCK to be tailored to individual company requirements for transport planning and thereby means it can be used as an industry wide scheduling algorithm.

For individual company's attempting to reduce their transport costs the process commences when the company models its existing transportation system using FastTRUCK (Figure. 3). Use of the tool occurs in two phases: 'modelling' and 'execution'. In order to obtain the information on the current system, the information is encoded in the "model template." This template is a Microsoft Excel Workbook which accepts information on the system's entities. Most companies already have the information required by FastTRUCK i.e. information on the depots, trucks, coupes, customers and routes, along with product supply and demand information that can be used to produce an optimised transport plan. During the research it became apparent that most industry partners sourced this information from a number of different places including talking directly to their haulage contractors, consulting the cutting-instruction and using information from the Global Positioning System (GPS) records that they use to monitor haulage contractor compliance with regulations as specified in their contracts.

Execution involves using the FastTRUCK software that can be operated on a conventional desktop computer. Users interact with it through its dashboard interface i.e. a series of windows that enables the user to model, simulate and report on current and optimised transport plans. The tool supports a range of settings including allowing users to control the type of scenarios that are explored. The "Simulation Settings" window controls the quality of the simulation. This highlights that there is a trade-off in terms of time expended in exploring possible solutions to locate the optimal trucking schedule within the constraints utilised. The "Model Settings and Constraints" window is where "what if" scenarios can be encoded to explore situations that may not exist currently but that the company might use to explore how best to redesign and improve their operations. A common option considered here is the size of the transport fleet and compliance with Australian Heavy Vehicle laws that dictate the number of hours a truck can work.

One important consideration in the use of FastTRUCK is the timeliness of the input data, as this is a crucial factor in determining where along the planning spectrum a company is operating and whether the tool is used for forecasting or summarising. The forest growers often have current and historical data, so it is possible for them to forecast the correct number of trucks for one week's cutting instruction several weeks in advance. They can also analyse exactly how many trucks were used by haulage contractors after a week's deliveries have taken place. Provided the data is available, the user can forecast any number of months ahead to get a strategic perspective.

Executing the model on a daily basis generates the dispatch schedule and this can be used by dispatchers in scheduling trucks for an optimal days' work – although the system currently does not account for "glitches" that may arise in practice on the ground, it is possible for dispatchers to manually adjust the simulation to consider these factors.

The "optimised plan" is the least-cost way of routing trucks to satisfy the demand for products. It is produced when FastTRUCK analyses the loads, pick-up points and delivery destinations, and matches these to the known truck fleet, constraints and known routes. In most of the systems analysed by the research team to date, when the 'optimal' plan is compared with the 'business as usual' plan, there is a large reduction in cost (up-to 10%) that is generated from planning the routing of trucks more effectively, avoiding delays in coupes or mills and running trucks to capacity.

FastTRUCK can be used by a variety of users, ranging from transport managers who decide on how many trucks to hire, through to truck drivers actually carrying out the deliveries. FastTRUCK provides three levels of reporting in Microsoft excel format:

- the 'Dispatch schedule' shows the strategic information, e.g. how many trucks the company needs and what they cost;
- the 'Truck schedule' shows the tactical information, e.g. the performance of each truck and how many hours trucks need to work on the day;
- the 'Stages' level shows the operational information, e.g. activity at the coupes and mills, and arrival times for the trucks. It also serves as the dispatch information for dispatching of trucks on the day.

