

Drive in, Drive Out Workforces: The impact of shift work changes on the Bowen Basin Coalfields

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Abstract

The Bowen Basin coalfields have experienced considerable changes in work practices since the late 1980s. A major aspect of this process of change has involved the introduction of new shift arrangements. In many instances, the move to new shift arrangements has been associated with the emergence of 'drive in, drive out' workforces, where mine employees or contractors live on the coast and drive to and from their place of work. The safety implications of this practice are largely unexplored. This study argues that there is, in fact, significant adverse health and safety concerns with a significant proportion of drivers falling asleep at the conclusion of their shifts.

Introduction

Throughout the last two decades the Australian workforce has experienced considerable changes in work practices, including skill utilization levels, terms of employment and hours of work. In the Queensland black coal mining industry, labour reforms and changing work practices has led to significant outcomes for employers and employees. There is little debate that for employers, labour reform has contributed greatly towards raising the productivity of the industry (Bowden 2003). The position for employees is somewhat less clear since the impact of labour reform can be seen in changes in shiftwork practice (Heiler & Pickersgill 2001) and a significant decrease in direct employment (Bowden 2003). Changes in work schedule and a move from permanent to contract employment among miners has resulted in a shift away from permanently residing in the Bowen Basin, to the coastal areas of Central Queensland (CQ). This has created in part, a drive in-drive out workforce (DIDOW) that is characterised by driving long distances to the mine site, living in local accommodation for the work period and then returning to the permanent home. The key concern with the creation of a DIDOW from an occupational health and safety (OHS) perspective is employee well being during the drive to and from the work period (Di Milia & Smith 2004). The aim of this research is to examine driver fatigue in a DIDOW, within the context of the overall changes occurring in the Central Queensland coal industry.

The Context: Workplace change in the Bowen Basin

The coal industry in the Bowen Basin of CQ can be considered successful from any number of indicators. The production of saleable coal from the central and northern coal districts of the Bowen Basin has increased from 92.5 million tonnes (1998-99) to 126.2 million tonnes (2002-03) (QDNR&M 2003). Overall coal exports for Queensland were 129.2 million tonnes earning approximately A\$8 billion free-on-board for the mining companies (Coffey, Smith & Abbott 2004).

A brief history of the CQ coal industry suggests three broad periods of changes in industrial relations practice. From 1965 to 1986, the industry operated in an environment of high coal prices and highly regulated industrial relations under the Coal Industry Tribunal. During this period, the mining workforce grew from a few hundred

to over 8,500 and the district's population rose from about 8,000 to approximately 44,500 (QPIFU 2002). Working arrangements included a permanent workforce, and while the form of shiftwork varied according to union membership, shift length was limited to eight hours (Barry, Bowden & Brosnan 1998). The success of the coal industry was underlined when Utah in 1977 recorded the largest profit ever for an Australian company to that time (Galligan 1987).

The second stage (1986-96) of industrial relations practice was triggered by a collapse of coal prices. This period marked the start of a significant campaign by employers to restructure mine-site work and employment arrangements. In 1989, the employers obtained from the Coal Industry Tribunal a restructuring agreement that introduced 'multi-skilling' and 'continuous shifts' into mine operations. However, shift length was still restricted to eight hours (CIT, 1989). Concerns about industrial restrictions on both how coal miners were employed, and when they could work, became the focus of a number of academic, industry and government studies during the 1990s. The Productivity Commission Inquiry (1998, p. 107) concluded the industry was plagued by a multitude of restrictive practices that reduced management's ability to employ the quantity and quality of labour best suited to each mine's operation. In addition, the inquiry suggested the short working week of 35 hours, on which overtime and penalty payments are based, imposed relatively high unit labour costs. To increase productivity, Hawke and Robertson (1999) supported employer demands for the implementation of continuous operations throughout all work areas, and thus limit the proportion of production time lost to working arrangements. The Rio-Tinto Group figured prominently in shaping the future of the coal industry and, in particular, what Peetz (2002) has called a 'decollectivist' industrial relations model. Rio-Tinto played an influential role in securing the use of contractors and outsourcing as strategies for bringing about cultural change in the industry. In its submission to the Productivity Commission, Rio-Tinto (1997, p. 3) stated that the industry's problems could only be overcome if 'producers have sufficient discretion to realize every cost saving and to make every productivity improvement'.

