

# Extended Working Hours in Australia: Counting the Costs

Commissioned by the Department of Industrial Relations





WOOD PANEL PLANTS

# **Extended working Hours in Australia: Counting the Costs**

Commissioned by the Department of Industrial Relations

**REPORT 2001**

Written by Professor Drew Dawson, Kirsty McCulloch & Dr Angela Baker  
The Centre for Sleep Research, The University of South Australia



## Contents

|          |  |           |
|----------|--|-----------|
|          | Executive Summary . . . . .                                | 2         |
|          | Foreword . . . . .   | 5         |
| <b>1</b> | <b>Background Information . . . . .</b>                    | <b>9</b>  |
| 1.1      | The Changing Nature of Work . . . . .                      | 9         |
| 1.2      | Who Works Long Hours? . . . . .                            | 10        |
| 1.2.1    | Gender . . . . .   | 11        |
| 1.2.2    | Job Categorisation . . . . .                               | 11        |
| 1.3      | Reasons for Working Long Hours . . . . .                   | 12        |
| <b>2</b> | <b>Impact of Extended Hours of Work . . . . .</b>          | <b>14</b> |
| 2.1      | Reduced Sleep . . . . .                                    | 14        |
| 2.1.1    | Fatigue . . . . .  | 15        |
| 2.1.2    | Performance and Productivity . . . . .                     | 16        |
| 2.1.3    | Accident Risk . . . . .                                    | 25        |
| 2.1.4    | Reduced Safety . . . . .                                   | 27        |
| 2.2      | Reduced Social Time . . . . .                              | 29        |
| 2.3      | Health Consequences . . . . .                              | 29        |
| <b>3</b> | <b>Current Initiatives . . . . .</b>                       | <b>34</b> |
| 3.1      | Initiatives to Date . . . . .                              | 34        |
| 3.1.1    | Quantifying the Indirect Costs of Extended Hours . . . . . | 37        |
| 3.1.2    | Policy Initiatives . . . . .                               | 41        |
| <b>4</b> | <b>Conclusions . . . . .</b>                               | <b>46</b> |
| 4.1      | Economically Rational Approaches . . . . .                 | 46        |
| 4.2      | Potential Benefits . . . . .                               | 46        |
| 4.3      | Potential Disadvantages . . . . .                          | 47        |
| 4.4      | A Conceptual Framework . . . . .                           | 47        |
|          | References . . . . .                                       | 50        |
|          | Appendices . . . . .                                       | 63        |

## Executive Summary

Over the last two decades, the Australian industrial relations landscape has fundamentally changed. During this period, we have seen a significant divergence of the labour market. Approximately one third of Australian workers are now working significantly longer hours than the standard work week, and a quarter significantly less.

Recent labour market statistics from the Australian Centre for Industrial Relations Research and Training at Sydney University [ACCIIRT] indicate that approximately three in every ten Australian workers are working extended hours. Of this group, approximately one third are working between 45 and 50 hours per week, one third between 50 and 60 hours per week, and the remaining third greater than 60 hours per week. When compared with other OECD countries, Australia now has the distinction of having more people working more hours than all other member countries except the US.

While there is little doubt that these changes have been accompanied by increased flexibility of the workforce, many of these productivity gains are not without consequence. An increasing body of evidence addressing hours of work indicates that we are fast approaching, or may have already passed, the point of diminishing returns in many industries. This is particularly relevant for those working significantly more than 50 hours per week.

In this paper, we will argue that the extension of working hours, particularly for shiftworkers, has significantly reduced the amount of time available for sleep and social activities. For many Australian workers, their families and communities, extended working hours have led to increased levels of fatigue and decreasing levels of social support. This in turn has the potential to compromise safety and the long-term health and wellbeing of workers and the organisations that employ them.

Evidence from a number of occupations and industries suggests that the relationship between hours of work and productivity has changed. In the past, the relationship between hours spent at work and outputs was relatively uncomplicated. The more hours spent at work, the more an employee produced. Many of the tasks undertaken by employees were relatively unskilled and as such, refractory to fatigue related impairment. Similarly, traditional family structures and community expectations of workers made extended hours easier on the family as a whole.

However, with changing workplace demands, increasing automation, greater task complexity and rapidly evolving social roles, the relationship between hours of work and outputs no longer automatically follows. A significant body of research has now demonstrated declining workplace performance has been associated with extended hours. In addition, extended hours of work have also been associated with reduced employee wellbeing, reduced organisational commitment and poor health outcomes. These factors in turn have been linked to declining levels of productivity and workplace safety.

It is our belief that many organisations have directly benefited from the productivity gains associated with extended hours of work, while passing the indirect costs on to the community and taxpayer. In order to determine whether extended hours of work advantages Australia as a whole, or constitutes an indirect subsidy to industry, it is essential to recognise a broader conception of costs in our overall evaluation of working hours policy. Indeed, where extended hours of work result in a net transfer of costs to the community and taxpayer, it can be argued that such practices constitute anticompetitive behaviour.

To ensure that changes to the labour market advantage the country as a whole, it is essential that organisations are accountable for both the direct and indirect costs associated with extended hours of work. The difficulty, however, is how to regulate this issue while maintaining the flexibility and productivity gains associated with recent labour market reforms.

Over the last decade, several initiatives addressing extended work hours have been implemented in Australia and overseas. One of the most important initiatives has been the European Community Directive on Working Time. This is prescriptive legislation that attempts to control the consequences of extended working hours. Broadly speaking, this legislation limits hours of work to an average of 48 hours per week. In France, this threshold has been lowered to 35 hours per week.

Given the recency of this legislation, it would be premature to draw definitive conclusions on the impact of the legislation. Nevertheless, it is probably reasonable to suggest that prescriptive models carry significant advantages and disadvantages with respect to the stated goals of the legislation. While prescribing hours of work is likely to reduce many of the problems associated with extended hours, it can also introduce structural rigidities to the workplace. These rigidities may be particularly critical in a local context given the relative isolation and the disparate social circumstances particularly in many parts of regional Australia.

Given the diversity of Australian workplaces and the people within them, it is our belief that hours of work can be managed most appropriately at the enterprise or industry level. This has been a particular aim of the recent ACTU position on reasonable hours, which introduces a general standard of fairness with respect to the requirement to work extended hours. As such, the recommendations of the clause are appropriately aimed at industry as a whole. Although, in our opinion, the subsequent clauses operationalising that principle are relatively conservative and may not consistently achieve the stated goals of the first clause.

In our opinion, it may be difficult to define generalised prescriptive regulations that would suit all workplaces on all occasions without introducing significant structural rigidities. Nevertheless, we believe it may be possible to approach this issue in a way that maintains the flexibility of the labour market, but ensures accountability for the indirect costs associated with extended hours.

To this end, we suggest a conceptual framework based on outcome-based regulation. We suggest that it would be reasonable to embrace the general principle of 'reasonable hours' but to require it to be operationalised at the enterprise and/or industry level. That is, to permit extended hours, but within a framework that requires an individual organisation to present a coherent argument as to why working extended hours in a specific context does not disadvantage the community or compromise safety in their workplace. In essence, we recommend applying the 'no net disadvantage' principle using a broad notion of cost-benefit analysis. From this perspective we suggest that organisations or industries might define a threshold level of hours above which the onus falls on the organisation to demonstrate through risk management and other techniques, why it is reasonable for employees to work extended hours.

Where an organisation is required to develop an argument supporting working hours beyond a given threshold, it is important that the arguments address a broad notion of the direct and indirect costs and risks associated with extended hours. Thus, we believe it is important that organisations and the community explicitly acknowledge the indirect health, social and safety costs associated with extended hours of work. To this end, it is important that we develop quantitative models of the impact of extended hours on indirect costs. Put more simply, if we don't count it, it doesn't count.

Recent developments from a number of research groups from around the world now enable organisations to quantify and assess the impact of working hours on sleep and social opportunity. The use of these models would enable organisations to quantify, compare and model the potential impact of extended working hours. Such approaches will also enable regulators to develop industry-specific guidelines and performance indicators for the indirect costs associated with extended hours.

In conclusion, we believe that extended working hours carry significant advantages and disadvantages to the community as a whole. In order to ensure that labour market reforms continue to contribute to the overall wellbeing of all Australians, it is important that we acknowledge and balance these costs and benefits. Labour market reforms that improve short-term productivity at the expense of long-term community interests are clearly unsustainable and possibly anticompetitive.

To this end, we believe that the introduction of the general industrial principle of 'unreasonable hours' is justified. Indeed it constitutes a critically important step in achieving social justice and workplace equity in Australia. Similarly, we recognise that it may be difficult to justify simplistic prescriptive models as a means of managing unreasonable hours. On the other hand, it would appear reasonable to require individuals and organizations to examine the overall costs associated with extended hours and to demonstrate empirically why such work practices would be in the organizations and community's long-term interest. That is, to demonstrate publicly that such work practices produce 'no net disadvantage' to the long-term economic and social wellbeing of the organization and the Australian community.

**Professor Drew Dawson, Kirsty McCulloch & Dr Angela Baker.**

Centre for Sleep Research, University of South Australia, August 13, 2001



## Foreword

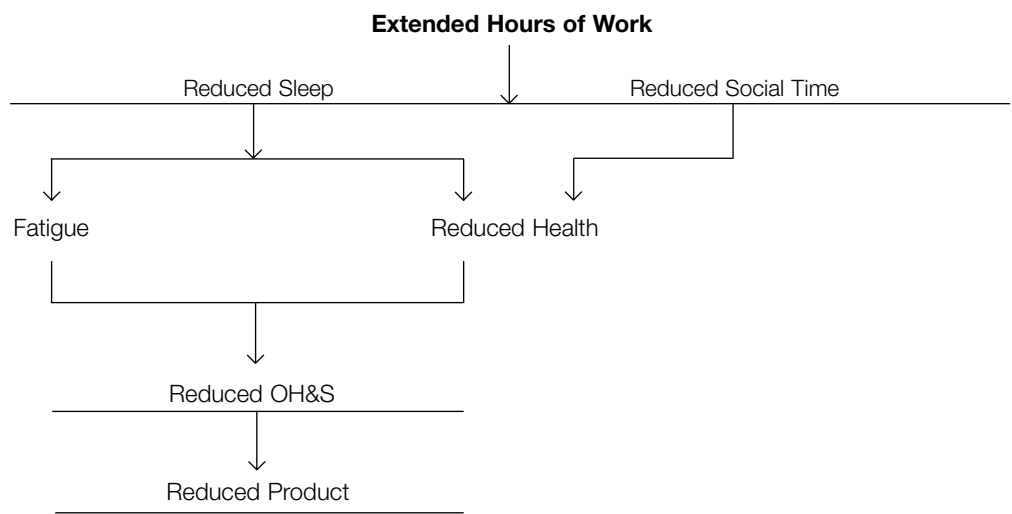
The Centre for Sleep Research has been contracted by the Queensland Department of Industrial Relations to prepare a report reviewing the impact of extended work hours on workplace safety and employee health.

Broadly speaking, the report addresses the following areas:

- Australian and international literature on the impact of extended work hours on workplace safety;
- the relationship between hours worked and fatigue;
- the impact of fatigue upon safety practices and occupational health and safety outcomes in the workplace;
- modelling of accident predictability used by some insurance companies;
- emerging rostering and shiftwork practices; and,
- links between current industrial relations practices and workplace negotiations over working hours and workplace safety.

The final section of the report provides advice and recommendations on reasonable work hours and related practices consistent with safe workplaces.

### Report Structure Diagram



## 1. Background Information

### 1.1 The Changing Nature of Work

Throughout the last century, the 'standard' working week consisted of work between 9a.m. and 5p.m., Monday to Friday (Allan, Brosnan & Walsh, 1998). In principle, standard work hours were considered those that did not intrude on the workers' premium social time on evenings and weekends. As such, the 8-hour working day evolved from the widely held belief that the 24-hour day should be split evenly between work, recreation and sleep (see for example: Rutenfranz & Knauth, 1976; Costa, 1997). While many take the 8-hour day for granted as a part of 'normal' life, such working conditions are a relatively recent industrial development.

While this is true, over the last two decades, the competitive pressure on corporate profitability and labour costs has resulted in a significant restructuring of the Australian labour market (Bielenski, 1998, 1999; Åkerstedt, 2000; Lowden & Åkerstedt, 2000; Gasparini et al., 1999). Alterations to the standard working week have been among the most important changes to the Australian industrial relation landscape over this period. As a consequence, the number of people working a full-time 'standard' week is now on the decline (Chambers, 1986; Hewitt, 1983; Sheehan, 1997; Morehead, 1999; Bosworth & Dawkins, 1980).

With the reduction of individuals working a standard working week (between 35-44 hours per week), two main trends have emerged. First, there has been a significant increase in the number and proportion of part-time employees (less than 35 hours per week) within the workforce. Indeed, the number of persons working part-time has increase by approximately 33% since 1981. Concurrently, the number and proportion of employees working extended hours (over 44 hours per week) has also significantly increased (Sabel & Zeitlin, 1997; Babbar & Aspelin, 1998; Lehndorf, 1998; Bielenski, 1999). Indeed, over the same period, the number of employees working extended hours has also increased from approximately 33% to 46%, indicating that just under one half of the full-time working population works extended hours. Moreover, between 1978 and 1996, the number of Australian employees working in excess of 60 hours per week increased from 3% to 7% (Heiler, 1998). This figure is the second highest in the developed world (Australian Council of Trade Unions - ACTU, 2001).

Figure 1 provides a clear view of the breakdown of work hours within the Australian labour force. Of the 9 million individuals surveyed, 8.3 million were employed, and 0.7million were unemployed. The figure is representative of the employed individuals. The figure shows the specific numbers and percentages of the workforce who are employed in extended hours, standard hours and part-time hours. Furthermore, for each category of employment, the figure distinguishes whether the workers are employed on a casual or permanent basis. More detailed information on this can be found in the Working Time Arrangements in Queensland paper, by Bretherton and colleagues (2001).

There are several reasons for lengthening work hours. From an industrial perspective, reasons include (Babbar & Aspelin, 1998; Parliamentary Inquiry, 2000):

- competition with lower labour costs from overseas;
- competitive pressure and consumer demands within the local economy;
- the impact of mergers; and,
- increased workloads due to downsizing and/or recession-induced cost cutting.

### 1.2 Who Works Long Hours?

Approximately 2.6 million Australian workers (29.6% of the labour force) work overtime on a regular basis. Furthermore, approximately 0.25 million workers (2.8% of the labour force) work full-time and have a second job (Harcourt & Kenna, 1997). Therefore, it is important to identify the sub-groups most likely to engage in long work hours.

