

POTENTIAL ECONOMIC IMPACT OF HIGH PRODUCTIVITY VEHICLES FOR WOODCHIP TRANSPORT IN THE GREEN TRIANGLE REGION OF AUSTRALIA

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Abstract

Transport cost are one of the major costs for forest operations and as the industry faces large increase in their freight task of over 350 million t-km in the next three years in the Green Triangle region they are eager to explore options to be as efficient as possible in tackling that new freight task. Through looking at their current payload efficiency using weigh bridge data it was noted that different configurations offer over double potential payload as compared to the basic semi-trailer but suffer from limited access. With the availability of Performance Based Standards to introduce new high productivity configurations the industry is now exploring three new configurations that have the potential to reduce cost by as much as 18% and fuel use and thus greenhouse gas emissions by up to 26%.

Keywords: performance based standards, Forestry, high productivity, transport efficiency

Introduction

Over the next 5 years the annual transport of plantation eucalyptus wood chips will increase more than 6 fold to over 350 million tonne kilometres per year in the Green Triangle region of south-west Victoria and the south-east of South Australia. According to Lambert (2006) this will represent nearly a doubling of the forestry freight task in the region and will more than double the freight flow through the Port of Portland, the destination for most of the new wood chip resource. With such a large increase in the freight task the forest industry in the area is actively investigating viable and cost effective transport solutions to help minimize the costs, fuel use and logistics complexity.

In his assessment of the new transport task Lambert (2006) identified that the use of B-doubles over semi-trailers would reduce the required fleet size by 25% and if a high productivity configuration like a road train could gain route access a further 15% reduction would be possible. While B-doubles are relatively common in the Green Triangle, and based on the quality of roads in the area are able to access up to 80% of the new freight task, road trains have not been permitted to be used in the area because of the potential negative impacts on road infrastructure and public concerns of the social impact of such vehicles. Since the 2006 report by Lambert the additional opportunity to use high productivity vehicles (HPV) approved through performance based standards (PBS) has become available to the industry and initial proposals include a quad-B-double and the use of steerable wheel semi-trailers.

With the background of the current forestry fleet performance relative to payload efficiency the potential of these two new HPV configurations will be explored for their potential impact on transport cost, fuel use and related emissions as well as the logistics of the operations.

Current haul operations

In order to understand the potential economic impact of the new HPV configurations it was important to clearly understand the performance of the existing configurations. To better understand the current payload performance with semi-trailers, B-doubles and road trains currently used in forestry transport, weighbridge data was collected from six companies across Australia for a period of six to twelve months each. Using tare weights and allowable gross vehicle weights for the three configurations the potential payload for each was established with a summary in Table 1.

Table 1: Summary of weighbridge data

	# Trucks	# Loads	Legal GVM ¹ (t)	Average Tare (t)	Average Potential Payload (t)
Semi-Trailers	97	9962	42.5	18.3	24.2
B-doubles	87	17212	62.5	22.7	39.8
79t Road Trains	209	20071	79.0	28.6	50.4

We can see that based on current performance the move from semi-trailer to B-double represents a 64% improvement in payload and a further 27% for the move up to road trains.

¹ GVM – Gross Vehicle Mass

These results are not a surprise and are supported in practice where the larger configurations are used, but due to their size and design are often restricted in use due to physical infrastructure limits or simple public acceptance.

In the Green Triangle region due to roads and regulatory limits only semi trailers and B-doubles are currently available and therefore will be the baseline values for comparison in this case study. Based on internal assessments by each of the three major companies in the Green Triangle region, Great Southern Plantations Ltd., Australian Bluegum Plantations Ltd. and ITC Ltd., 80% of their plantations are accessible with B-doubles with the remaining 20% only able to be accessed with semi-trailer configurations.