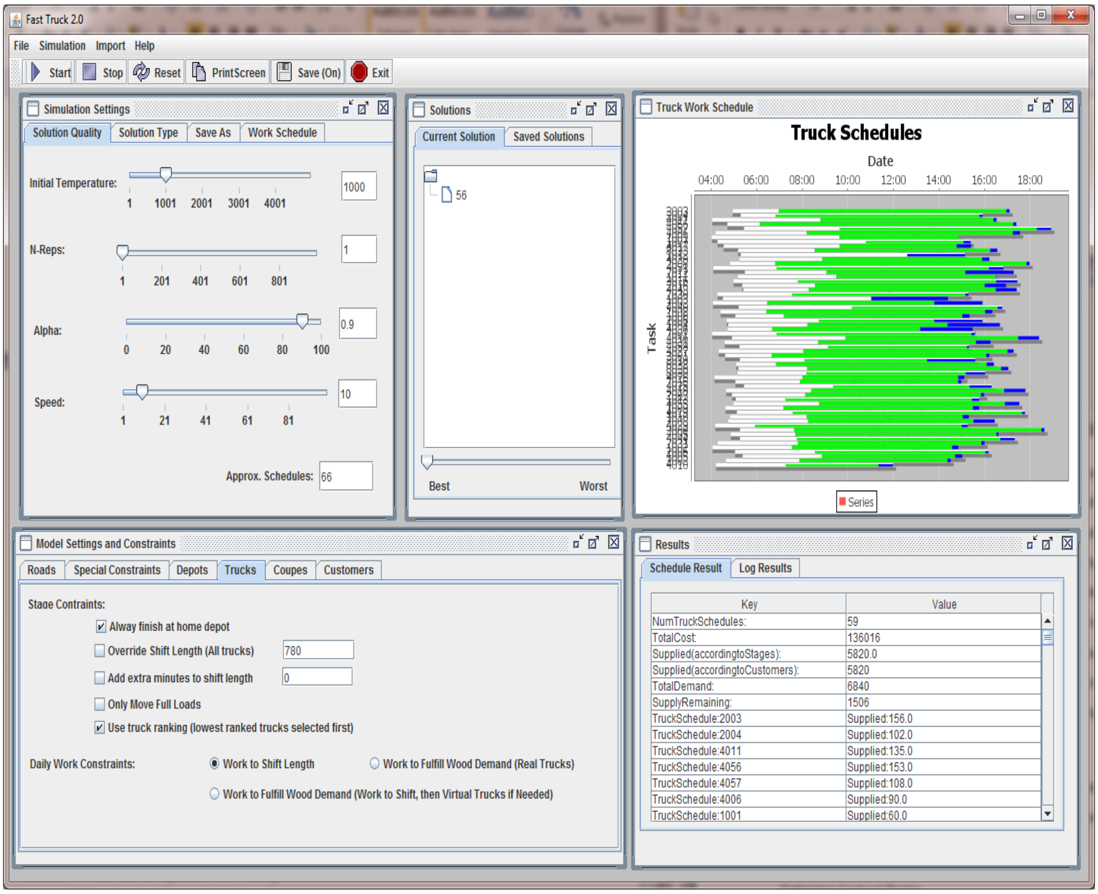

Figure. 3 *FastTRUCK operates on a desktop computer*

Each report contains critical statistics, showing information on the fleet's performance, i.e. utilisation, the percentage of kilometres used transporting loaded vehicles, loading and unloading times, and delays. All of this is useful for understanding how transportation costs can be reduced. Each report also satisfies distinct reporting outcomes as required along the planning horizon so the metrics in the "dispatch schedule", for example, are relevant to the types of questions likely posed by planners at this stage. But because the schedules are interrelated, and fundamentally rely upon the individual tasks completed by each truck, it's possible to see how daily operations affect the strategic outcomes long term.

Finally, from a distribution point of view, the research team aimed to support the possibility for users to run the software tool on a variety of computing platforms. Therefore, the team chose a programming language that operates correctly irrespective of underlying system architecture. The Java programming language is a modern object oriented language that runs within a virtual environment, the Java Runtime Environment (JRE). Java programs, once written are easily distributed as applications and can be run provided the host machine has the JRE installed. An additional benefit of having chosen Java is from a development point of view. There is also a lot of support for Java on the internet – which means many of the elementary aspects of the software like production of reporting interfaces such as charts can simply be sourced openly from the programming community. Java also provided the research team with the ability to control source code distribution: using web technologies, it can be installed on a web server and executed remotely but run locally on a host machine such that in the future; it might be possible to offer a single copy for distribution to all Cooperative Research Centre for Forestry (CRCF) participants. Finally, in terms of validation, the research team followed the principles articulated by Robinson (2004) who acknowledges that it is difficult to formally validate tools like FastTRUCK and the models that they encode except through widespread acceptance and use amongst users in the specific domain.

5 Case study: optimising transport operations

FastTRUCK has already been used by the transport operations of six large Australian forestry industry companies to model "business as usual" costs and compare these with the results of how simple changes to their transport planning schedules can translate into substantial cost reductions.

This section of the paper presents results from the use of FastTRUCK in one of these companies, Forestry Tasmania (FT). The results obtained through modelling FT operations are highly representative of the savings FastTRUCK has identified in the other five companies through optimised transport planning.

FT is a forestry growth and resource management company that outsources transportation of its wood to its customers, via a closed tendering process for minimum three year periods. The haulage companies used all operate decentralised transport systems.