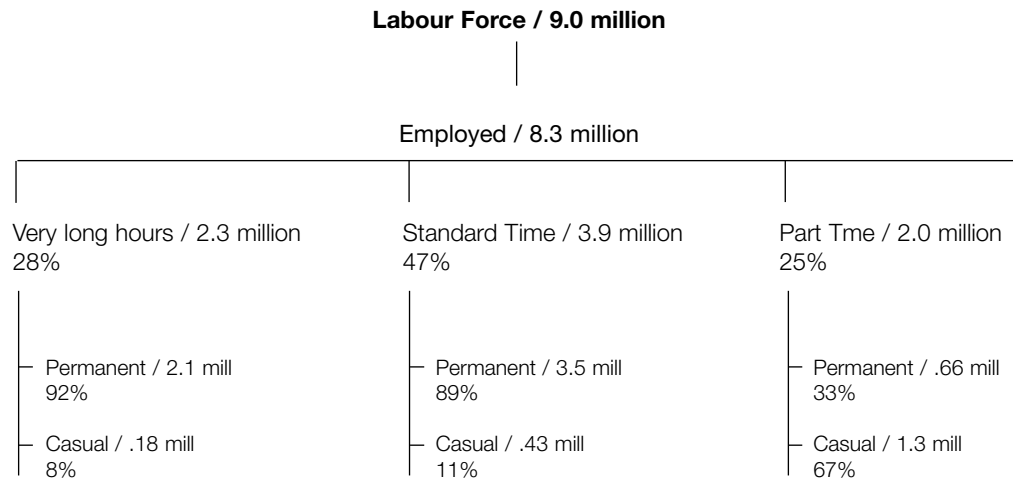


Figure 2: Proportions of work hours among the Australian labour force (ABS, 1997).

Participation in paid work varies greatly not just from place to place, but also according to individual circumstances and choice (Atkinson et al., 1999; Hecker, 1999). Indeed, many employees work long hours for a wide range of reasons. Characteristics of individuals working long hours vary greatly from one person to the next. However, some distinguishing characteristics can be seen, including:

- gender and
- job categorisation.

### 1.2.1 Gender

By and large, men work longer paid hours than women. Indeed, over the last 15 years, the number of males working over 49 hours a week has significantly increased (Morton, 1998). This was highlighted by a recent study, stating that 17% of full-time employed men work paid overtime in comparison to 6% of full-time women (Bretherton, Buchanan & Considine, 2001). This has also been noted in the United States. For example, research by Hecker (1999) found that:

- approximately 30% of men worked more than 44 hours per average week, 10% worked more than 54 hours; and,
- approximately 15% of women worked more than 44 hours per average week, 3% worked more than 54 hours.

However, the Australian Bureau of Statistics also found that for unpaid overtime, men and women worked similar proportions of 20% and 18% respectively (ABS, 1999).

### 1.2.2 Job Categorisation

In response to increasing hours of work, many commentators have suggested they are relatively industry specific and limited to certain occupations. Traditionally, long hours of work have been associated with blue-collar occupations. While this may once have been true,

longer working hours can now be found across the board. Indeed, standard hours tend to be specific to both blue-collar and white-collar occupations (Hecker, 1999). As such, extended hours tend to be most prevalent among managerial occupations, employers, the self-employed and blue-collar occupations (Bretherton, Buchanan & Considine, 2001).

### 1.3 Reasons for Working Long Hours

There are three main reasons individuals choose to work long hours:

- monetary gain;
- organisational and/or occupational expectation; and,
- personal satisfaction.

The most obvious reason for working long hours is monetary gain (Belgum, 2000). Typically, the more hours people work, the more they earn (Hecker, 1999). In recent years, declining real pay rates mean that many workers now manage their daily family budget through dependence on overtime and shift premiums (Nishiyama & Johnson, 1997). Others simply enjoy the freedom that extra money gives them outside work (Babbar & Aspelin, 1998). A quote by Watts (1972, p57) sums it up perfectly:

'We therefore work, not for work's sake, but for money - and money is supposed to get us what we really want in our hours of leisure and play' (Watts, 1972, p57).

In reality however, only a third of Australian labourers working overtime or extended hours receive remuneration for these additional hours (Harcourt & Kenna, 1997). The remaining two-thirds receive time-off in lieu provisions, or work longer hours for reasons other than finance. For example, many work long hours due to the declining nature of job security, whereby an employee may be 'laid off' for not contributing the appropriate volume of hours.

An additional reason for working long hours may be to maintain a professional image. Many organisations continue to measure employee value by inputs. That is, by hours worked rather than by outputs. Indeed, extremely long hours of between 50 and 60 hours per week are frequently viewed as indicating loyalty and commitment to the organisation (Morehead, 1999). In many cases, these long hours can consume most waking hours and dominate workers' lives. While some employees work long hours as a voluntary expression of dedication, others feel it is expected of them and an implicit criterion for promotion or job retention (Babbar & Aspelin, 1998).

Some individuals choose to work long hours for reasons beyond monetary gain or company image. Indeed, various studies indicate work has a large influence over self-esteem (Csikzentmihalyi & Le Feure, 1989; Pugliesi, 1995; Mutran, Reitzes, Bratton & Fernandez, 1997; Peetz, Gardener, Brown & Bens, 1999), self-identity (Beck, 1994; Pease & Wilson, 1991), self-worth and belonging (ABS, 1997; Dempsey, 1997); social status (Grint, 1991; Beck, 1994; Casey, 1995) and wellbeing (Gramm, 1987; Makowski, 1995; McEwin, 1998). As such, individuals may only work to prove their personal worth. This is true even when longer hours have no impact on salaries or professional promotion (Morehead, 1999).



## 2. Impact of Extended Work Hours

While the 24-hour society has been effective in producing greater productivity and a higher level of competition within business, it has come at a cost to the individual and community. As work hours increase, the individual compensates for the increased time spent at work by reducing the amount of time allocated to sleep and social activities.

Not surprisingly, as hours of sleep are reduced, the individual begins to accumulate a sleep debt. As such, fatigue levels rise, leading to detrimental effects on both health and performance. Similarly, as the amount of time available for social activities declines, so will employee engagement in family and community activities. In the majority of cases, a range of deleterious consequences accompanies this disruption of social and community responsibility. The following sections will focus upon the effects of decreased sleep and social opportunities on the health, safety and wellbeing of employees.

### 2.1 Reduced Sleep

Long work hours are widely accepted in the research literature as a major contributor to fatigue (Åkerstedt & Gillberg, 1980; Carey & Fishburne, 1989; Arnold et al., 1997; Buchanan & Bearfield, 1997; Burton & Turrell, 2000; Parliamentary Inquiry, 2000). Indeed, research findings show that as hours of work increase, sleep is reduced with a concomitant elevation in fatigue and reduced levels of alertness (Carey & Fishburne, 1989). This results from both the increased fatigue due to longer hours of work and decreased sleep opportunity [i.e. recuperative time]. As such, once employees work more than 48 hours per week, the increased competition between sleep and other activities of daily living results in significant reductions in sleep (Dawson, 1997).

Not surprisingly, long hours and shiftwork patterns frequently result in sleep of limited quality and duration (Mitler et al., 1988; Fischer et al., 1993, 2000; Peternitis, 1980). For example, a major study by Heslegrave and colleagues (2000) found:

- workers slept significantly less on a 10-hour shift routine than an 8-hour shift routine;
- for 10-hour day shifts, workers reported significantly less refreshing sleep, of diminished duration; and,
- workers slept longer on their days off compared to when they are working.

The amount of sleep obtained as a function of hours of work can be further reduced depending on the timing of the work and sleep periods. Shiftworkers as a group obtain significantly less sleep than those working equivalent hours that do not intrude on the typical sleep period [2300-0700h]. A considerable body of evidence has demonstrated that shiftworkers obtain significantly less sleep than matched controls (i.e. those not working shiftwork). In laboratory studies and in field data from a range of shiftworking industries, sleep quality and duration have been linked to the timing of sleep relative to the internal biological clock. (Maruyama et al., 1995; Caldwell & Gilreath, 2001; Åkerstedt & Gillberg, 1980). In general, sleep at inappropriate biological times reduces the quantity and quality of that sleep. Thus, shiftwork reduces sleep by increasing competition between social activities, and the associated daytime sleep is substantially reduced in duration, quality and recovery value compared with night sleep.

#### 2.1.1 Fatigue

Although there are no widely accepted definitions of fatigue, several have been proposed. Åkerstedt (2000), suggested that 'fatigue is often used as a synonym for drowsiness, sleepiness and tiredness'. Another definition (Bourgeois-Bourgrine et al., 2000) considered fatigue as a range of manifestations stimulated by a sustained effort. These manifestations included

subjective feelings of sleepiness and a reduction in performance. In summary, this definition considers fatigue as a mental state that results from insufficient recuperative sleep. Over the last 50 years a substantive body of human research has linked this mental state to objective and subjective measures of impaired neurobehavioural performance (Taub & Berger, 1973; Kjellberg, 1977; Angus & Heslegrave, 1985; Dinges & Barone-Kribbs, 1991; Belensky et al., 1994; Angus et al., 1995; Blagrove et al., 1995; Pilcher & Huffcutt, 1996; Baranski & Pigeau, 1997; Williamson & Feyer, 2000).

In this report we suggest that there is a simple relationship between extended hours of work and safety. That is, extended hours of work lead to reduced amounts of sleep. The reduction in sleep has been associated with increased levels of fatigue and reduced alertness. High levels of fatigue and/or reduced alertness have been associated with:

- reduced workplace performance and productivity; and
- increased risk of accident and injury.

### 2.1.2 Performance and Productivity

The relationship between extended hours of work and productivity is a complex one. There is a general historical and cultural value system from which our understanding of hours of work emerges. It has been suggested that the essential belief system that underlies this discussion is based on religious artefact. In many developed societies there is a general belief that the more hours we work, the more 'productive' we are to the organisation. The historical bases for this perception are difficult to deconstruct. In European cultures it is thought to reflect the historical traditions associated with the Protestant work ethic and the nature of work as it has evolved since the industrial revolution.

Historically, the Protestant work ethic derives from the postmedieval belief that hard work and discipline increases the likelihood that one will go to heaven. In essence, heaven was constructed as the 'reward' for long and dutiful commitment. This cultural value has been further reinforced by the nature of work. Since the industrial revolution, work has become increasingly independent of the physical environment. In agricultural societies, the timing and distribution of work was driven by the seasons and the day/night cycle. Work was frequently linked to seasonal and daily rhythms in food gathering and agrarian activities.

As work became industrialised, the higher capital costs and investments associated with machinery and equipment meant that workplaces were increasingly operated on a 24 hours a day/7 days a week (24/7) basis to ensure profitability. Up until the late twentieth century, much work was relatively unskilled and increased hours of work did not necessarily impact negatively on work performance. Much of the research has indicated that many typical workplace skills are relatively refractory to fatigue and there is little performance impairment provided an employee can maintain wakefulness.

On the other hand, in the last 20 years, workplaces have become increasingly complex from a cognitive perspective with fewer employees engaged in tasks that are more susceptible to the effects of fatigue on performance. Therefore, the relationship between marginal productivity and hours of work has started to breakdown. Increasingly the economy is creating jobs/tasks that require much higher levels of alertness.

For many organisations, traditional costing models have looked at the optimum mix of ordinary hours and overtime and have assumed that productivity is maintained regardless of the number of hours worked per week. Recent studies suggest that this model may be increasingly inappropriate as the cognitive demands of work increase.

For example, many companies justify overtime on a purely economic basis. It is considered a greater direct expense to the company to hire an additional employee to relieve workloads than to have existing workers work for longer periods. As such, there is no expense of additional training and less employee administration. Furthermore, a payroll tax based upon the number

of employees rather than hours worked, is more likely to increase the incentive to keep employee numbers down but hours up (Harcourt & Kenna, 1997).

At the superficial level, having few employees working long hours appears financially beneficial to companies. However, the research indicates otherwise. Indeed, the specific impact of extended hours on fatigue and subsequent performance and productivity has been well documented throughout the last few decades (Taub & Berger, 1973; Herscovitch et al., 1980; Dinges & Barone Kribbs, 1991; Dinges et al., 1997; Bruck & Pisani, 1999; Jewett et al., 1999; Lamond & Dawson, 1999). Such studies have shown that employee productivity per hour for 10- to 12-hour shifts is significantly lower than for an 8-hour shift. For example, one study by Heslegrave et al. (2000), found workers on 10-hour shifts reported significant performance impairment for alertness, memory and attention compared to 8-hour shifts.

A comprehensive review by Harrison & Horne (2000) discusses the effect of sleep deprivation associated with long working hours on performance. In this review, the authors highlight nine dimensions of workplace performance susceptible to the effects of fatigue, including:

- the ability to comprehend complex situations without distraction;
- monitoring events and improving strategies;
- risk assessment, and accurate prediction of consequences;
- thinking laterally and being innovative;
- personal interest in the outcome;
- controlling mood and behaviour;
- monitoring personal performance;
- recollection of timing of events; and,
- effective communication.

#### *2.1.2.1 The ability to comprehend complex situations without distraction*

This concept involves processing substantial amounts of data within a small time. The lack of focussed attention associated with sleep deprivation is likely to reduce the efficiency of such processing. Indeed, studies have shown sleep deprivation to heighten visual and auditory distraction in tasks (Hockey, 1970; Norton, 1970; Blagrove, Alexander & Horne, 1995) and diminish subject discrimination in dealing with ambiguous material (Blagrove, 1994, 1996). Blagrove (1994, 1995) also found that individuals become less assertive and more easily influenced by leading comments when sleep deprived. Using a simulated marketing game (described below), Harrison and Horne (1999) also found that after one night of sleep deprivation, individuals lost attention during decision making to miniscule details that had no impact on the situation outcome.

In the past, sleep deprived individuals have been shown to perform normally on intelligence tests (Percival, Horne & Tilley, 1982; Webb, 1986). Hence, task complexity may not have been a contributing factor to performance in these studies.

#### *2.1.2.2 Monitoring events and improving strategies*

A study using simulated team-based activities, examined the effect of sleep deprivation associated with up to 80 hours of constant work on military soldiers (Bandaret, Stokes, Francesconi, Kowal & Naitoh, 1981). Results showed that subjects became distracted from critical tasks after 36 hours, neglecting to update their maps upon instruction, and took longer on tasks that had been dealt with quickly before. The authors found similarities between these results and a friendly-fire incident during Operation Desert Storm, in which fighter pilots destroyed US military vehicles from the same unit. The Operation Desert Storm event resulted from the pilots failure to update their position maps, leading to disorientation and confusion. Prior to the event, the pilots involved had experienced 48 hours of restricted sleep.

Two further studies by Wimmer, Hoffman, Bonato and Moffit (1992) and Horne (1988a) examined the effects of sleep deprivation on innovative strategies in decision making. Sleep deprivation was shown to cause significant impairment on planning tasks that required the use of innovative decision making approaches. An additional study by Herscovitch, Stuss & Broughton (1980), using the Wisconsin Card Sorting Task, found that partially sleep deprived individuals were unlikely to alter their strategy, even when their technique was obviously not working.

#### *2.1.2.3 Risk assessment and accurate prediction of consequences*

To date, little research has assessed risk in terms of consequences or cost-benefit analyses. However, indirect evidence suggests that fatigued individuals are more likely to engage in risk-taking behaviours. For example, a study on driving behaviour during extended journeys (Brown, Tickner and Simmons, 1970), found that fatigued individuals were more likely to use dangerous overtaking manoeuvres. It was noted that such behaviour could be confused with a general deterioration of driving skills caused by fatigue. Furthermore, drivers did not become more cautious with increasing fatigue, which might be generally expected under such conditions.