Potential High Productivity Vehicles with PBS

With recent introduction of PBS in Australia alternative HPV have become possible to achieve or exceed the current payload performance with more infrastructure friendly, safer and more publicly acceptable designs. As a result the forest industry is exploring three new configurations that meet or exceed the performance criteria for access to routes currently limited to semi-trailers and/or B-doubles. One of the configurations is a quad B-double configuration based on the National Transport Commission’s (NTC) blue print vehicle with Level 2 route access, roughly equivalent to B-double routes for the Green Triangle region. The other two configurations are based on new trailer designs using steerable wheel technology one of which could have Level 1 route access, roughly equivalent to semi-trailer routes in the Green Triangle region and could be coupled to make a road train for Level 3 route access and in some cases permitted access to Level 2 routes. The second steerable wheel trailer would be done as a b-double replacement for Level 2 route access.

1.1 Quad B-Double

One concept that has shown promise for several bulk transport applications, including wood chip transport in the forest industry, is the quad-B-double configuration done as a PBS blueprint configuration by NTC for Level 2 route access when coupled with an appropriate prime mover. Figure 1 shows the quad-B-double configuration. Through the inclusion of two additional self-steering axles over a traditional B-double the GVM is increased by 14.5 tonnes. This approach is favoured by the transport industry as it is design and technology they are familiar with and at only 1 m longer than a B-double, the industry believes the task of gaining public acceptance will be less onerous with a reasonable level of effort for routes already approved for B-double use.

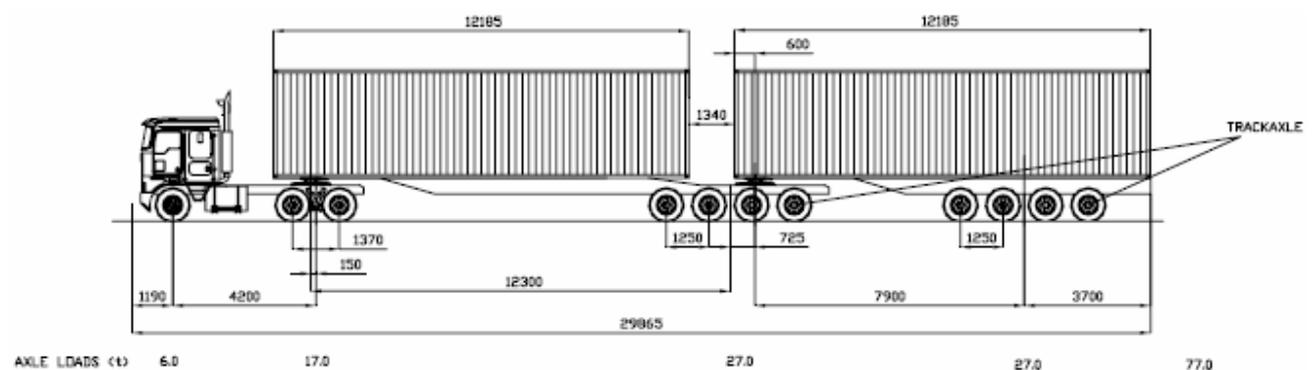


Figure 1: Quad B-double

Initial evaluation of the concept for wood chip transport has verified that the configuration will allow sufficient volume to reach full loads based on wood chip density the companies currently work with . Since the quad-B-double is not currently hauling woodchips determining the tare weight for evaluation of the impact on haulage efficiency requires certain assumptions to be made. First, since the quad-B-double design is the same as the standard B-double, it is assumed the tare weights would be about the same with an allowance for the two additional axles and the extra one meter of length. Each axle weighs between 800 kg and 1200 kg depending on the axle design and suspension, with self-steering axles tending to the heavier end of the range. The weight of the extra meter in length would vary between 200 kg and 400 kg depending on frame and wall materials. Based on these ranges it is assumed the quad-B-double would weigh, on average about 2400 kg more than a standard B-double giving a probable average tare weight of 25.1 tonnes and a potential payload of 51.9 tonnes.