The third stage of change in industrial relations was brought about by the introduction of the *Workplace Relations Act (WRA)* in December 1996. The WRA delivered the flexibility in work scheduling and employment that producers had been seeking. Smith, Brown and Di Milia (1992) arguably conducted one of the first studies in changing from eight hour to 12-hour shiftwork at Rio-Tinto's Blair Athol mine in the Bowen Basin. Union opposition to longer daily working hours effectively ended when the AIRC announced employers could introduce ten-hour shifts without agreement and could apply for 12-hour shifts in order to raise productivity. A review of working hours suggested that 12-hour shift arrangements are now common in the coal industry (Helier & Pickersgill 2001). Weekly working hours in excess of 41 hour in the coal industry increased from 43 per cent to 52 per cent between 1991-1996 and an additional 4 per cent worked in excess of 49-hour per week (Helier & Pickersgill 2001). Wooden (2000) provided evidence suggesting that long working hours were more common at worksites that were governed by individual contracts.

Within a month of the introduction of the WRA, Rio-Tinto management at Blair Athol mine indicated that contractors were no longer required to be union members to work on site. By 2001 even the Construction Forestry Mining and Energy Union (CFMEU) agreed to a certified agreement giving management the right to use contractors 'on any

work as required (AIRC 2001a). Rio-Tinto's success was followed by BHP Coal's notice to unions to exercise its 'right to free and unfettered use of contractors' at its Bowen Basin operations (BHP Coal 2001). This 'request' was agreed to by the union in the Enterprise Agreement (AIRC 2001b). The impact of this agreement can be seen in Table 1. In the open-cut pits of Queensland's central and northern districts, which were responsible for the bulk of the state's production and exports, the number of directly employed miners fell from 6,665 in 1996 to 3,373 in 2000. By contrast, in the six years between 1996 and 2002 the number of contractors (and their employees) engaged in these operations increased from 416 to 2,480 (QDNR&M, 2002). There is little doubt that the labour flexibility introduced by the *WRA* led to significant productivity gains for the industry. Total employment fell from 10,962 in 1995-96 to 7,972 in 1999-2000 while saleable coal output per employee increased from 7,709 to 14,483 tonnes in the same period. Recent data, however, suggests that total workforce numbers (including contractors) for 2002-03 have returned to 10,723 (Coffey, Smith & Abbott 2004), reflecting increased international demand and the construction of new mines.

Table 1: Employees and Contractors (and their Employees): Central Queensland's Opencut Mines, 1996-2002

Year	Employees	Contractors
1996	6,665	416
1998	4,355	1,002
2000	3,373	1,027
2001	4,203	1,954
2002	3,954	2,480

(Source: Statistical Office, Queensland Department of Natural Resources and Mines)

The impact of labour reform for miners can be seen in changes to shiftwork practice and employment status. Weekly rotating 8-hour shifts which were the norm prior to the 1990s have long been criticised on biological and social reasons (Waterhouse, Folkard & Minors 1992). The focus on work scheduling allowed an opportunity to consider work schedules that improved shiftworker well-being. In general, a 'well designed' 12-hour shift system with rapid rotation allows for reduced cumulative sleep loss, reduced biological disruption and increased social opportunities (Knauth 1997). While there are persistent concerns about excess fatigue with 12-hour shifts, these arrangements have proved widely popular, irrespective of the actual roster design because they provide better utilisation of leisure time (Di Milia 1998a; Lowden, Kecklund, Axelsson & Akerstedt 1998). Shiftworker concern's with impaired social opportunities has always been a major issue (Baker et al. 2002; Wedderburn 1981).