Harrison & Horne (1998b) have reported similar findings: that sleep deprived individuals were less concerned about negative outcomes when offered possible reward. Participants were presented with a simulated gambling situation, where four packs of cards were displayed face down on a computer screen. Subjects were informed that the majority of cards carried rewards, while only some carried penalties. The obvious aim was to accrue as many points as possible by choosing any card from any pack. By and large, success was determined by individual ability to select cards on a cost-benefit analysis. Non-sleep deprived individuals successfully avoided the packs with the lowest chance of winning, choosing cards with low rewards, but accruing an overall profit. On the other hand, sleep deprived individuals were not affected by heavy losses, continuing to draw from the high-risk decks.

#### *2.1.2.4 Thinking laterally and being innovative*

In 1987, a study by May & Kline monitored the performance of sleep deprived military personnel on a series of tasks, both with and without the presence of additional physical fatigue. The tests included embedded figures, verbal fluency, ideational fluency, inductive reasoning, spatial ability, short-term memory, basic arithmetic, logical reasoning, and flexible thinking. While the participants performed well on convergent tasks, innovative thinking and the generation of ideas showed obvious deterioration. These latter skills are essential in dealing with complex and unpredictable situations.

Harrison and Horne (1999) developed Masterplanner, a marketing strategy simulation game. The main goal for participants using the game is to promote sales for a given product and, in the end, achieve domination over the market, accruing sizeable profits along the way. Throughout the game, the individual is required to continuously remember changes that take place. As such, the game requires a connection between the learned skills needed to play the game, and more spontaneous abilities to respond to unfamiliar or unusual circumstances. Each session lasts for one hour, at the start of which participants review the decisions made in their last game with an understanding of their current position. As individuals progress through the sessions, Masterplanner becomes increasingly difficult, producing harder challenges for the individuals. Following 36 hours of sleep deprivation, most participants were unable to cope with the demands of the programme and became bankrupt. That is, when given two different options to choose from, sleep-deprived participants consistently opted for one choice, even when it was clearly causing them to lose the game. In contrast, non-sleep deprived controls performed well, altering their choices appropriately in order to win the game, and continued to do so in further sessions if required.

#### *2.1.2.5 Personal interest in the outcome*

Studies have shown that compensatory effort can be effective in maintaining performance in experimental settings (Horne & Petitt, 1985; Wilkinson, 1965). Kjellberg (1975, 1977) suggested that the decrements found in dull, lengthy tasks are likely to reflect a lack of interest in performing well. In addition, other motivating factors have been suggested to interact with sleep deprivation in maintaining vigilance type performance (Lester, Knapp & Roessler, 1976; May & Kline, 1987). A study on retention of numerical patterns in sleep-deprived subjects found that following sleep deprivation, a sense of futility interferes with the willingness to apply effort (Kjellberg, 1975).

#### *2.1.2.6 Controlling mood and behaviour*

A recent meta-analysis of sleep deprivation studies by Pilcher and Huffcutt (1996) considered 56 investigations. Thirty-seven were excluded from the analysis because of insufficient details or methodological reasons. Hence, the 19 remaining studies were compared in terms of consistency of findings and size of effect. Results of the meta-analysis found that the strongest consistency was in mood changes rather than cognitive or motor performance. However, due to the exclusion of high-level processing studies in the selection criteria, the specific impairment of mood states is still unclear. Nevertheless, as argued by Angus, Heslegrave and Myles (1995), complex and demanding tasks tend to effect individual mood states more profoundly during sleep deprivation.

Mood states and behaviours, including lack of regard for normal social conventions, childish humour, impatience, irritability and inappropriate interpersonal behaviours have all been described anecdotally in experimental settings of sleep deprivation (Horne, 1993). The childish humour associated with sleep deprivation was discussed over four decades ago by Bliss, Clark and West (1959) and Kollar, Slater, Palmer, Doctor & Mandell (1966). Bliss and colleagues (1959) noted that 'several [participants] passed through periods of giddiness and silly laughter like addled drunks, when their behaviour became uninhibited' (p354). As such, the behaviours appear to result from the relaxation of social inhibition, which may in turn result from the effects of sleep deprivation on the prefrontal cortex (Horne, 1993). In an applied setting, such behaviours could influence other effects of sleep deprivation. For example, aspects of language and communication failures between individuals could well be influenced by mood states.

In a study of soldiers on 'early call' trials, Haslam (1984) found that participants became quieter and compliant. However, the author was concerned with the finding that as sleep deprivation increased, officers resigned their leadership roles, concentrating instead on personal survival. As such, patrols' motivation to forward plan was reduced and when faced with group tension, behavioural disinhibition increased, which was deemed to be affected by sleep deprivation (Haslam, 1984).

Additionally, research has shown that sleep deprivation has a mood-enhancing effect on depressed patients. Indeed, one night of sleep deprivation has been associated with significant mood enhancement for up to 60% of patients. Some effect has been observed with partial sleep deprivation of four hours per night (Wu & Bunney, 1990). While the results are limited to depressed patients, the findings encourage further research on the milder effects found in normal sleep deprived individuals.

#### *2.1.2.7 Monitoring personal performance*

Research has shown that having insight into personal performance is essential to stop recurring errors. In laboratory settings, performance feedback is considered a critical factor in motivating subjects to perform well. In applied settings however, immediate feedback is seldom available.

Therefore, those decision makers who rely on their own performance assessment raise doubt about their ability to perform effectively when they are sleep-deprived.

Sleep deprivation has been associated with an impairment of low-level tasks, including visual perception, vigilance, reaction time and mental arithmetic. Furthermore, it has a bearing on mood factors and the usage of some psycho stimulants designed to alleviate subjective sleepiness. Baranski and Pigeau (1997) reported that when treated with 20 mg of d-amphetamine or placebo, individuals accurately monitored their decline in performance. In contrast, 300mg Modafinil (a new, nonamphetamine-based psycho stimulant) led to overconfidence in performance ability. A related study by Bard, Sotillo, Anderson, Thompson & Taylor (1996), reported that when administered Modafinil, sleep deprived individuals became more blasé during communication and took risks by failing to use confirmatory feedback. In conclusion, Bard et al. (1996) suggested that although individuals overestimated their own competence, they did not lose sight of their objectives.

To date, little research has studied self-monitoring in relation to complex tasks. However, a recent study by Harrison & Horne (2000) found that sleep deprivation in a temporal memory task created greater confidence in ambiguous responses than without sleep deprivation.

#### *2.1.2.8 Recollection of timing of events*

Sleep deprivation has been shown to specifically influence memory for when events occur (temporal memory). This was first observed in 1960 by Morris, Williams and Lubin who noticed that the participants in a sleep deprivation study could recall what they had eaten for meals but not when. Forty years later, Harrison and Horne (2000) replicated these findings, reporting that although sleep deprived individuals could remember details about events, they were unable to remember their recency or timing. Neuropsychological studies have shown that this timing element is determined by frontal lobe functioning (Milner, Corsi & Leonard, 1991). Sleep deprivation may confuse individuals when remembering serial ordering of facts, events, instructions, or encounters with colleagues.

#### *2.1.2.9 Effective communication*

Sleep deprivation is likely to have an effect on interactive communication due to associated insufficiencies in language processing. Indeed, after only one night of sleep deprivation, research has indicated qualitative changes in word articulation (Harrison & Horne, 1997). Similarly, Whitmore and Fisher (1996) found that specific voice qualities were influenced by sleep deprivation. In studying a four man bomber crew over a 36-hour exercise, researchers found that the voice displayed reduced intonation and a slowing of speech. In addition, they noted a strong circadian influence in voice articulation.

Schein (1957) simulated a message transmission task to explore communication skills. In the first task, subjects were required to describe an intricate visual arrangement, specifically conveying the spatial relations between objects. The message was transmitted to a partner, whose job it was to construct the unseen arrangement, based entirely on the message. Problems began to appear after 55 hours of sleep deprivation, with both the sending and receiving of messages. The author noted that those with 'high intellectual ability' had the most difficulty, but offered no explanation. It was observed that during sleep deprivation, subjects 'dropped the intensity of their voice, paused for long intervals without apparent reason, enunciated very poorly or mumbled instructions inaudibly, mispronounced, slurred or ran words together and repeated themselves or lost their place in the sequence' (p250). Similar observations were made by Morris and colleagues (1960), who noted that sleep deprived individuals became difficult to understand due to a heightened rate of speech errors, mispronunciations, and repeating themselves. Given these findings, it is surprising that so little attention has been given to this area in recent years.

In a study by Angus and Heslegrave (1985), sleep deprivation was found to increase response reaction time to received messages in a setting of constant distraction. To date, this topic has received little attention within applied settings. However, a study by Neville, Bison, French and Boll (1994) reported that sleep deprivation increased inaccuracies in sending and receiving messages in US military aircrew.

One of the first signs of sleep deprivation upon language is impairment in word retrieval (Harrison & Horne, 1997; Horne, 1988a; May & Kline, 1987; Tilley & Warren, 1984). Indeed, a study by May and Kline (1987) demonstrated that soldiers struggled with word generation after two nights of sleep deprivation. In a task requiring participants to generate words from a letter prompt, Horne (1988a) and Harrison and Horne (1997) found an effect similar to that observed under conditions of sleep deprivation. When sleep deprived individuals stayed within a specific category, they showed less spontaneity and flexibility in word retrieval. Harrison & Horne (1997) further examined this effect, requiring subjects to dramatically read sections from a story with the appropriate intonation. After 36 hours of sleep deprivation, voices were judged to be more monotonic, making it easy for naïve judges to detect higher levels of fatigue.

Harrison & Horne (1998a) further investigated sleep deprivation on language flexibility using a language inhibition task (the Haylings Sentence Completion task). The task was comprised of two parts. The first task required participants to complete a verbally presented sentence with the predictable last word. For example: 'Father carved the turkey with a sharp...' where 'knife' was the correct answer. In the second task, participants were presented with the same style of incomplete sentences, however, they had to say an inappropriate single word ending. After 36 hours of sleep deprivation, participants became particularly impaired on part two of the test, responding more often with either the meaningful completion or a semantically related completion. Sleep deprivation also led to longer response times during the second task.

In summary, sleep deprivation has been shown to influence speech through a reduction in verbal spontaneity and word retrieval. It also has a tendency to alter articulation and other voice characteristics. Furthermore, sleep deprived individuals are less willing to convey factual details, feeling that it is not important for their colleagues to know about them. In combination, these factors can greatly impair the conveyance of ideas between colleagues, particularly in conversational flow. This may be particularly relevant to situations where the decision maker cannot be at the scene of action, and is required to control from a distance, receiving and distributing information as needed (Flin, Slaven & Stewart, 1996).

#### *2.1.2.10 Summary*

Each of the cognitive skills mentioned above are widely applicable across many if not all occupations. Many of the studies cited indicate specific and general effects of fatigue on workplace performance and/or the component skills that underlie most workplace activities.

While the studies cited point to significant effect of fatigue upon performance, it should be noted that the majority were simulated studies. That is, the studies were conducted outside of the actual workplace, in simulated environments. Studies measuring performance within actual workplaces are extremely rare. Data within such a real-life situation has been complex to quantify and measure, as the technology to do so has not yet been developed. While such technology is under construction to conduct the research, however, we must realise that lack of field data does not purport a lack of effect for fatigue. Indeed, the performance and safety detriments that have been identified by the simulated studies lay grounds for action in determining the costs and benefits of related working hours.

In addition, long working hours have been shown to contribute significantly to increasing disability claims, reducing employee productivity and increasing absenteeism (Mulcany, 1991; Philip et al., 2001). The cited studies clearly support the argument that extended hours of work may not be a sustainable work practice. It may be the case that extended hours of work may

provide a limited short-term benefit to the organisation and/or community but that these productivity gains may be outweighed by the longer term costs associated with absenteeism, staff turnover and disability claims related to stress and burnout.

There are many in the community who would argue that the preceding paragraphs reflect a radical view of the changing nature of the workplace. Nothing could be further from the truth. For example, as far back as 1912, Josephine Goldmark postulated that working long hours is not only inhumane, but is probably also economically irrational for businesses.

### 2.1.3 Accident Risk

In addition to reducing company productivity and employee performance, high fatigue levels have been shown to increase accident risk (Lauber & Kayten, 1988; Carey & Fishburne, 1989; Yedida et al., 1993; Green, 1995; Rosekind et al., 1995; Smith, 1996; Revicki et al., 1997; Hanecke et al., 1998; Nocera & Strange-Khursandi, 1998; Epstein et al., 2000; Gander et al., 2000; Kinn et al., 2000; Kitahara et al., 2000; Parliamentary Inquiry, 2000). Indeed, there are numerous examples of accidents and incidents on roads, railways, at sea and in the air where human fatigue is cited as a major contributing factor.

Over the last decade, much research has explored the risks and dangers of fatigue. Specifically, studies show an exponential increase of accident risk beyond the eighth hour at work (Hanecke et al., 1998). One study by Nachreiner and colleagues (2000) collected four years of data on the incidence of fatal accidents and work hours from both a workers' compensation board and an occupational health and safety board. Results found significant increase in fatal accidents beyond the 9th hour of work. The authors conclude with an argument against the extension of the 8hour workday, and furthermore to limit companies' and individuals' ability to alter the length of working day outside of safe limits.

Accidents are not only a risk at work, but also in transit between work and home. Employees working long hours are likely to be driving home from work having accrued a significant sleep debt. Furthermore, sleep restricted individuals operating motor vehicles may be subjectively unaware of their degree of sleepiness (Phillip et al., 1997; 1999) or the increased likelihood of unanticipated sleep onset (Horne & Reyner, 1995; Arendt et al., 2000). Over the last two decades numerous studies of fatigue related accidents in road transport indicate that between 10 and 40% of road accidents involve driver fatigue as a primary or major contributory factor (Shafer, 1993: 10-40%; New South Wales Roads and Traffic Authority, 1994: 16.9%, 1995: 17.7%; Horne & Reyner, 1995: 20-25%; Maycock, 1995: 5-15%). While there are some studies that place the percentage significantly lower or higher than 30%, most literature reviews and consensus reports agree that this figure is derived from relatively stringent criteria.

Methodologically these studies are most likely to detect accidents where the driver fell asleep. The research literature suggests that fatigue related errors are common well before the point at which an individual can no longer sustain wakefulness. Thus, the fatigue studies are likely to be a conservative estimate of the overall incidence of fatigue related accidents. In reality, the actual contribution of fatigue to transport accidents may be even higher.

In addition to studying the direct link between accidents and fatigue, the cognitive impairment thought to mediate the relationship has been well researched. Major findings show mood, attitude and cognitive performance, such as judgement and competence, deteriorate with sleep loss (Epstein et al., 2000; Nocera & Strange-Khursandi, 1998). Moreover, research shows fatigue is four times more likely to be a cause of workplace impairment than drugs or alcohol (Parliamentary Inquiry, 2000; Åkerstedt, 2000).

In a landmark series of studies, the effects of fatigue on cognitive performance have been compared using alcohol intoxication as a positive control (eg. Dawson & Reid, 1997; Fell, 1998; Fairclough & Graham, 1999; Lamond & Dawson, 1999; Williamson & Feyer, 2000). The purpose behind these studies has been to provide policy makers and regulators with an easily grasped

index of the relative impairment associated with fatigue.