Like the weights, because the trailer has no history of hauling woodchips, the costs of operations have to be estimated based on current B-double operations. To account for the extra axles and length the purchase price was increased over a standard B-double by \$15,000. However, this could be highly variable based on the market and competition. Operating costs could be more confidently estimated as they are linked to the GVM where fuel consumption and vehicle maintenance was increased relative the increase in weight of the vehicle. Table 2 shows a summary of the comparison of the two vehicles. The results show that the quad-B-double would have a per tonne cost 18% lower than the current standard B-doubles with the 30% increase in payload. Because more wood is transported per load, even with an increase in fuel consumption per 100 km travelled to account for the extra weight, the fuel use for a given freight task would be expected to be 12% L/t-km less using quad-B-doubles instead of standard B-doubles. Thus 12% less greenhouse gas emissions would also result from using quad-B-doubles.

Table 2: Summary of comparison on B-double and Quad-B-double

	B-double	Quad-B-double	Difference (%)
Payload (t)	39.8	51.9	30.4%
Fuel use (l/t-km)	0.033	0.029	12.1%
Operating cost(\$/t-km)	0.181	0.148	18.2%
Trips per year	70,352	53,950	23.3%

Taking these results and applying them to the Green Triangle case study of 350,000,000 t-km per annum of wood chip transport, with Level 2 route access the quad-B-double (NTC) will only be an alternative for those plantations currently accessible for B-doubles or 80% of the freight task. As a result there is a potential to reduce the costs of the total eucalypt plantation freight task in the Green Triangle by about 14% and reduce the fuel and greenhouse gas emissions by about 10%. It is also of notable benefit that the 30% increase in payload will result in over 16,000 fewer truck trips per year.

1.2 Steerable Wheel Trailers

Steerable Wheel Systems Pty Ltd (SWS) has developed an innovative modular steerable wheel system that comprises twin wheels with integrated suspension that are electronically controlled (Prem, May & Davey 2008). There are many advantages created with this new technology highlighted in the report that 'have significant positive outcomes on vehicle productivity, safety performance, infrastructure impacts and occupational health and safety' (Prem, May & Davey 2008), but of particular interest for the blue gum plantation industry with regards to woodchip transport is the lack of trailer wheel axles allowing for greater load volumes with a lower centre of gravity. In addition, the actively steered wheels allow for longer single trailer units that can be unloaded more quickly than multiple trailer configurations together with potential wheel spacing options that allow for higher GVM within current semi-trailer and B-double dimensions.

As a new technology the steerable wheel trailers perform quite differently to the traditional configurations and without a trailer currently operating for bulk commodity transport like that considered for woodchip transport it is important to look carefully at how the vehicle will perform within PBS standards. Table 3, shows the results of comprehensive modelling done for SWS which they have provided for this report. This modelling is for the 18.75 m configuration and you will note it exceeds requirements for all the criteria for Level 1 route access.

As part of their strategy to introduce the steerable wheel technology to the Australian transport industry SWS is building a set of 18.75 m configuration bulk transport trailers. The trailers will be used to verify the performance modelling in Table 3 and will be used to further test the concept of coupling two units with a powered dolly for Level 3 route access and potentially permitted Level 2 route access where payloads could exceed 100 tonnes while only exceeding the length limit in the performance based standards for level 2 route access.

Assuming successful performance verification, the 18.75 m configuration will be tested in woodchip transport later in 2010 to evaluate and confirm the physical and economic performance of the configuration for the eucalypt plantation forest industry. If successful, further opportunities with a longer 26 m configuration and road train configurations will be explored. While modelling has not been completed for the 26 m configurations, based on how the technology works it is expected that it will perform equally well for Level 2 route access. Figure 2 is a conceptual diagram of the 18.75 m steerable wheel configuration for Level 2 route access. The Level 1 route access 18.75 m unit would have one less axle, whereas the 26 m configuration would have an additional axle.