In using FastTRUCK the first issue examined in the modelling was existing truck utilisation. There are many factors to consider when scheduling trucks, so the potential for human error is high. Sometimes, this means trucks are sent to harvest locations or mills when loading and unloading equipment is already in use, causing delays throughout the entire day. In the modelling, FastTRUCK was used to inform on efficiencies and resultant truck numbers required when operational factors were under ideal conditions. In the modelling, by scheduling trucks to travel to harvest locations and mills only when loading and unloading equipment was available, delays were avoided, making the trucks in the model about 9% more productive over the course of their shifts (Table 1).

Table 1 *FastTRUCK was used to inform on efficiencies and resultant truck numbers required under ideal conditions, increasing productivity for each truck in the modelling*

	Current fleet	**Optimised fleet**	**Utilisation increased**
Truck utilisation	77%	79%	2%
Utilisation over shift	54%	63%	9%

Using FastTRUCK's capacity for exploring 'what if' scenarios in FT's transport plans it was possible to examine 'before and after' effects of proposed changes. In the modelling, FT were able to explore how changes in the existing transport operations would impact on transport operations under ideal conditions. Factors considered here included: travel speeds, loading and unloading times. In the modelling, adjustments to the existing transport system constraints revealed that the truck fleet size could be reduced initially by 15% across all locations (see Table 2).

***Table 2** FastTRUCK was used to show the difference between optimisation and business as usual, enabling the company to model current operations, and then remove constraints that have existed*

	Current fleet	Optimised fleet	Number reduced	Percentage reduced
Location A	30	25	5	17%
Location B	44	44	0	0%
Location C	49	34	15	31%
Location D	21	19	2	10%
Overall	144	122	22	15%

For FT, when FastTRUCK was used to explore a range of scenarios through modelling, cost reductions flowed from the increased utilisation and reduced fleet size; because of commercial-in-confidence surrounding the cost-model, the exact figures cannot be shown here.

In the modelling, FastTRUCK was used to inform how this company's transport operations could be redesigned to reduce costs from an operations point of view. Although the modelling identified ways of improving the current transport system, given the level of abstraction of the modelled system and other limitations, FT is not looking at implementing these changes.

Rather, the modelling with FastTRUCK has highlighted to FT the benefits which arise when a mode-two simulator (such as FastTRUCK) is used to "inform" during the process of analysis of transport operations: the ability to model the existing system, explore "what-if" scenarios and engage a range of participants familiar with transport and logistics during analysis, leads to increased understanding and increased interest in the forestry transport system.

The outcomes this case study are on par with those outcomes suggested by Robinson (2004) when mode-two simulators are developed and applied for modelling purposes.

6 Conclusion

With Australian forestry industry transportation costs running at over one million dollars per day, transport planning is an area in need of optimisation to realise cost savings. The FastTRUCK software tool can assist the forestry industry to reduce these costs by: demonstrating the benefits of investing in transport planning systems and encouraging forestry companies to move to centralised planned transport systems. The case study highlighted the benefits which arise when a mode-two simulator (such as FastTRUCK) is used to "inform" during the process of analysis of transport operations: mode-two simulator usage leads to increased understanding and increased interest in the forestry transport system.

Since this research began the team have completed work with six of the largest forest companies in Australia: Elders Forestry, Hancock Victoria Plantations (HVP), Forests New South Wales (FNSW), Forestry Tasmania, Australian Blue Gum Plantations (ABP), and Gunns, as well as a large road transport dispatching company, Asset Logistics. While the research team recognise that there are a number of potentially "more sophisticated" software tools in the international market-place in optimised transport planning, FastTRUCK has been developed directly with the Australian industry and has already overcome a major obstacles to its acceptance and use within the industry.

Moving forward, FastTRUCK has already garnered industry support for 'live trials', with analysis and reporting on the results of these trials anticipated within the next 12 to 18 months, with expectations that these will be publishable. Whereas the reported case study applied mode-two simulation techniques, future work will examine the mode-one (predictive) aspects of the tool. One of these projects with Forests New South Wales (FNSW) is now investigating their capacity to untether harvesting and haulage operations, and to optimise the deployment of the log haulage fleet. Another project will use FastTRUCK to reduce the incidence of work-related injury by producing and applying driver schedules which reduce driver fatigue, thereby, reducing the chances of fatigue related health and safety issues across the workplace workforce. These new projects have emerged from the industry interest garnered by the work reported in this paper.

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