Indeed, the effects of increased levels of fatigue on human performance and the community are profound. Research has demonstrated that fatigue-related impairment is not dissimilar to the effects of moderate alcohol intoxication. In humans, fatigue delays response and reaction times, negatively impacts on logical reasoning and decision making and impairs hand-eye co-ordination - all critical safety issues in the workplace. A significant body of research has concluded that fatigue is rapidly emerging as one of the greatest single safety issues now facing industry.

#### **2.1.4 Reduced Safety**

In the previous sections, it has been argued that extended hours of work reduce the opportunity to obtain sufficient sleep. The reduced opportunity and amount of sleep obtained leads to increased levels of fatigue and reduced alertness. It has also been argued that moderate levels of sleep loss (in the order of 1 to 2 hours per day) can lead to cognitive impairment equal to or greater than that associated with proscribed levels of alcohol intoxication. It will now be argued that the cognitive impairment associated with fatigue increases the accident and injury risk of employees.

It is important to understand that fatigue in and of itself is not the key problem. In actual fact it is the risks associated with fatigue impairment that cause accidents and injuries. As such, fatigue is a context-dependent safety hazard. This is an important distinction since fatigue can carry significant risk in some situations and little or no risk in others. For example, in some cases, fatigue induced impairment and accidents may be inconsequential, creating only minor delays in completing a task, or may be detected by failsafe systems. In other situations however, the risks of equipment damage, personal injury and public safety can be far greater. Indeed, the consequences of fatigue related accidents can be catastrophic. For example, fatigue is considered to have played a role in several major industrial accidents, including the Exxon Valdez oil tanker grounding in Alaska, and the Three Mile Island nuclear partial meltdown disasters (National Transport Safety Board, 1990; United States Nuclear Regulatory Commission, 1979).

Within Australia fatigue is increasingly being recognised as a safety issue of the highest priority to the community (Parliamentary Report, 2000). It is our belief that extended hours of work are one of the principal contributory causes of sleep loss and subsequent fatigue related accidents and injuries.

'Fatigue is not just an industrial issue to be negotiated between employers and employees. It is also an occupational health and safety issue, a commercial issue, a public safety issue and, at times, an environmental issue. Individuals and organisations that fail to manage fatigue sensibly, risk having or creating accidents with a broad range of damaging and enduring consequences' (Parliamentary Inquiry, 2000, p1).

#### **2.2 Reduced Social Time**

In the previous sections we have argued that extended hours of work reduce the opportunity for sleep and the amount obtained. In addition, extended hours of work can also reduce the opportunity for social activity, and the amount undertaken. A significant body of research over the last few decades suggests that the reduction in access to social opportunity plays an important role in mediating the social and health impacts of extended hours of work.

A recent ACIRRT report (Bretherton, Buchanan & Considine, 2001) also depicted extended working hours as impinging on family time. Indeed, US research cited in the report revealed that children require more time with their parents. More importantly, they want their parents to have energy and to be in a good mood state rather than be exhausted from work.

In simple terms, the primary effects of extended hours are a reduction in social interactions and isolation of the individual worker from normal social and community support systems.

One major consequence of reduced social time is a diminished sense of social support. Indeed, a Department of Industrial Relations (DIR) survey found dissatisfaction among many workers with the balance between their work and family responsibilities (Harcourt & Kenna, 1997; Babbar & Aspelin, 1998). Furthermore, studies have shown long working hours to have an adverse impact on individuals' family relations (Bosworth & Dawkins, 1980; Costa, 1996).

Further detail on social support and the psychosocial impact of long working hours is given in Appendix A.

### 2.3 Health Consequences

In addition to the consequences of lack of sleep, much research has been attributed to the consequences of reduced non-work time (eg. Costa, 1996, 1997; Bosworth & Dawkins, 1980; DIR, 1994; Nishiyama & Johnson, 1997; Tamaki, 1998). As such, achieving a balance between sleep, social activities and work is considered essential for an individual's health and wellbeing (Primeau, 1995; Argyle, 1996).

Furthermore, reduced social time often compromises a 'healthy lifestyle'. While it is difficult to point to a specific disease state associated with extended hours of work, there are clearly established relationships between extended hours of work and a constellation or cluster of 'lifestyle' diseases. In a sense, the archetypal overworked Australian employee was best illustrated by the character immortalised in 1980s public health campaigns: 'Norm'.

If Norm had been a shiftworker, he would be a worthy media manifestation of the effects of overwork and shiftwork. While this is true, there is more than anecdotal evidence to support this argument. Indeed, the last 40 years has produced a considerable body of research across a broad cross-section of industries evidencing the relationship between extended hours of work and health consequences. Among such consequences are higher consumption of alcohol, caffeine and tobacco, poor physical exercise and unbalanced diet and nutrition, which in turn, has led to increase in unhealthy weight gain.

Several studies to date have examined the effect of extended work hours on alcohol consumption and smoking. For example, in a study of 71 workers in the retail industry, Steptoe and colleagues (1998) found that for men with poor social supports, extended hours of work was associated with a significantly increased consumption of alcohol. Similarly, results showed that female smokers consumed more cigarettes when working long hours than when working a standard week. Interestingly, the study found no alcohol effect for women, and no smoking effect for men. However, another study by Shields (1999), reported an increase in alcohol intake for women and not men. The results of this study also showed a substantial increase in smoking for both men and women. This particular study included 3830 Canadian workers from a variety of occupations. Therefore, it could be said that extended hours have the potential to increase alcohol consumption in both men and women.

Another study has linked extended hours of work with caffeine intake (Maruyama et al., 1995). The study focussed on 3928 white-collar, middle-management employees in 110 large Japanese companies. Results showed a significant relationship between working long hours and caffeine intake, largely through the consumption of tea and coffee.

Unhealthy weight gain has also been cited as a negative consequence of long working hours (Shields, 1999). This has been thought to be a direct consequence of other associates with long working hours, namely, poor physical exercise, unbalanced nutrition and irregular meals. Indeed, Maruyama and colleagues (1995) found a significant relationship between long working hours and poor physical exercise. They also reported a significant relationship between long working hours and unbalanced nutrition, irregularity of daily life and irregularity of daily meals.

There are several important conclusions that can be drawn from this research. First, extended hours of work have been associated with an increase in inappropriate coping strategies used by workers to deal with the stress associated with extended hours of work. Many of the short-term coping strategies, while providing short-term relief, become counterproductive in the longer-term. That is, they are increasingly unsustainable from a health perspective. As a consequence of these inappropriate coping strategies, many employees report negative health outcomes (Spurgeon et al., 1997; ACTU, 2001).

Indeed, a substantial body of literature has indirectly linked long working hours with negative health outcomes such as:

- heart problems and high blood pressure (Uehata, 1991);
- negative effects for pregnant women and fertility rates (Henderson, 1997);
- gastrointestinal disorders (Costa, 1999);
- psychological wellbeing (Babbar & Aspelin, 1998); and,
- circadian disruption, including effects on eating and sleep (Costa, 1996).

The impact of extended hours on cardiovascular problems has been well documented within the scientific literature (Uehata, 1991; Hayashi et al., 1996; Costa, 1999). One particular study by Hayashi and colleagues (1996), investigated such effects among several groups of white-collar males working both standard hours and extended hours. Results showed a significant burden on the cardiovascular system with extended hours of work. This study also reported significant increases in blood pressure with extended working hours. As such, the 24-hour average blood pressure of the overtime workers was higher than that of the control groups working standard hours. Moreover, for those who only worked extended hours periodically, the average blood pressure and heart rate increased substantially during the 'busy period'.

Another study by Uehata (1991) surveyed the workers' compensation claims of 203 Japanese workers, who had died from cardiovascular attacks. Of the reports studied, fatalities included 123 strokes; 50 acute cardiac failures; 27 myocardial infarctions and 4 aortic ruptures. Further analyses revealed that over two thirds of the workers were working hours in excess of 60 hours per week; 50 hours overtime per month; or more than half of their fixed holiday breaks before the attacks. For white-collar workers, the extended hours were often accompanied by excessive business trips, career problems and changes of work places. For blue-collar workers, on the other hand, extended hours were often accompanied by irregular midnight work, understaffing and long-distance driving. These factors were also likely to have impacted upon the cardiovascular attacks.

Another major concern regarding the impact of long work hours on health is its effect on pregnancy and fertility. In a Thai study of 1496 women, long working hours were found to affect fertility (Tuntiseranee et al., 1998). In this study, the ratio of infertility was highest when both partners worked in excess of 70 hours per week. Another study by Henderson (1997), surveyed female law graduates for the incidence of miscarriage as a function of work hours. The study found that women working over 45 hours per week experienced a three-fold higher rate of miscarriage. This statistic was produced after taking into account other factors such as age, smoking, alcohol consumption, and previous marriages.

In addition to infertility and miscarriage, birth characteristics have also been studied in relation to work hours. For example, a study by Hatch and colleagues (1997) focussed on foetal growth. The study consisted of 575 New York women of various occupations, who worked throughout their pregnancy. Results indicated that long working hours did indeed reduce foetal growth. More specifically, the infants of women working extended hours during late pregnancy had reductions in gestation-adjusted birth weight of about 80gms, compared with women working 20 hours or less. Moreover, when working extended hours, combined with excessive job activity, estimated birth weight reductions added up to 350gms. Therefore, both hours of work and job tasks may be important to consider for pregnant workers.

Psychological well being has also been widely cited as an effect of extended work hours. A large portion of this literature has particularly focussed on the incidence of work stress and burnout (eg. Babbar & Aspelin, 1998; Henderson, 1997; Mulcany, 1991; Hobson & Beach, 2000). For example, a study of 584 women law graduates found that women who worked more than 45 hours per week were five times more likely to experience high stress levels at work (Henderson, 1997). This finding held true even when external, domestic and social aspects were accounted for. Another study of 600 US workers by the North Western National Life Company, found high levels of stress among the workers, which in turn, lead to disability claims, decreased productivity and increased absenteeism (Mulcany, 1991). The study cited extended hours and overtime as a major cause of the stress.

Research has also linked long working hours to psychological depression. For example, a study by Shields (1999) indicated that women in particular, working long hours had an increased likelihood of subsequently experiencing depression.

Extended hours have also been linked to psychophysical homeostasis such as circadian rhythms, eating and sleep. For example, a study by Adeniran and colleagues (1996), examined 55 student nurses who were working night shifts for the first time. The study reported significant disturbances in energy, sleep and appetite with the onset of night work, which indirectly lead to decreases in concentration and interest. This would clearly have an effect on the level of employee performance.

It is clear from the preceding sections that extended hours of work, particularly when associated with shiftwork, are linked with significant reductions in health status. It is such indirect consequences as these that need to be considered when deciding the appropriateness of allowing extended work hours.



### 3. Current Initiatives

#### 3.1 Initiatives to Date

While many in the community have been quick to implement benefit from non-standard working hours, there has been a slower recognition of the longer-term costs to the community. It could be argued that many organisations and employees have profited directly from the short-term benefits associated with changes in hours but have socialised the costs, passing them on to the families and communities that support those workers. If, as has been argued above, these changes are not sustainable, then over the longer-term, the overall cost benefit analysis may be counterproductive.

There are numerous examples of negative cost transfers associated with industrial reform. Over the last 10-15 years, industrial relations 'reform' has permitted employees and employers to negotiate hours of work agreements that are inconsistent with the occupational health and safety requirement for a safe system of work. In the short term, both parties may benefit through improved productivity, higher income, perceived job security or career development. On the other hand, the increasing risk associated with these changes to hours of work can result in elevated risk, reduced safety and higher OH & S costs.

For example, it has been suggested that the productivity savings associated with reduced training and staffing levels at the Esso Refinery at Longford were unlikely to equal the litigation costs associated with the subsequent incident in which several lives were lost and gas supply to Melbourne was interrupted for nearly two weeks (Berger, 2000). Similarly, incidents such as the Exxon Valdez and the Challenger Shuttle clearly indicate the enormous indirect costs that can result from the short-term productivity gains associated with extended hours of work or reduced staffing levels.

In many cases, the indirect costs associated with changes in hours of work may accrue at some distance from the original policy change. For example, in an evaluation of the impact of 12hour shifts in regional mining communities, initially many male employees regarded the impact as positive. However, after 12-18 months, it was observed that participation in sporting teams had declined and that travel away from the community had significantly increased. Given the central role of sporting teams within the social fabric of the community, it has been suggested that 12hour shifts contributed significantly to the declining sense of community and social disintegration within the township. Similarly, many of the female partners indicated that the transition to 12 hour shifts had provided 4-day periods of leave on a regular basis with a subsequent increase in the time spent away from family engaged in male-only leisure pursuits (eg. fishing, shooting, farming). Thus, the flow on effects of extended hours may be relatively localised that is, related to factors costed within the workplace (eg. health and safety) or may be more diffuse and impact more slowly.

The obvious question in this situation is why individuals and organisations engage in such unsustainable work practices. Studies in the psychology of risk provide a key factor in understanding this behaviour. When employees are faced with the choice of a change in behaviour with a high likelihood of reward and an extremely low probability of cost, they will typically choose that behaviour, even when the relative costs benefit ratio is adjusted for risk.

Typically, the organisational or individual reasoning goes something like this: If I (or my employee) do not work for an additional x hours (shifts), then I am guaranteed not to receive extra money. On the other hand, my chance of having an accident is still only very low, so it makes more sense to take a very small risk given I have a hundred percent chance of foregoing the benefit if I do not work the extra hours (shifts). Because an individual has a low probability of an accident or injury, the 'correctness' of the decision to work the additional hours (shifts) is frequently reinforced, despite the fact that it is statistically irrational. It is only on the relatively few occasions when a catastrophic event occurs that one individual or organisation realises the total cost for which many others may have received the benefit.

Unfortunately, the fact that individuals and organisations can transfer social costs to the community while absorbing the benefits creates a significant disincentive to recognise and manage the problem. Indeed the externalities attributable to fatigue alone have been estimated to cost the Australian taxpayer over A\$3billion annually (Bureau of Transport Economics, 2000; Parliamentary Inquiry, 2000). As such, there may be a significant economic burden of long working hours to the sustainability of industry and the community over a long period. If this is the case then it might also be suggested that these externalities are inconsistent with competition policy since they constitute an indirect subsidy to those organisations.

While some might consider this a radical interpretation of competition policy, many organisations within Australia are beginning to appreciate both the direct and indirect costs attributable to extended hours of work and shiftwork. There is a fundamental shift in perspective occurring at present. As such, both private and public sectors are increasingly taking a longer-term view of the sustainability of extended hours of work and implementing systems that enable them to identify, quantify and manage many of the externalities associated with extended hours.

Consequently, these organisations are implementing cost analyses that enable them to understand how extended hours of work are costing their organisation in the long-term. Studies examining the relationship between extended hours of work and overtime, absenteeism, staff turnover, accidents and injury as well as compensation litigation have proliferated in recent years (Costa, 1996; Flin et al., 1996; Hayashi et al., 1996; Henderson, 1997; Axelsson et al., 1998; ; Babbar & Aspelin, 1998; Hanecke et al., 1998; Barnett et al., 1999; Burton & Turrell, 2000; Frank, 2000; Gander et al., 2000; Lowden & Åkerstedt, 2000; Nachreiner et al., 2000; Philip et al., 2001). Already, a significant number of organisations have realised the economic irrationality underlying many of the work practices that have evolved in recent years, and have already made appropriate changes.