Table 3: Dynamic modelling results for 18.75 m steerable wheel configuration

Performance Standard	Performance Value	Performance Requirement			
		L1	L2	L3	L4
1 Startability	24%	≥15%	≥12%	≥10%	≥5%
2 Gradeability					
a) Maintain forward motion on grade	33.20%	≥20%	≥15%	≥12%	≥8%
b) Minimum speed on 1% grade	93.7km/h	≥80km/h	≥70km/h	≥70km/h	≥60km/h
3 Acceleration Capability		Modelling demonstrates the vehicle satisfies the performance requirements			
4 Tracking Ability on a Straight Path	2.8m	≤2.9m	≤3.0m	≤3.1m	≤3.3m
5 Overtaking Provision (Level of Service)	18.75 OAL				
6 Low-Speed Swept Path Width	5.9m	≤7.4m	≤8.7m	≤10.1m	≤13.7m
7 Frontal Swing					
a) Prime mover	0.3m	≤0.70m			
b) Semi-trailers					
i) maximum of difference (MoD)	n/a	≤0.40m			
ii) difference of maxima (DoM))	n/a	≤0.20m			
8 Tail Swing	0.19m	≤0.30m	≤0.35m	≤0.35m	≤0.50m
9 Steer Tyre Friction Demand	34.00%	≤80%			
10 Static Rollover Threshold	0.67g	≥0.35g			
11 Rearward Amplification	1	≤5.7SRT _{truck} 3.82			
12 High-Speed Transient Offtracking	0.1m	≤0.6m	≤0.8m	≤1.0m	≤1.2m
13 Yaw Damping Coefficient	1	≥0.15			
14 Directional Stability Under Braking	ABS/EBS	Meets the performance requirements			
Performance Standard	Performance Value	Performance Requirement ^a			
		L1	L2	L3	L4
1 Pavement Vertical Loading					
a) Average SARS per Axle Group	GML/HML loads	9 tonnes per single axle group			
b) Load sharing	All axles and wheels	2 or more axles in a groups load share			
2 Pavement Horizontal Loading					
a) Steerable Axles					
i) Number of axles in group	All wheels are steerable	if >3 axles add at least 1 steerable axle			
ii) Axle group spread	All wheels are steerable	if spread > 3.05m add at least 1 steerable axle			
b) Driving Axles					
i) max GCM (tandem axle drive)	50 t (L1), 59 t (L2)	≤62.5t	≤90.5t	≤90.5t	≤120t
ii) distribution of tractive effort	Equal	equal distribution of tractive effort			
3 Tyre Contact Pressure Distribution					
Tyre inflation pressure	<825kPa (<825kPa) ^d	≤825kPa for radial ply tyres, ≤700kPa for other			
4 Bridge Loading	L1 50 t, L2 54.7 t & 57 t, L3 & 4 - 59 t	MERRV ≤ 1.0			
	a) Performance requirements as set out in National Road Transport Commission PBS Standards				
	b) All axle groups are either at or below General Mass Limits.				
	c) Load sharing between all modular steerable wheel-pair groups and between each wheel pair.				
	d) Radial ply tyres in all wheel positions.				