There is evidence to support an argument that extended workshifts and the use of contractors has resulted in a shift in lifestyle for some miners. Anecdotal and empirical evidence suggests some miners spend their roster days away from the mining districts and travel to the coast. Di Milia and Smith (2004) estimated 6 per cent of miners from the central districts left for the coast directly after working a spell of 12-hour night shifts. The mean one-way travel distance was 244km (max. 655km). A further 10 per cent had travelled to the coast during the roster break. In the northern districts some 18

per cent of drivers reported a mean one-way travel distance of 193km (max. 600km) following the end of night shift. An additional 12 per cent were driving similar mean distances during the roster break. The drivers in the northern districts were approximately equally divided between mine employees and contractors. Miners from both districts indicated being away from work for approximately four days that coincided with the mean number of rostered days off. In addition, a small number of miners reported being permanent residents on the coast and travelled and lived in temporary accommodation near the mine site during the work period.

The impact of increasing contractor usage is associated with a decline in the regional population from 42,571 (1996) to 40,789 (2001). Data from the 2001 census estimated 28 per cent homes in some towns were either empty or abandoned (QPI & FU 2001). These data suggest that in general contractors are not living in the regional centres on a permanent basis. The larger contract labour companies are based in coastal regional centres. Therefore, contractors are required to travel to mine sites to perform work and live in temporary accommodation during the work period.

Changes in working practices have produced at least three categories of workers who regularly drive long distances. These are: a) employees residing in mining towns but regularly driving to the coast, b) employees permanently living at coast but travel to mining regions for the work period, and c) contractors permanently living at coast but travel to mining regions for the work period. The interest in this study is workers living outside of the mining towns who travel long distances to work and live in temporary housing whilst at work. These employees are considered to be a DIDOW.

A DIDOW has the potential to be exposed to a greater risk of driver fatigue. Increased driving accident risk has been linked to sleep loss (Maycock 1996), working hours (Akerstedt 1995), driving in the early morning hours (Di Milia 1998b) and distance driven (Rogers, Holmes & Spencer 2001). The literature on driver accidents consistently implicates sleep loss as a central factor. Fell and Black (1997) reported 57 per cent of drivers did not have a full night sleep prior to the accident. The key factors associated with sleep loss included long working hours, working night shift and driving to work in the early morning.

More recently Rogers et al (2001) concluded shiftworkers were more tired on the drive to and from the work place, and more at risk of falling asleep behind the wheel compared to day-workers. In particular, the drive home post night shift was associated with higher levels of sleepiness and driving impairment, and more so when longer distances were involved. The greatest number of falling asleep incidents occurred after night shift. Shiftworkers with less than 6-hours of sleep also reported more driving impairment. While night shift appears to be more problematic, it does not follow that day-workers are 'safe'. Rogers et al. reported 25 per cent of shiftworkers and 22 per cent of day-workers had fallen asleep in the previous 12 months. Similarly, Heslegrave, Rhodes and Gil (2000) examined a change from 9-hour to 12.5-hour shifts on a number of indicators including commuting. The frequency of lapses in attention, falling asleep at the wheel, near misses and accidents were all higher on the extended shift schedule for both shift types.

The aim of this study is to examine indicators of driver fatigue and incidents in a DIDOW. At present there is little if any, published material to inform employers and employees of the risks associated in using a DIDOW strategy.

Method

As part of a larger study, 48 employees were identified as DIDOW. Employees received a package that included a note describing the purpose of the survey, the survey and a return addressed envelope. The survey was voluntary and confidential. The survey collected biographical, work and travel details, sleep duration, estimates of driver fatigue (sleepiness) and driving impairment when travelling to and from work, and accident/incident involvement. The sleepiness scale was anchored; a rating of '1' = very alert and '9' = very sleepy (fighting sleep). The driving impairment scale was also anchored; a rating of '1' = never and '5' = always.

To account for the variability in leaving for work, three groups were formed: a) those departing home 03.00 – 04.15 am, b) those departing 04.30 – 05.30 am, and c) 'all others' - those travelling outside these time periods. The driving distances for these groups also showed large differences and therefore, analyses of sleepiness and driving impairment were weighted by driving distance. For these analyses all workers were considered since they were all driving at the same time of day. Analyses for return journey were examined by shiftworker and day-worker since the time of journey was significantly different.