Unfortunately, this process may not be sufficient to achieve an outcome that is optimum for the community as a whole. For many organisations, it is entirely economically rational to transfer costs onto the community. While the costs associated with overtime, absenteeism and workers' compensation may affect the profitability of an individual organisation, health, safety and social costs borne by family and community do not. In fact, the ability to transfer these costs has actually increased the profitability of many organisations at the expense of the taxpayer. Thus, it is generally considered appropriate for the community to set guidelines to ensure that the costs to the community are not greater than the benefit to the individual employee or organisation.

In Australia and overseas, this process has already begun. Many initiatives have been developed and implemented to address the problem of extended hours of work. The majority of initiatives are government sponsored, and offer guidelines for industry to implement 'reasonable' work hours. Three major examples of such initiatives include:

- The European Community Directive on Working Time (EU Directive);
- The Australian Parliamentary Inquiry into Fatigue in Transport (Parliamentary Inquiry); and
- The Australian Council of Trade Unions (ACTU) Test Case on Reasonable Work Hours (ACTU Test Case).

Each above-mentioned initiative will be discussed in some detail in the subsections that follow. Other examples, including specific industry initiatives have been included in Appendices B, C and D.

### 3.1.1 Quantifying the Indirect Costs of Extended Hours

Clearly, the introduction of legislative limits on hours of work is always going to be controversial. Given the potential for such rules to limit short-term income and reduce workplace flexibility, proposals that limit hours of work will frequently generate more heat than light.

Not surprisingly, individuals and organisations will typically behave in ways that protect their short-term financial interests. Thus, doomsday scenarios and economic fundamentalism have dominated the employers' argument against limiting hours of work. Similarly, income assurance and individual rights arguments have traditionally dominated the employee arguments in favour of unlimited hours. Indeed, we have already seen limitations on hours of work exploited as a means of generating additional overtime.

It is essential that policy is, at least in part, derived from evidence-based analysis of this question. We believe that is essential for policy-makers to address this issue from an empirical perspective, which is to attempt to quantify the effects of extended hours of work on health, safety and community as part of the evaluation process. Until the debate around hours of work becomes primarily empirical, then it will continue to be dominated by the ideological fashions of the time. This, in turn, will encourage individuals and organisations to:

- continue to transfer the indirect costs associated with extended hours to the taxpayer and the community or,
- reduce competitiveness by limiting flexibility and productivity within the workplace

In many cases the absence of evidence has been interpreted as evidence of an absence of effect. That is, because we cannot point to a significant and irrefutable body of evidence demonstrating the relationship the relationship does not exist. It is our belief that this represents a significant 'error of reasoning'.

Given the potential impact of extended hours on health, safety and community we believe it is reasonable to expect employers and unions to accept the fact that the cost benefit analysis may change as hours of work are extended beyond the traditional work week. We also believe that it is reasonable for any parties proposing an extended hours regime to assume the burden of:

- [a priori] - proving their case empirically; and/or
- [post-hoc] - instituting evaluation methodologies which determine whether the projected outcomes are actually realised.

That is, an empirical framework to determine whether extended hours of work benefit the community's overall interests [or not]. To this end, there are a range of emerging technologies that enable us to quantify, audit and model the potential effects of changes in hours-of-work and 'extended hours' in particular.

The technologies fall into two broad categories. The first are prospective tools that enable organisations to model, predict or estimate the likely effects of the proposed changes. The second are evaluative methodologies that enable organisations to determine the impact of changes post-implementation. In this paper we will focus on the more recently evolved prospective tools since they would permit the assessment of the impact of extended hours of work without the need to actually implement them first.

Several predictive or prospective models of the effects of hours of work on sleep and fatigue have been published recently in the international literature (Borbély, 1982; Daan & Beersma, 1984; Daan, Beersma & Borbély, 1984; Borbély, Achermann, Trachsel & Tobler, 1989; Folkard & Åkerstedt, 1987, 1992; Kronauer, Czeisler, Pilato, Moore-Ede & Weitzman, 1982; Gander, Kronauer, Czeisler & Moore-Ede, 1984; Kronauer, 1990). Several of these models are explored in detail in Appendix E. Within Australia, the dominant model (published by the Centre for

Sleep Research, University of S.A), enables organisations to determine the potential and actual impact of hours of work on fatigue.

This model has been implemented across broad sectors of industry, particularly within transport. It is used by the rail industry as a national standard for determining the acceptability of a given work pattern vis-à-vis the safety implications of fatigue. Similarly, this model is also used as the basis for exemptions to the flight and duty time limitations [CAO-48] used by the Civil Aviation Safety Authority for ensuring that pilots are not excessively fatigued. The same model is increasingly used by the road transport sector and has been used in the evaluation of the current draft guidelines for hours of work in the road transport sector by the National Road Transport Commission.

Perhaps one of the most interesting sequelae of this approach has been its use by the insurance industry. Over the last few years, MMI insurance have conducted research that indicates that approximately 30% of their long-haul road transport accidents are fatigue-related and these accidents constitute nearly 80% of their overall claims cost in this sector (Dean Crokes, 2000). In this analysis, it was also suggested that these accidents were not distributed randomly across the client base. That is, for fatigue-related accidents, some operators had claims-to-premium ratios up to an order of magnitude greater than other operators.

It is our understanding that MMI now uses the modelling approach to determine the risks associated with specific company schedules and is now setting premia and excesses to reflect fatigue-related increases in risk for the individual organisation. Given the recency of this approach, there is not yet published data on the impact of this methodology on claims outcomes. However, this approach appears to have resulted in significant change in the shift patterns of clients whose schedules were considered a poor insurance risk.

Given the success of the MMI approach in Australia, transport regulators in Europe and North America are now evaluating this approach for implementation under their jurisdiction. The Federal Railways Administration [FRA] and the Federal Aviation Administration [FAA] in the US, the department of Transport in Canada [Transport Canada] and the Civil Aviation Authority [CAA] in the UK have all now used this approach as part of their role in determining acceptable shift schedules within their respective jurisdictions.

The definition of this model and the published empirical support for it have been included below and detailed in Appendices F and G. In addition, cases studies outlining the adoption and implementation of this model within the Australian Rail industry have also been included.

The initial success of fatigue modelling approaches has encouraged parallel models of the psychosocial impact of extended hours to emerge. These models are based on the basic premise that the psychosocial 'value' of time is not constant. That is, for each individual, certain times of the day, week or year have inherently more or less psychosocial value than others. Once one has accepted this premise, then the impact of specific work patterns or extended hours are relatively clear. They reduce the opportunity to experience the social value of time away from work and the relative cost will depend on the value assigned to that time by a given individual.

In simple terms, if you are required to work on a Tuesday night and miss football practice this may carry a higher cost than on Wednesday night if you had nothing planned. Similarly, work time that extends into the weekend when there is a significant psychosocial premise, is likely to have a greater impact than on a Monday night when one misses only the late night movie.

By asking individuals to assign a relative value to time off based on time of day, day of week or time of year it is possible to quantify the relative impact of changing hours of work at the individual level. This information can then be aggregated to determine the relative effect across an entire organisation. Furthermore, this approach can be used to determine whether specific demographic groups may experience a differential impact of changing hours of work based on how they as individuals, or organisations, value their time.

Psychosocial models differ from fatigue-based approaches only as a function of factors driving the psychosocial- rather than sleep-value of time. Sleep propensity is primarily biological driven and varies principally with respect to time-of-day. In contrast, the psychosocial impact of hours of work are more individualistic and reflect demographic factors in addition to day of week and time of day.

In the following sections, we have outlined briefly the use of fatigue and psychosocial modelling as potential mechanisms for quantifying some of the indirect costs associated with extended hours-of-work (see Appendix H for more detailed information). We do not offer these as evidence that extended hours has necessarily produced negative impacts in all cases.

Indeed, we offer these approaches primarily as evidence of an existing methodology with which to empirically evaluate the potential impact of extended hours at the individual, organisational and community levels. This provides the opportunity for organisations to embark upon a more informed debate that addresses both direct and indirect consequences of industrial reform and the appropriateness of extended hours practices.

It will also enable the community and regulators to identify, in a disciplined and repeatable manner, organisations in which extended hours practices are not likely to meet the overall interests of the community. Most importantly, it will also allow those organisations for whom the impact is minimal or positive to clearly identify themselves as appropriate end-users of extended hours practices.

Specific examples of this approach and the effect of extended hours are contained in subsequent sections of this document. Quantitative psychosocial impact assessments have also been prepared with Dr. Angela Baker as part of a paper by Dr. Barbara Pocock on the family and community impact of extended hours.

### 3.1.2 Policy Initiatives

#### 3.1.2.1 *The European Community Directive on Working Time*

The EU Directive was introduced on 23 November 1993 under the Health and Safety Provisions contained in Article 118a in the Treaty of Rome (Milner, 1999). The full version of the directive is included as Appendix I. It was introduced to ensure against the adverse effects on health and safety of working excessively long hours, having inadequate rest, or the disruptive working patterns on workers (IDS, 1993).

In essence, the EU Directive suggests weekly limits on working time, rest periods during the working day and in the working week, annual leave and protection of night workers. It covers both public and private industry sections. As such, the main provisions of the Directive are:

- a maximum working week of 48 hours, calculated over a reference point of no more than four months;
- entitlement to a rest break - the specific details to be agreed by collective bargaining or determined by law;
- entitlement to a minimum uninterrupted rest period of at least 11 hours in any 24-hour period;
- entitlement to at least 24 consecutive hours break in each seven day period, to be calculated over a period not exceeding 14 days;
- entitlement to four weeks paid annual leave; and,
- the right to free health checks for night workers.

#### 3.1.2.2 *The Australian Parliamentary Inquiry*

A parliamentary inquiry was conducted in the first half of 2000, and is included in Appendix J. As a result, it provided a series of recommendations for the transport industry in regard to fatigue management. Many of the recommendations are equally relevant to the wider workforce. Such recommendations include:

- **Recommendation 5:** 'The Civil Aviation Safety Authority should implement a Fatigue Risk Management System to regulate flight and duty times for aircrew as soon as it is feasible to do so.';
- **Recommendation 7:** 'The Civil Aviation Safety Authority should be required to develop hours of duty rules for aircraft maintenance engineers, incorporating fatigue management principles and auditable fatigue management systems.';
- **Recommendation 8:** 'In determining whether an operator has implemented a fatigue management system, one of the factors the Civil Aviation Safety Authority should consider is whether shift rosters for aircraft maintenance staff are routinely tested using reputable computer-based fatigue modelling packages.';
- **Recommendation 9:** 'The Civil Aviation Safety Authority should:
  - > require that operators of commercial transport services introduce and maintain effective systems to monitor staffing levels and anticipated workloads; and
  - > routinely review these records to satisfy itself that effective staffing levels are maintained';
- **Recommendation 10:** 'The Civil Aviation Authority should:
  - > develop comprehensive hours of duty regulations for air traffic controllers incorporating basic fatigue management principles;
  - > require all air traffic service providers to maintain auditable fatigue management systems; and
  - > in determining whether an air traffic service provider has implemented an adequate fatigue management system, consider whether shift rosters for air traffic controllers are routinely tested against reputable computer-based fatigue modelling packages';
- **Recommendation 27:** 'The Employment Advocate should, when providing information to parties to an Australian Workplace Agreement (in accordance with Section 170VO of the Workplace Relations Act 1996) include explicit information on fatigue and fatigue management, particularly about the requirements of any industry codes of practice or government regulations in the transport industry'.

A whole of government response to this report will be released in the next few weeks. The response will detail specific action steps to be taken by the government in order to address the parliamentary inquiry recommendations.

### *3.1.2.3 ACTU Test Case on Reasonable Work Hours*

The aim of the ACTU clause on reasonable work hours is to establish an award benchmark for what is a reasonable level of total hours worked, and a reasonable configuration for these hours (ACTU, 2001). It is intended to be general in nature for wide application across the workforce. It does not attempt to prescribe a numerical limit on hours worked, as this will vary with each industry and situation. It does, however, describe certain criteria for unreasonable work hours, providing entitlement for employees who work extended hours each week. The full version of the ACTU clause is presented in Appendix K for further reading.

The ACTU reasonable work hours clause states that employers must not require employees to work unreasonable hours. As such, unreasonable hours are defined by:

- the total number of hours exceeding the standard work week;
- the total number of hours worked on any particular day or shift;
- the total number of hours worked over an extended period;
- the total number of hours worked without a break;
- minimum time off between shifts;
- fatigue risk;
- remuneration received for excess hours worked;
- rostering arrangements;

- extent of night work;
- employees' workload;
- work intensification resulting from understaffing, and the ability of workers to meet targets while working reasonable daily hours;
- time required to achieve remuneration in accordance with performance based pay schemes;
- exposure to occupational health and safety hazards;
- employees' social and community life; and,
- employees' family responsibilities.

Reasonable overtime:

- An employer may require an employee to work reasonable overtime at overtime rates, other than employees employed part-time in accordance with the clause on parental leave of the award, who cannot be required to work overtime against their wishes.
- An employee may refuse to work hours in excess of ordinary hours on a particular day for reasons including, but not limited to, the employee's family responsibilities, or pre-arranged personal commitments.

Extreme working hours are defined as:

- an average of 60 hours per week over a four week period;
- 26 days over a four week period;
- an average of 54 hours per week over an eight week period;
- 51 days over an eight week period;
- an average of 48 hours per week over a 12 week period; or
- 74 days over a 12 week period.

The ACTU test case is certainly a step in the right direction in addressing the issue of extended working hours. The initial point made, that 'an employer must not require an employee to work unreasonable hours of work' is fundamental to the work hours debate. The point is absolutely essential, and should be embedded into the industrial relations landscape.

While this may be a step in the right direction however, there are some limitations that need to be considered. The ACTU clause is very conservative, and as such, does not go far enough in its recommendations. Indeed, under the proposed ACTU clause, there would be numerous cases where extended hours can be worked, without breaching any of the guidelines.

In addition, although the clause states 'time off between shifts' as a factor that needs to be considered in determining unreasonable hours of work, no prescriptive guidelines are given for minimum weekly breaks. Research has shown that employees require sufficient time to recover from undesirable side effects arising from work (Craig & Cooper, 1992). For example, increased time off for recovery in a sample of nurses was shown to increase social satisfaction on subsequent work days (Totterdell et al., 1995). Therefore, researchers have recommended at least two consecutive days off per working week, thereby allowing a maximum of five consecutive work days per roster (Knauth, 1993; Knauth, 1997).



## 4. Conclusions

### 4.1 Economically Rational Approaches

In this paper, it has been suggested that while the benefits associated with extended hours of work have been willingly accepted, the true costs are not well captured and may constitute a work practice that is unsustainable in the long-term and therefore economically irrational for the community. Indeed, it has been suggested that in view of the unrecognised externalities, current practices with respect to extended hours of work are more consistent with a system of economic fundamentalism. As long as it is possible for individuals and organisations to externalise the true costs associated with extended hours of work, then it will be economically rational for them to maximise income/profitability by ignoring the true costs. Conversely, it will remain economically irrational for the community to permit these costs to be transferred to the taxpayer without concern for the overall benefit to the community of such practices.