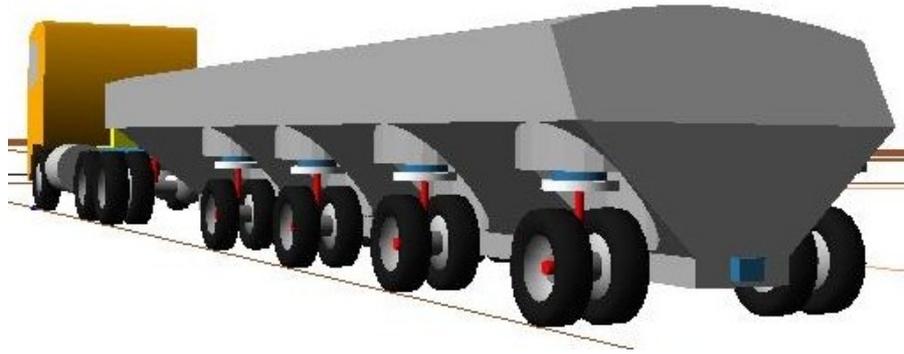


Figure 2: Steerable wheel trailer

The steerable wheel trailers are a new concept based on a new technology with new trailer designs tailored to the technology and, like the quad-B-double, there are no examples on the road to obtain actual weight and cost information. Weights and payload are derived from theoretical weights provided by design models from the manufacturer and costs are based on the proposed costing models from the manufacturer. In the case of the 18.75 m configuration the allowable GVM based on PBS will be 49.3 tonnes on Level 1 routes and 55.7 tonnes on Level 2 routes. In the three axle design configuration for Level 1 routes only the unit is expected to have a tare weight of 14.4 tonnes and the four axle version that can be used for Level 2 routes would be 1 tonne heavier. Since it would be more practical for industry to have the flexibility of the four axle trailer it was used for the comparison. The 26 meter configuration would have a 68 tonne GVM on Level 2 routes and the design model predicts a tare weight of 18.4 tonnes.

Table 4 looks at the summary of impacts of replacing the existing configurations with comparable steerable wheel configurations. In an operation that requires high levels of flexibility in the fleet to move between Level 1 and 2 routes, a transport company might take the approach of using only the 18.75 m for the entire freight task but the more likely approach would be a mixed fleet of the 26 m vehicles for Level 2 routes and 18.75 m vehicles for Level 1 routes.

Table 4: Summary of potential payload performance for all configurations considered

	Semi trailer	18.75-SW-L1	Difference (%)
Payload (t)	24.2	34.9	44.2%
Fuel use (l/t-km)	0.042	0.031	26.2%
Operating cost(\$/t-km)	0.238	0.209	12.2%
Trips per year	28,926	20,058	30.7%
	B-double	18.75-SW-L2	Difference (%)
Payload (t)	39.8	41.3	3.8%
Fuel use (l/t-km)	0.033	0.027	18.2%
Operating cost(\$/t-km)	0.181	0.174	3.9%
Trips per year	70,352	67,796	3.6%

	B-double	26-SW-L2	Difference (%)
Payload (t)	39.8	49.6	24.6%
Fuel use (l/t-km)	0.033	0.026	21.2%
Operating cost(\$/t-km)	0.181	0.160	11.6%
Trips per year	70,352	56,452	19.8%

A fleet of only 18.75 m configuration vehicles for the Green Triangle freight task would offer greater flexibility than the current mixed fleet of semi-trailers and B-doubles and it would reduce costs more than 5.0%, fuel use by 19% and there would be nearly 4000 less truck trips per year. Keeping a similar mixed fleet using 18.75 m configurations in place of semi-trailers and 26 m configurations in place of B-doubles would constrain operational flexibility but the cost savings increase to over 27%, fuel savings to 22% and decrease the truck trips by more than another 8000 trips.

Conclusion

Transport costs are important to the forest industry and looking at the current fleet shows that increased payload configurations are very effective at reducing costs, fuel use and truck trips to complete a freight task. Traditional configurations currently available have limited scope of application and limited potential payload that can now be exceeded with new configurations through PBS that in most cases are also safer and more infrastructure friendly.

With the opportunity of new operations starting in the Green Triangle with no existing fleet to displace and the opportunity of high productivity vehicles through PBS the industry can greatly reduce their transport costs, fuel use and use of the road network. All of the new configurations, based on the projected costs and performance offer significant benefits over the existing commercially available truck configurations that warrant operational investigation. These investigations will be initiated over the next year as the new configurations are available and harvest operations start up in the Green Triangle.

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