Results

Surveys were completed by 24 male shiftworkers and 24 day-workers (male=22). The mean age for all workers was 40 years old and the age range was 19-62 years. All shiftworkers worked more than 10-hour and most worked 12-hour shifts. Shift changes were at 06.30 and 18.30. Day-workers completed five consecutive shifts with weekends off. Nine workers reported working between 10 and 12-hour shifts and 15 recorded working longer than 12-hour per day. Work commenced at approximately 7.00 am.

Results for driving to work

The overall mean distance was 238km. The distances and travel time to work are shown in table 2. These data suggest that the further the distance to work, the earlier the drive commenced. The 'all others' group left as early as 02.00 the day before the shift and drove up to 1300km to attend work. Others in this group left home from 08.00 and drove up to 1000km. An additional three employees travelled 100 to 2000km by bus but were not included for data analysis.

Table 2: Mean Distance Travelled and Travel Time from Home to start Day Shift.

Group	Distance (km)			Travel time (hours, minutes)		
	Mean	Min Value	Max Value	Mean	Min Value	Max Value
3.00 – 4.15	154	100	230	1.40	1.18	2.18
4.30 – 5.30	136	50	200	1.43	0.45	5.00
All others	454	90	1300	4.52	1.00	14.00
Overall	238	50	1300	2.39	0.45	14.00

The values for sleepiness and driving impairment whilst driving to work are shown in table 3. A significant difference was found between the means for the groups '4.30 – 5.30' and 'all others' ($p < 0.05$). This suggested that driving earlier and longer distances was associated with increased sleepiness and driving impairment. The overall unweighted mean for sleepiness and driving impairment ratings were 4.22 and 2.17 respectively.

Table 3: Mean Sleepiness and Driving Impairment by Time of Departing Home to commence Day Shift.

Group	Sleepiness			Driving Impairment		
	Mean*	CI Range**		Mean*	CI Range**	
3.00 – 4.15	4.14	3.07	5.21	2.26	1.69	2.83
4.30 – 5.30	3.66	2.33	4.98	2.10	1.40	2.81
All others	5.63	4.90	6.35	2.46	2.07	2.84
Overall	4.48	3.86	5.09	2.27	1.95	2.60

* Estimated mean weighted by distance travelled.

** Confidence Interval range

Six workers (13 per cent) reported falling asleep while driving to day shift in the previous 12 months. The number of fall asleep incidents and distances travelled were: a) 'once or twice'; 120 – 1300km, b) 'three / four'; 500 – 1000km, and c) 'more than four times'; 150km. The details are shown in Table 4. The type of accidents or incidents associated with falling asleep whilst driving to day shift included: run off road and shoulder, crossed the centre line and braked the car for no reason. These incidents were associated with getting up to 5-hour of sleep.

Table 4: Frequency of Falling Asleep when Driving to Day Shift

Group	Frequency of falling asleep			
	Never	Once or twice	Three / four	More than four
3.00 – 4.15	16	2	0	1
4.30 – 5.30	13	0	1	0
All others	12	2	0	0
Overall	41	4	1	1

Results for driving from work

The mean home arrival time was 09.48 (range 07.48 – 20.00) and 17.00 (range 03.00 – 23.00) for shiftworkers and day-workers respectively. The mean arrival time for day-workers suggested that employees left work earlier than normal on the last day since 63 per cent of the day-workers reported working more than 12-hour.

The values for sleepiness and driving impairment whilst driving home are shown in Table 5. For shiftworkers, mean sleepiness was higher ($p \leq 0.05$) after night shift (5.50 versus 3.78) compared to driving to day shift. Driving impairment was also higher ($p \leq 0.05$) when driving home after night shift (2.67 versus 1.92).

Table 5: Mean Sleepiness and Driving Impairment by Shift Type when driving to distant Home.

Shift Type	Sleepiness			Driving Impairment		
	Mean	CI Range*		Mean	CI Range	
Night	5.50	4.88	6.12	2.67	2.32	3.01
Day	4.50	3.91	5.27	2.25	1.85	2.65

* Confidence Interval range

The number of times the employee fell asleep when driving home in the previous year is shown in Table 6. Overall 23 per cent reported some degree of falling asleep. Shiftworkers were involved in more fall asleep events than day-workers. The type of accidents or incidents associated with falling asleep whilst driving home included: run off road and shoulder, crossed the centre line and braked the car for no reason. These events were associated with getting up to 5-hours of sleep for shiftworkers whereas DWM reported 6 to 8-hours of prior sleep.