### 4.2 Potential Benefits

The potential benefits of limiting hours of work are significant. In a recent review of this area (Department of Industrial Relations, 1994) many of the most significant potential benefits for the community have already been delineated, including:

- increased unit productivity per employee per hour;
- reduced stress, improved morale and commitment;
- reduced costs through improved occupational health and safety record;
- reduced lateness and absenteeism;
- increased staff retention;
- increased return on training investment;
- increased ability to attract and recruit staff;
- improved ability to meet equal opportunity objectives; and,
- improved corporate citizenship and enhanced corporate image.

### 4.3 Potential Disadvantages

While implementing such a strategy would appear self-evident based on the potential benefits, many employers are concerned that prescriptive approaches may not be the most effective way of identifying potential cost savings. Not surprisingly, they view regulation with suspicion since it has the potential to reduce workforce flexibility, increase short-term labour costs and negatively impact profitability.

As such, in presenting a case to limit working hours, it is likely that business will present a number of potential disadvantages. Such disadvantages of limiting work hours may include:

- reduced profitability (eg. unpaid overtime);
- reduced earning potential for employees and managers (eg. lower potential for promotion and over-time rates); and
- reduced competitive advantage with overseas markets.

At the local level, these arguments can be seen to be true, and reasonable. To date however, such arguments have failed to consider the true costs of such working hours to the community. While it is true that any argument against working hours' restrictions needs to be considered and taken seriously, at the end of the day, the only way to make a reasonable decision is to look at all the rational arguments for both the costs and benefits to both industry, and the wider community.

#### **4.4 A Conceptual Framework**

In our opinion, the goal of regulating extended hours of work while maintaining workforce flexibility and profitability can best be achieved by targeting high-risk individuals and organisations. At present, there is clear evidence that employees working more than 48 hours per week are at significantly greater risk of poor health, safety and social outcomes. Similarly, more than 60 hours per week is even more risky. Thus, it would appear reasonable to limit working hours to a specified maximum threshold as has occurred in Europe and has been proposed by the ACTU.

On the other hand, prescriptive rules based on input factors are increasingly unpopular as a method of regulation since they are relatively heavy-handed and do not allow for unique circumstances at either the individual or organisational level. Increasingly regulators are moving toward output-based regulations that require the individual organisation to demonstrate outcomes rather than comply with inputs. From this perspective, we have seen a shift in OH&S legislation over the previous decade. In essence, there has been a reversal of the burden of proof. Under this model, individuals or organisations are required to present a case justifying why a system of work is safe rather than the regulator being responsible for proving that the system is unsafe.

We think an output-based approach is entirely appropriate for managing extended hours of work in Australia. Based on the previous arguments and evidence, where an employee works less than a safe threshold of hours with no work scheduled through the normal sleep period [2300 hours to 0700 hours] then there is little evidence that health and safety are significantly impacted. Where an employee works more than a safe threshold of hours, we would suggest that the onus should be on the employer to demonstrate how these hours are consistent with the long-term interests of the employee and the community. Similarly, where an employee can be scheduled to work across the typical sleep hours then the employer should be required to demonstrate how these hours are consistent with the long-term interests of the employee and the community.

Such an approach would be reasonably flexible since it would enable an employer to construct a 'safety case' argument for why hours in excess of the threshold were reasonable. It is our experience that many such situations arise. For example, remote location mining operations where employees fly in and out for a two or three week work period is one example of such a situation. Given the lack of social opportunities in such environments it may be possible to work more than 48 hours since employees only have time to work or sleep. In these circumstances, a working week longer than 48 hours may be entirely appropriate.

An outcome-based approach would also be desirable since it would enable each organisation or industry to develop guidelines appropriate to their interests and circumstance while remaining mindful of the purpose of limiting hours of work. That is, to ensure sustainable work practices that promote the long-term health and wellbeing of workers and the long-term interests of the community and taxpayer. The flexibility of this approach would also ensure that specific industries did not end up with restrictive work practices that reduced their relative competitiveness.

A key element to such an approach is to foster the development of a culture of transparent evidence-based policy. To achieve this, organisations and industries should be required to record and quantify the relationship between hours of work and health and safety outcomes on an ongoing basis. It would also require regulators to collect information at an aggregate level in order to improve the development of subsequent safety cases.

This approach would take the regulation of extended hours one step further than the ACTU clause. The ACTU proposal is effective in that it provides standard limitations on working hours that should be the basis for industry operation. However, requiring industry to legitimise hours worked, allows for increased involvement of, and input from, industry itself, as well as increased management of safety in the workplace as a corollary of extended working hours.



## References

- Adeniran, R., Healy, D., Sharp, H., Williams, J.M., Minors, D. & Waterhouse, J.M. (1996) 'Interpersonal sensitivity predicts depressive symptom response to the circadian rhythm disruption of nightwork', *Psychological Medicine*, Vol. 26 (6), 1211-1221.
- Åkerstedt, T. & Gillberg, M. (1980) 'Sleep Disturbances and Shiftwork'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 127-137, Pergamon Press: Paris.
- Åkerstedt, T. (1998) 'Shiftwork and disturbed sleep/wakefulness', *Sleep Medicine Reviews*, Vol. 2 (2), 117-128.
- Åkerstedt, T. (2000) 'Consensus Statement: Fatigue and accidents in transport operations', *Journal of Sleep Research*, Vol. 9, 395.
- Allan, C., Brosnan, P. & Walsh, P. (1998) 'Non-standard working-time arrangements in Australia and New Zealand', *International Journal of Manpower*, Vol. 19 (4), 234-249.
- Angus, R.G. & Heslegrave, R.J. (1985) 'Effect of sleep loss on sustained cognitive performance during a command and control situation', *Behavior Research Methodology and Instrumentation*, Vol. 17, 55-67.
- Angus, R.G., Heslegrave, R.J. & Myles, W.S. (1995) 'Effects of prolonged sleep deprivation with and without chronic physical exercise on mood and performance', *Psychophysiology*, Vol. 22, 276-282.
- Arendt, J.T., Wilde, G.J.S., Munt, P.W. & Maclean, A.W. (2000) 'Simulated driving performance following prolonged wakefulness and alcohol consumption: separate and combined contributions to impairment', *Journal of Sleep Research*, Vol. 9, 233-241.
- Arnold, P.K., Hartley, L.R., Corry, A., Hochstadt, D., Penna, F. & Feyer, A.M. (1997) 'Hours of work, and perceptions of fatigue among truck drivers', *Accid Anal Prev*, Vol. 29 (4), 471-477.
- Atkinson, J., de Nanteuil, M., Latta, M. & Parent-Thirion, A. (1999) *Labour Market Participation: Now and in the Future*, European Foundation for the Improvement of Living and Working Conditions: Ireland.
- Australian Bureau of Statistics (1997) *Working Arrangements in Australia*, Cat no 63420.
- Australian Bureau of Statistics (1999) *Working Hours of Wage and Salary Earners, Queensland*, Cat no 63443.
- Australian Bureau of Statistics (2000) *Employment Arrangements and Superannuation, Australia*, Cat no 63610.
- Australian Council of Trade Unions - ACTU (2001) *Briefing Notes re: Reasonable Hours Test Case*, Melbourne: Australia.
- Axelsson, Keckland, G., Åkerstedt, T. & Lowden, A. (1998) 'Effects of alternating 8- and 12-hour shifts on sleep, sleepiness, physical effort and performance', *Scandinavian Journal of Work Environment and Health*, Vol. 24, 62-68.
- Babbar, S. & Aspelin, D. (1998) 'The overtime rebellion: symptom of a bigger problem? (implications of forced overtime)', *The Academy of Management Executive*, Vol. 12, 68-77.
- Banderet, L.E., Stokes, J.W., Francesconi, R., Kowal, D.M. & Naitoh, P. (1981) 'Artillery teams in simulated sustained combat: Performance and other measures'. In L.C. Johnson, D.J. Tepas, W.P. Colquhoun & M.J. Colligan (Eds) *Biological Rhythms, Sleep and Shiftwork*, 459-477, New York: Spectrum.
- Baranski, J.V. & Pigeau, R.A. (1997) 'Self-monitoring cognitive performance during sleep deprivation: Effects of modafinil, d-amphetamine and placebo', *Journal of Sleep Research*, Vol. 6, 84-91.
- Bard, E.G., Sotillo, C., Anderson, A.H., Thompson, H.S. & Taylore, M.M (1996) 'The DCIEM map task corpus: Spontaneous dialogue under SD and drug treatment', *Speech Communication*, Vol. 20, 71-84.
- Barnett, R.C., Gareis, K.C. & Brennan, R.T. (1999) 'Fit as a mediator of the relationship between work hours and burnout', *Journal of Occupational Health Psychology*, Vol. 4 (4), 307-317.
- Bechara, A., Damasio, H., Tranel, D. & Damasio, A.R. (1997) 'Deciding advantageously before knowing the advantageous strategy', *Science*, Vol. 275, 1293-1295.
- Beck, U. (1994) 'Destandardisation of labour'. In M. Ritter (Ed), *Risk Society, towards a new modernity*, 139-150, Sage Publications: London.
- Belensky, G., Penetar, D.M., Thorne, D.R., Popp, K., Leu, J., Thomas, M., Sing, H., Balkin, T.J., Wesensten, N.J. & Redmond, D.P. (1994) 'The effects of sleep deprivation on performance during continuous combat operations'. In B.M. Marriott (Ed) *Food components to enhance performance*, 127-135, Washington DC: National Academy Press.

- Belgum, D. (2000) 'Rookie Lawyers Will Work Hard for Higher Salaries', *Los Angeles Business Journal*, Vol. 22 (21), 5-7.
- Berger, Y. (2000) Report on the Esso Explosion at Longford, Sate Commissions Report to the AWU.
- Bielenski, G., Penetar, D.M., Thorne, D.R., Popp, K., Leu, J., Thomas, M., Sing, H., Balkin, T.J., Wesensten, N.R. & Redmond, D.P. (1994) 'The effects of sleep deprivation on performance during continous combat operations'. In B.M. Marriouitt (Ed), *Food components to enhance performance*, 127-135, National Academy Press: Washington DC.
- Bielenski, H. & Kauppinen, T. (1998) *Working Time Needs of Europeans*, European Foundation for the Improvement of Living and Working Conditions: Munich.
- Bielenski, H. (1999) *Employment Options of the Future: High Demand for New Jobs in Europe - High Interest in Non-Standard Work-Forms*, European Foundation for the Improvement of Living and Working Conditions: Munich.
- Blagrove, M. (1994) 'Interrogative suggestibility - The effects of sleep deprivation and the relationship with field-dependence', *Applied Cognitive Psychology*, Vol. 8, 169-179.
- Blagrove, M. (1996) 'The effects of length of sleep deprivation on interrogative suggestibility', *Journal of Experimental Psychology: Applied*, Vol. 2, 48-59.
- Blagrove, M., Alexander, C. & Horne, J.A. (1995) 'The effects of chronic sleep reduction on the performance of cognitive tasks sensitive to sleep deprivation', *Applied Cognitive Psychology*, Vol. 9, 21-40.
- Bliss, E.L., Clark, L.D. & West, C.D. (1959) 'Studies of sleep deprivation: Relationship to schizophrenia', *Archives of Neurology*, Vol. 81, 348-359.
- Bonnet, M.H. & Arand, D.L. (1999) 'Level of arousal and the ability to maintain wakefulness', *Journal of Sleep Research*, Vol. 8, 247-254.
- Borbély, A. (1986) *Secrets of Sleep*, Harper Collins: Stuttgart, Germany.
- Borbély, A.A. (1982) 'A two process model of sleep regulation', *Human Neurobiology*, Vol. 1, 195-204.
- Borbély, A.A., Achermann, P., Trachsel, L. & Tobler, I. (1989) 'Sleep initiation and sleep intensity: interaction of homeostatic and circadian mechanisms', *Journal of Biological Rhythms*, Vol. 4, 149-160.
- Bosworth, D.L. & Dawkins, P.J. (1980) 'Private and Social Costs and Benefits of Shift and Nightwork'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 207-213, Pergamon Press: Paris.
- Bourgeois-Bougrine, S., Carbon, P., Gounelle, C., Mollard, R., Coblentz, A. & Speyer, J.J. (2000) 'Fatigue in aviation: the point of view of French pilots'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 73-77, Peter Lang: Frankfurt.
- Bretherton, T., Buchanan, J. & Considine, G. (2001) *Working Time Arrangements in Queensland*, ACIRRT, University of Sydney: Sydney.
- Brown, I.D., Tickner, A.H. & Simmons, D.C. (1970) 'Effect of prolonged driving on overtaking criteria' *Ergonomics*, Vol. 12, 239-242.
- Bruck, D. & Pisani, D.L (1999) 'The effects of sleep inertia on decision-making performance', *Journal of Sleep Research*, Vol. 8, 95-103.
- Buchanan, J. & Bearfield, S. (1997) *Work hours*, Australian Centre for Industrial Relations Research Training, University of Sydney: Sydney.
- Bureau of Transport Economics (2000), *Road Crash Costs in Australia: Report 102*, Department of Transport and Regional Services, Canberra, p.xi.
- Burton, N.W. & Turrell, G. (2000) 'Occupation hours worked, and leisure-time physical activity', *Preventative Medicine*, Vol. 31 (6), 673-681.
- Caldwell, J.A. Jr & Caldwell, J.L. (1998) 'Comparison of the effects of zolpidem-induced prophylactic naps to placebo naps and forced rest periods in prolonged work schedules', *Sleep*, Vol. 21 (1), 79-90.
- Caldwell, J.L. & Gilreath, S.R. (2001) 'Work and sleep hours of U.S. Army aviation personnel working reverse cycle', *Military Medicine*, Vol. 166 (2), 159-166.
- Campbell, I. (1997) 'Working time: comparing Australia and Germany'. In P. James, W.F. Veit & S. Wright, *Work of the future: global perspectives*, Melbourne: Allen & Unwin.
- Campolo, M., Puch, J., Thompson, L. & Wallace, M. (1998) 'Pioneering the 12-hour shift in Australia - implementation and limitations', *Australian Critical Care*, Vol. 11 (4), 112-115.
- Carey, J.C. & Fishburne, J.I. (1989) 'A method to limit working hours and reduce sleep deprivation in an obstetrics and gynecology residency program', *Obstetrics & Gynecology*, Vol. 74 (4), 668-672.

- Carlson, N.R. (1998) *Physiology of Behavior* (6th Edition), Allyn & Bacon: Boston.
- Casey, C. (1995) 'Critical analysis and the problem of work'. In *Work, self and society, after industrialism*, 7-25, Routledge: London and New York.
- Chambers, D.A. (1986) 'The constraints of work and domestic schedules on women's leisure', *Leisure Studies*, Vol. 5, 309-325.
- Costa, G. (1996) 'The impact of shift and night work on health', *Applied Ergonomics*, Vol. 27, 9-16.
- Costa, G. (1997) 'The problem: Shiftwork', *Chronobiology International*, Vol. 14 (2), 89-98.
- Costa, G. (1999) 'Shiftwork and Health', *Med Lav*, Vol. 90 (6), 739-751.
- Costa, G. (2000) 'Shiftwork and health: the heritage of the twentieth century'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 155-160, Peter Lang: Frankfurt.
- Craig, A. & Cooper, R.E. (1992) 'Symptoms of acute and chronic fatigue'. In A.P. Smith & D.M. Jones (Eds.), *Handbook of human performance*, Vol. 3, p 289-339, London: Harcourt Brace Jovanovich.
- Crokes, D. (2000) 'Why fatigue management won't work: economic realities', 4th International Conference on Fatigue in Transportation, Freemantle, WA.
- Csikszentmihalyi, M. & LeFevre, J. (1989) 'Optimal Experience in Work and Leisure', *Journal of Personality and Social Psychology*, Vol. 56 (5), 815-822.
- Daan, S. & Beersma, D.G.M. (1984) 'Circadian gating of human sleep-wake cycles'. In M.C. Moore-Ede & C.A. Czeisler (eds), *Mathematical models of the circadian sleep-wake cycle*, New York, Raven Press, 129-158.
- Daan, S., Beersma, D.G.M. & Borbély, A.A. (1984) 'Timing of human sleep: recovery process gated by a circadian pacemaker', *American Journal of Physiology*, Vol. 246, R161-R178.
- Damasio, A.R. (1996) 'The somatic marker hypothesis and the possible functions of the prefrontal cortex', *Philosophical Transactions Royal Society London: Series B*, 351, 1413-1420.
- Dawson, D. & Reid, K. (1997) 'Fatigue, alcohol and performance impairment', *Nature*, Vol. 388, 235.
- Dawson, D. (1997) 'Managing shiftwork: not just the roster', *The Journal of Occupational Health and Safety - Australian and New Zealand*, Vol. 13 (5), 411-413.
- Dempsey, K. (1997) *Inequalities in Marriage: Australia and Beyond*, 21-66, Oxford University Press: Oxford.
- Department of Industrial Relations (1994), *The Workplace Guide to Work and Family*, 3.
- Desir, D., Van Cauter, E., Golstein, J., Fevre, M., Jadot, C., Refetoff, S. & Copinschi, G. (1980) 'Adaptation of the nycthermal variations of pituitary and related hormones after transmeridian transportation in normal man'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 365, Pergamon Press: Paris.
- Dex, S. & McCulloch, A. (1997) *Flexible Employment: The Future of Britain's Jobs*, Macmillan Press: Basingstoke.
- Dinges, D.F. & Kribbs, N.B. (1991) 'Performing while sleepy: Effects of experimentally induced sleepiness'. In T.H. Monk (Ed) *Sleep, sleepiness and performance*, 97-128, Wiley: Winchester, England.
- Dinges, D.F., Pack, F., Williams, K., Gillen, K.A., Powell, J.W., Ott, G.E. Aptowicz, C. & Pack, A.I. (1997) 'Cumulative Sleepiness, Mood Disturbance and Psychomotor Vigilance Performance Decrements During a Week of Sleep Restricted to 4-5 Hours per Night', *Sleep*, Vol. 20 (4), 267-277.
- Dorrian, J., Lamond, N. & Dawson, D. (2000) 'The ability to self-monitor performance when fatigued', *Journal of Sleep Research*, Vol. 9, 137-144.
- Drummond, S.P.A., Brown, G.G., Gillin, J.C., Sticker, J.L., Wong, E.C. & Buxton, R.B. (2000) 'Altered Brain Response to Verbal Learning Following Sleep Deprivation', *Nature*, Vol. 403, 655-657.
- Ehret, C.F. (1980) 'New Approaches to Chrono-Hygiene for the Shiftworker in the Nuclear Power Industry'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 263-270, Pergamon Press: Paris.
- Epstein, R., Tzischinsky, O., Chillag, N., Zohar, D., Tov, N. & Lavie, P. (2000) 'Sleep-Wake Cycles of Medical Residents Working Extended Shifts in Israel'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 55-60, Peter Lang: Frankfurt.
- Evans, J.M. & Lippoldt, D.C. (2000) 'The growth of part-time work in Europe: for good or ill?', *Best*, Vol. 2, 15-21.
- Fairclough, S.H. & Graham, R. (1999) 'Impairment of Driving Performance Caused by Sleep Deprivation or Alcohol: A Comparative study', *Human Factors*, Vol. 41(1), Page 61-70.

- Fell, J. (1998) 'Personal Communication to Dr. Alison Smiley' as cited in 'Fatigue Management: Lessons from Research'. In: L. Hartley (Ed), *Managing Fatigue in Transportation*, Oxford Elsevier Science Ltd, 1-23.
- Fischer, F.M., Moreno, C.R. de c., Fernandez, R de L., Berworth, A., dos Santos, A.M. & Bruni, A de C. (1993) 'Day- and shiftworkers' leisure time', *Ergonomics*, Vol. 36 (1-3), 43-49.
- Fischer, F.M., Moreno, C.R.C., Borges, F.N.S. & Louzada, F.M. (2000) 'Alertness and sleep after 12-hour shifts: differences between day and night work'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 43-48, Peter Lang: Frankfurt.
- Flin, R., Slaven, G. & Stewart, K. (1996) 'Emergency decision making in the offshore oil and gas industry', *Human Factors*, Vol. 38, 262-277.
- Folkard, S. & Åkerstedt, T. (1987) 'Towards a model for the prediction of alertness and/or fatigue on different sleep/wake schedules'. In A. Oginski, J. Pokorski & J. Rutenfranz (eds), *Contemporary Advances in Shiftwork Research*, Krakow Medical Academy, 231-240.
- Folkard, S. & Åkerstedt, T. (1992) 'A three process model of the regulation of alertness-sleepiness'. In R.J. Broughton & R.D. Ogilvie (eds), *Sleep, arousal and performance: problems and promises*, Boston, Birkhauser, 11-26.
- Frank, A.L. (2000) 'Injuries related to shiftwork', *American Journal of Preventative Medicine*, Vol. 18 (4), 33-36.
- Gander, P.H., Kronauer, R.E., Czeisler, C.A. & Moore-Ede, M.C. (1984) 'Modeling the action of zeitgebers on the human circadian system: Comparisons of simulations and data', *American Journal of Physiology*, Vol. 247, R427-R444.
- Gander, P.H., Merry, A., Millar, M.M. & Weller, J. (2000) 'Hours of work and fatigue-related error: a survey of New Zealand anesthetists', *Anaesthetic Intensive Care*, Vol. 28 (2), 178-183.
- Gasparini G., Parent-Thirion, A., Latta, M. & de Nanteuil, M. (1999) *Full-Time or Part-Time Work: Realities and Options*, European Foundation for the Improvement of Living and Working Conditions: Ireland.
- Goldmark, J. (1912) *Fatigue & Efficiency: a study in industry*, New York Press: New York.
- Goulet, L.R. (1999) 'Research Briefs: How managers control employees' time', *The Academy of Management Executive*, Vol. 13, 114-115.
- Gramm, W.S. (1987) 'Labour, Work and Leisure: Human Well-Being and the Optimal Allocation of Time', *Journal of Economic Issues*, Vol. 21 (1), 7-40.
- Green, M.J. (1995) 'What (if anything) is wrong with residency overwork?', *Annals of Internal Medicine*, Vol. 123 (7), 512-527.
- Grint, K. (1991) 'What is work?'. In *The Sociology of Work*, 7-40, Polity Press: Cambridge.
- Grundheber, A. (2000) 'On Time: European Working Time Policy in the Public Services', *Best*, Vol. 2, 27-28.
- Hanecke, K., Tiedemann, S., Nachreiner, F. & Grzech-Sukalo, H. (1998) 'Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population', *Scandinavian Journal of Work and Environmental Health*, Vol. 24 (Suppl 3), 43-48.
- Harcourt, T. & Kenna, S. (1997) *Discussion Paper on Working Time*, Australian Council of Trade Unions: Victoria.
- Harma, M.I. & Illmarinen, J.E. (1999) 'Towards the 24-hour society - new approaches for aging shiftworkers', *Scandinavian Journal of Work Environment and Health*, Vol. 25 (6), 610-615.
- Harma, M.I. (1995) 'Sleepiness and Shiftwork: Individual Differences', *Journal of Sleep Research*, Vol. 4 (S2), 57-61.
- Harrison, Y. & Horne, J.A. (1997) 'Sleep deprivation affects speech', *Sleep*, Vol. 20, 871-878.
- Harrison, Y. & Horne, J.A. (1998a) 'Sleep deprivation impairs short and novel language tasks having a prefrontal focus', *Journal of Sleep Research*, Vol. 7, 95-100.
- Harrison, Y. & Horne, J.A. (1998b) 'Sleep loss affects risk-taking', *Journal of Sleep Research*, Vol. 7 (Suppl. 2), 113.
- Harrison, Y. & Horne, J.A. (1999) 'One night of sleep loss impairs innovative thinking and flexible decision making', *Organisational Behaviour and Human Decision Processes*, Vol. 78, 128-145.
- Harrison, Y. & Horne, J.A. (2000a) 'The Impact of Sleep Deprivation on Decision Making: A Review', *Journal of Applied Experimental Psychology*, Vol. 6 (3), 236-249.

- Harrison, Y. & Horne, J.A. (2000b) 'Sleep loss and temporal memory', *The Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, Vol. 53a, 271-279.
- Haslam, D.R. (1984) 'The military performance of soldiers in sustained operations', *Aviation, Space and Environmental Medicine*, Vol. 55, 216-221.
- Hatch, M., Ji, B.T., Shu, X.O. & Susser, M. (1997) 'Do standing, lifting, climbing or long hours of work during pregnancy have an effect on fetal growth?', *Epidemiology*, Vol. 8 (5), 530-536.
- Haus, E., Sackett, L.L., Haus, M., Swoyer, Sr. J., Babb, W.K. & Bixby, E.K. (1980) 'Cardiovascular and temperature adaptation to phase shift by intercontinental flights - longitudinal observations'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 375-390, Pergamon Press: Paris.
- Hayashi, T., Kobayashi, Y., Yamaoka, K. & Yano, E. (1996) 'Effect of overtime work on 24-hour ambulatory blood pressure', *Journal of Occupational Medicine*, Vol. 38 (10), 1007-1011.
- Heaton, R., Chelune, G., Talley, J., Kay, G. & Curtiss, G. (1993) *Wisconsin Card Sorting Test Manual: Revised and Expanded*, Odessa FL: Psychological Assessment Resources.
- Hecker, D. (1999) 'Work more, earn more? How work hours affect occupational earnings', *Occupational Outlook Quarterly*, Vol. 43 (4), 45-60.
- Heiler, K. (1998) 'The 'petty pilfering of minutes' of what has happened to the length of the working day in Australia?', *International Journal of Manpower*, Vol. 19 (4), 266-280.
- Henderson, C.W. (1997) 'Study links long hours, job stress to miscarriages', *Women's Health Weekly*, 06/09/97-06/16/97, 9-10.
- Herscovitch, J., Stuss, D. & Broughton, R. (1980) 'Changes in Cognitive Processing Following Short-term Cumulative Partial Sleep Deprivation and Recovery Oversleeping', *Journal of Clinical Neuropsychology*, Vol. 2 (4), 301-319.
- Heslegrave, R.J., Reinish, L., Beyers, J., Picard, L., Horbul, B., Huterer, N., Jovanovic, D., Sabanadzovic, S., Kayumov, L., Chung, S., Flint, A., Hall, G. & Shapiro, C. (2000) 'The differential impact of extended 10-hour shifts on day and night shifts'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 67-72, Peter Lang: Frankfurt.
- Hewitt, P. (1993) *About Time: The revolution in work and family life*, Rivers Oram Press: London.
- Hobson, J & Beach, J.R. (2000) 'An investigation of the relationship between psychological health and workload among managers', *Occupational Medicine*, Vol. 50 (7), 518-522.
- Hockey, G.R.J. (1970) 'Changes in attention allocation in a multicomponent task under sleep deprivation', *British Journal of Psychology*, Vol. 61, 473-480.
- Hollingsworth, R. & Boyer, R. (1997) *Contemporary Capitalism: The Embeddedness of Institutions*, Cambridge University Press: Cambridge.
- Horne, J.A. & Pettitt, A.N. (1985) 'High incentive effects on vigilance performing during 72 hours of total sleep deprivation', *Acta Psychologica*, Vol. 58, 123-139.
- Horne, J.A. & Reyner, L.A. (1995) 'Driver Sleepiness', *Journal of Sleep Research*, Vol. 4 (Sup 2), 23-29.
- Horne, J.A. (1988a) 'Sleep deprivation and divergent thinking ability', *Sleep*, Vol. 11, 528-536.
- Horne, J.A. (1988b) *Why we sleep - the functions of sleep in humans and other mammals*, Oxford University Press: Oxford.
- Horne, J.A. (1993) 'Human sleep, sleep deprivation and behaviour: Implications for the prefrontal cortex and psychiatric disorder', *British Journal of Psychiatry*, Vol. 162, 413-419.
- Horne, J.A. (2000) 'Images of lost sleep', *Nature*, Vol. 403, 605-606.
- Incomes Data Services (1993) *European Working Time Directive*, Council Directive No 93/104/EC of 23 November 1993, The Council of the European Union: Brussels.
- Incomes Data Services (2001) 'Changes to working time rules', *IDS Brief 653: United Kingdom*.
- Irsfeld, M. (2000) 'Overtime Laws Aside: The Industry's Image Can Benefit By Separating Hourly, Management Tasks', *Nation's Restaurant News*, Vol. 34 (36), 27-28.
- Jewett, M.E., Wyatt, J.K., Ritz-De Cecco, A., Khalsa, S.B., Dijk, D-J. & Czeisler, C.A. (1999) 'Time course of sleep inertial dissipation in human performance and alertness', *Journal of Sleep Research*, Vol. 8, 1-8.
- Kinn, S., Khuder, S.A., Bisesi, M.S. & Woolley, S. (2000) 'Evaluation of safety orientation and training programs for reducing injuries in the plumbing and pipefitting industry', *Journal of Occupational Medicine*, Vol. 42 (12), 1142-1147.