Table 6: Frequency of Falling Asleep when Driving Home

Shift Type	Frequency of falling asleep			
	Never	Once or twice	Three / four	More than four
Night	18	4	2	0
Day	19	4	1	0
Overall	37	8	3	0

Discussion

The key argument in this paper suggested that changes in work schedule and a move to contract employment has created a DIDOW that has chosen to permanently reside in coastal central Queensland and work in the Bowen Basin. This research examined the travel patterns, associated driver fatigue and accident risk for a DIDOW. The safety of a DIDOW is an important issue for the industry, the employee and their families. Fatigued individuals are at greater risk of impaired cognitive functioning and react more slowly to driving demands (Lyznicki et al. 1998).

A risk management strategy for a DIDOW has to consider a number of features outside of the actual hours being worked. These include at least; the amount of sleep prior to

travel (Maycock 1996), time of journey (Di Milia 1998b), distance to be driven (Rogers et al. 2001) and the monotony of the task. Each of these variables serve to compound the issues associated with working hours alone.

Driving too early in the morning has two main difficulties. It requires driving when the body is most influenced by a biological sleep drive (Dinges 1995) and requires the driver to deal with the sleep inertia caused by early waking. The results clearly showed that driver fatigue ratings and driving impairments were higher with earlier driving start time. The 'all other' group seemed more at risk and the most likely explanation is that whilst there was much variability in the journey start time, this group on average drove the longest distance (454km) and included early journey start time. One shiftworker reported leaving home at 2.00 am and driving up to 1300km. The frequency of falling asleep at the wheel seemed to be linked to early morning departure and distance driven. Workers driving 500–1000km reported falling asleep three-four times in the previous 12 months. The type of sleep related incidents included crossing the road centre line, running onto the shoulder and leaving the road. These incidents were associated with having had less than 5-hours of sleep.

The drive home resulted in significantly higher reported levels of driver fatigue and driving impairment for both day-workers and shiftworkers than driving to work. In both cases, the results may suggest that the completion of work contributes to greater accident risk. However, night workers reported higher levels than day-workers. Night workers are at greater risk of driver fatigue due to a combination of several factors. These include a sleep debt across successive night shifts; tiredness from the work itself; driving long distances and undertaking a monotonous task. There did not appear to be differences by shift in falling asleep at the wheel. However, 23% of DIDOW reported falling asleep at the wheel when driving home compared to 13% when driving to work. The sleep related incidents were consistent with loss of concentration; run off road and shoulder and crossing the centre line. For shiftworkers, these incidents were associated with getting up to 5-hours of sleep whereas day-workers slept 6 to 8-hours.

These findings suggest employers investigate strategies to better protect workers from the risk of driving long distances post shift. These may include providing education, sleep facilities and/or assisting with transport. It is the case that in some mines sleep facilities are available but there is no requirement to make use of the facility.

This study has a number of limitations. The relatively small sample raises some question regarding the wider estimate of driver fatigue in a DIDOW. While a larger sample may provide a better estimate, the present results do suggest that driver fatigue is an issue for wider consideration. A second limitation is that a number of different work systems were combined for data analysis and this may have contributed towards minimising any differences between different forms of shiftwork and between shiftworkers and day-workers. Finally, total working hours were not identical between shift and day-workers so it may be possible that hours of work have confounded the results. Future studies should seek to use a larger sample and an experimental design to better control the number of variables in the relationship between a DIDOW and driver fatigue.

In summary, this study has argued that changes in work schedule and the use of contract labour has created a DIDOW. The results from this study suggest that a DIDOW is at

some risk of increased driver fatigue and driving impairment. The most likely factors include time of driving, prior sleep and sleep debt, the distance travelled and the monotony of the driving task over long distances. The results also indicated that end of shifts have a higher risk and more so for night shift. These findings suggest employers may need to consider strategies to assist DIDOW. Future follow up studies using larger sample sizes will provide more definitive data to guide the coal industry.

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