- Kitahara, K., Shigemura, K., Yoshizumi, K., Furuki, K. & Higashi, T. (2000) 'Survey on health indices and lifestyle in relation to work systems in an automobile manufacturing plant'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 161-167, Peter Lang: Frankfurt.
- Kjellberg, A. (1975) 'Effects of sleep deprivation on performance of a problem-solving task', *Psychological Reports*, Vol. 37, 479-485.
- Kjellberg, A. (1977) 'Sleep deprivation on some aspect of performance', *Waking and Sleeping*, Vol. 1, 139-143.
- Knauth, P. (1993) 'The design of shift systems', *Ergonomics*, Vol. 36, 15-28.
- Knauth, P. (1996) 'Work organisations and work schedules in the future', in J. Rantanen (Ed.) *Work in the information society. Proceedings of the International Symposium*, 84-89, Finnish Institute of Occupational Health: Helsinki.
- Knauth, P. (1997) 'Changing schedules: Shiftwork', *Chronobiology International*, Vol. 14 (2), 159-171.
- Knauth, P. (2000) 'Innovative design of working time: profitability AND humanity?'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, p 13-18, Peter Lang: Frankfurt.
- Kollar, E.J., Slater, G.R., Palmer, J.O., Doctor, R.F. & Mandell, A.J. (1966) 'Stress in subjects undergoing sleep deprivation', *Psychosomatic Medicine*, Vol. 28, 101-113.
- Kronauer, R.E. (1990) 'A quantitative model for the effects of light on the amplitude and phase of the deep circadian pacemaker, based on human data'. In J. Horne (ed), *Sleep 90'*, Proceedings of the Tenth European Congress on Sleep Research, Dusseldorf, Pontenagel Press, 306-309.
- Kronauer, R.E., Czeisler, C.A., Pilato, S.F., Moore-Ede, M.C. & Weitzman, E.D. (1982) 'Mathematical model of the human circadian system with two interacting oscillators', *American Journal of Physiology*, Vol. 242, R3-R17.
- Labergie, L., Petit, D., Simard, C., Vitaro, F., Tremblay, R.E. & Montplaisir, J. (2001) 'Development of sleep patterns in early adolescence', *Journal of Sleep Research*, Vol. 10, 59-67.
- Lamond, N. & Dawson, D. (1999) 'Quantifying the performance impairment associated with fatigue', *Journal of Sleep Research*, Vol. 8, 255-262.
- Latta, M. (2000) 'Labour market re-entry and working time preferences', *Best*, Vol. 2, 23-26.
- Lauber, J.K. & Kayten, P.J. (1988) 'Sleepiness, circadian dysrhythmia and fatigue in transportation accidents', *Sleep*, Vol. 11, 503-512.
- Lehndorf, S. (1998) 'From 'collective' to 'individual' reductions in working time? Trends and experience with working time in the European Union', *Transfer*, 4/4/1998, 598-620.
- Lester, J., Knapp, T.M. & Roessler, R. (1976) 'Sleep deprivation, personality and performance on a complex vigilance task', *Waking and Sleeping*, Vol. 1, 61-65.
- Lewittes, L.R. & Marshall, V.W. (1989) 'Fatigue and concerns about quality of care among Ontario interns and residents', *Canadian Medical Association Journal*, Vol. 140, 21-24.
- Lowden, A. & Åkerstedt, T. (2000) 'Self-selected work hours - work satisfaction, health and social life'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 345-350, Peter Lang: Frankfurt.
- Lowden, A., Kecklund, G., Axelsson, J. & Åkerstedt, T. (1998) 'Change from an 8-hour shift to a 12-hour shift, attitudes, sleep, sleepiness and performance', *Scandinavian Journal of Work, Environment and Health*, Vol. 24 (supplement 3), 69-75.
- Makowski, Z. (1995) 'Psychological characteristics of work and family as determinants of stress and well-being of women: A preliminary study', *International Journal of Occupational Medicine and Environmental Health*, Vol. 8 (3), 215-222.
- Maruyama, S., Kohno, K. & Morimoto, K. (1995) 'A study of preventive medicine in relation to mental health among middle-management employees (Part 2) - effects of long working hours on lifestyles, perceived stress and working-life satisfaction among white-collar middle-management employees', *Nippon Eiseigaku Zasshi*, Vol. 50 (4), 849-860.
- May, J. & Kline, P. (1987) 'Measuring the effects upon cognitive abilities of sleep loss during continuous operations', *British Journal of Psychology*, Vol. 78, 443-455.
- McCarthy, M. (1993) *Information on Shiftwork for Shiftworkers*, James Cook University of North Queensland: Australia.
- McEwin, B. (1998) *Good Stress and Bad Stress*, Transcript from the Health Report, Radio National, 13 April.
- Merllie, D. & Paoli, P. (2000) *Ten Years of Working Conditions in the European Union: Summary*, European Foundation for the Improvement of Living and Working Conditions: Ireland.

- Milner, S. (1999) 'Time for a Change?: The European Union and the Regulation of Working Time', Paper to ECSA Sixth Biennial Congress, Pittsburgh, 2-5 June.
- Milner, S., Corsi, P. & Leonard, G. (1991) 'Frontal lobe contributions to recency judgements', *Neuropsychologist*, Vol. 29, 601-618.
- Mitler, M., Carskadon, A.M., Czeisler, C.A., Dement, W.C., Dinges, D.F. & Graeb, R.C. (1988) 'Catastrophes, sleep and public policy: consensus report', *Sleep*, Vol. 11, 100-109.
- Morehead, A. (1999) 'A Question of Time', *Work and Family Unit*, Issue 19, 1-4.
- Morris, G.O., Williams, H.L. & Lubin, A. (1960) 'Misperception and disorientation during sleep', *Archives of General Psychiatry*, Vol. 2, 247-254.
- Morton, T. (1998) 'Democratizing domesticity: men and the post-industrial family', *Australian Options*, 8-12.
- Mulcany, C. (1991) 'Workplace stress reaches epidemic proportion', *National Underwriter*, Vol. 95 (4), 20-21.
- Mutran, E.J., Reitzes, D.J., Bratton, K.A. & Fernandez, M.E. (1997) 'Self-esteem and subjective responses to work among mature workers: similarities and differences by gender', *Journals of Gerontology, Series B, Psychological Sciences and Social Sciences*, Vol. 52 (2), 88-96.
- Nachreiner, F., Akkermann, S. & Haenecke, K. (2000) 'Fatal accident risk as a function of hours into work'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 19-24, Peter Lang: Frankfurt.
- Naitoh, P. (1976) 'Sleep deprivation', *Waking and Sleeping*, Vol. 1, 53-60.
- Nakanishi, N., Yoshida, H., Nagano, K., Kawashimo, H., Nakamura, K. & Tatara, K. (2001) 'Long working hours and risk for hypertension in Japanese male white collar workers', *Journal of Epidemiology & Community Health*, Vol. 55 (5), 316-322.
- National Transportation Safety Board (1990) 'Grounding of the US Tank Ship Exxon Valdez on Bligh Reef, Prince William Sound, near Valdez, Alaska, March 24, 1989', National Transportation Board. Maritime Accident Report, NTSB/MAR-90/04.
- Neville, K.J., Bisson, R.U., French, J. & Boll, P.A. (1994) 'Subjective fatigue of C-141 aircrews during Operation Desert Storm', *Human Factors*, Vol. 36, 339-349.
- Nishiyama, K. & Johnson, J.V. (1997) 'Karoshi-Death from overwork: Occupational health consequences of the Japanese production management', *International Journal of Health Services*, 520-532.
- Nocera, A. & Khursandi, D.S. (1998) 'Doctors' working hours: can the medical profession afford to let the courts decide what is reasonable?', *Medical Journal of Australia*, Vol. 168, 616-618.
- Norton, R. (1970) 'The effects of acute sleep deprivation on selective attention', *British Journal of Psychology*, Vol. 61, 157-161.
- Ong & Kogi, K. (1990) 'Shiftwork in developing countries: Current issues and trends'. In A.J. Scott (Ed), *Shiftwork*, 417-428, Hanley & Belfus: Philadelphia.
- Parliamentary Inquiry (2000) *Beyond the Midnight Oil: Managing Fatigue In Transport*, The Parliament of the Commonwealth of Australia, House of Representatives: Canberra.
- Pease, B. & Wilson, J. (1991) 'Men in Families', *Issues facing Australian Families*, 54-64.
- Peetz, D., Gardner, M., Brown, K & Berns, S. (1999) 'A Gender equity index and Australian Workforce Performance: Conference Proceedings', *The Association of Industrial Relations Academics of Australia and New Zealand: Adelaide, February*.
- Percival, J.E., Horne, J.A. & Tilley, A.J. (1982) 'Effects of sleep deprivation on tests of higher cerebral functioning', *Sleep 1982: 6th European Congress of Sleep Research*, 390-391.
- Philip, P., Ghorayeb, I., Leger, D., Menny, J.C., Bioulac, B., Dabodie, P. & Guilleminault, C. (1997) 'Objective measurement of sleepiness in summer vacation long-distance drivers', *Electroencephalographic Clinical Neurophysiology*, Vol. 102, 383-389.
- Philip, P., Taillard, J., Guilleminault, C., Quera Salva, M.A., Biolac, B. & Ohayon, M. (1999) 'Long distance driving and self induced sleep deprivation among automobile drivers', *Sleep*, Vol. 22, 475-480.
- Philip, P., Taillard, J., Niedhammer, I., Guilleminault, C. & Bioulac, B. (2001) 'Is there a link between subjective daytime somnolence and sickness absenteeism? A study in a working population', *Journal of Sleep Research*, Vol. 10, 111-115.
- Pilcher, J.J. & Huffcutt, A.I. (1996) 'Effects of sleep deprivation on performance: A meta analysis', *Sleep*, Vol 19, 318-326.

- Price, W.J. & Holley, D.C. (1980) 'The last minutes of flight 2860: an analysis of crew shiftwork scheduling'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Vol. 30, 287-294, Pergamon Press: Paris.
- Probert, B. (1996) 'The Social Shaping of Work: Struggles Over New Boundaries', 5-27.
- Pternitis, C. (1980) 'Shiftwork: Work load, Fatigue and States of Vigilance'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 171-177, Pergamon Press: Paris.
- Pugliesi, K. (1995) 'Work and wellbeing: gender differences in the psychological consequences of employment', *Journal of Health and Social Behaviour*, Vol. 36 (1), 57-71.
- Revicki, D.A., Whitley, T.W. & Gallery, M.E. (1997) 'Organisational characteristics, perceived work stress, and depression in emergency medicine residents', *Hospital Topics*, Vol. 75, 30-37.
- Robins, N. (1995) *The Girl Who Died Twice: Every Patient's Nightmare: The Libby Zion Case and the Hidden Hazards of Hospitals*, Delacorte Press: New York.
- Rosekind, M., Smith, R., Miller, D., Co, E., Gregory, K., Webbon, L., Gander, P. & Leboq, Z. (1995) 'Alertness management: strategic naps in operational settings', *Journal of Sleep Research*, Vol. 4 (Sup1), 62-66.
- Rutenfranz, J. & Knauth, P. (1976) 'Hours of Work and Shiftwork', *Ergonomics*, Vol. 19 (3), 331-340.
- Sabel, C. & Zeitlin, J. (1997) *World of Possibilities: Flexibility and Mass Production in Western Industrialisation*, Cambridge University Press: Cambridge.
- Sanquist, T.F., Raby, M., Forsythe, A. & Carvalhais, A.B. (1997) 'Work hours, sleep patterns and fatigue among merchant marine personnel', *Sleep Research*, Vol. 6 (4), 245-251.
- Schein, E.H. (1957) 'The effects of sleep deprivation on performance in a simulated communication task', *Journal of Applied Psychology*, Vol. 41, 247-252.
- Scherrer, J. (1980) 'Man's Work and Circadian Rhythm Through the Ages'. In A. Reinberg, N. Vieux & P. Andlauer (Eds) *Night and Shiftwork Biological And Social Aspects: Advances in the Biosciences*, Volume 30, 1-10, Pergamon Press: Paris.
- Sheehan, P. (1997) 'Australia between East and West: aspects of economic growth and employment beyond 2000'. In P. Sheehan (Ed), *Economic growth and employment*, 21-50, The Brotherhood of St Laurence: Fitzroy
- Shields, M. (1999) 'Long working hours and health', *Health Rep*, Vol. 11 (2), 33-48.
- Smith, L., Folkard, S., Tucker, P. & MacDonald, I. (1998) 'Work shift duration: a review comparing eight hour and 12 hour shift systems', *Occupational and Environmental Medicine*, Vol. 55 (4), 217-229.
- Smith, S.J.L. (1996) 'Junior Doctors Argue Over Longer Hours', *Student BMJ*, Vol. 4 (42), 223-224.
- Spencer, M.B., Rogers, A.S., Birch, C.L. & Belyavin, A.J. (2000) 'A diary study of fatigue in air traffic controllers during a period of high workload'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 251-256, Peter Lang: Frankfurt.
- Spurgeon, A., Harrington, J.M., Cooper, C.L. (1997) 'Health and safety problems associated with long working hours: a review of the current position', *Occupational and Environmental Medicine*, Vol. 54 (6), 367-375.
- Steptoe, A., Wardle, J., Lipsey, Z., Mills, R., Oliver, G., Jarvis, M. & Kirschbaum, C. (1998) 'A longitudinal study of work load and variations in psychological well-being, cortisol, smoking and alcohol consumption', *Annals of Behavioural Medicine*, Vol. 20 (2), 84-91.
- Tamaki, K. (1998) 'Karoshi - Recently certified suicides from overwork', *Japan Occupational Safety and Health Resource Centre Newsletter*, No. 15, 1-3.
- Taub, J.M. & Berger, R.J. (1973) 'Performance and Mood Following Variations in the Length and Timing of Sleep', *Psychophysiology*, Vol. 10 (6), 559-570.
- Tepas, D. (2000) 'Should a general recommendation to nap be made to workers?'. In S. Hornberger, P. Knauth, G. Costa & S. Folkard (Eds) *Arbeitswissenschaft in der betrieblichen Praxis 17: Shiftwork in the 21st Century*, 25-30, Peter Lang: Frankfurt.
- Tilley, A. & Warren, P. (1984) 'Retrieval from semantic memory during a night without sleep', *The Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, Vol 36A, 281-289.
- Totterdell, P., Spelten, E., Smith, L., Barton, J. & Folkard, S. (1995) 'Recovery From Work Shifts: How Long Does It Take?', *Journal of Applied Psychology*, Vol. 80 (1), 43-57.
- Tsanera, N., Nicolova, R., Topalova, M. & Doner, S. (1990) 'Changes in the organism of shiftworkers operating a day and night 12-hour schedule in carbon disulfide production'. In G. Costa, G. Cesena, K. Kogi & A. Wedderburn (Eds), *Shiftwork: health, sleep & performance*, 324-329, Peter Lang: Frankfurt am Main.

- Tuntiseranee, P., Olsen, J., Geater, A. & Kor-anantakul, O. (1998) 'Are long working hours and shiftwork risk factors for subfecundity? A study among couples from southern Thailand', *Occupational and Environmental Medicine*, Vol. 55 (2), 99-105.
- UAW (2001) 'Haymarket Riots', UAW 2166, Shreveport, Louisiana.
- Uehata, T. (1991) 'Long working hours and occupational stress-related cardiovascular attacks among middle-aged workers in Japan', *J Hum Ergol*, Vol. 20 (2), 147-153.
- United States Nuclear Regulatory Commission (1979) 'Investigation into the March 28, 1979, Three Mile Island Accident by the Office of Inspection and Enforcement', Investment report no.50-320/j79/10. NTIS NUREG-0600.
- Vermeesch, J. (1999) National Campaign on Dangerous Hours: Reasonable Hours are Safer Hours, ACTU: <http://www.actu.asn.au/campaigns/hours/index.htm>.
- Wallace, M. (1989) 'The 3 day week: 12 hour shifts'. In M. Wallace (Ed.), *Managing Shiftwork*, 49-56, Brain Behaviour Research Institute, Department of Psychology, LaTrobe University: Bundoora, Australia.
- Watts, A. (1972) *The Book: On the Taboo Against Knowing Who You Are*, Vintage Books: New York.
- Webb, W.B. (1986) 'Sleep deprivation and reading comprehension', *Biological Psychology*, Vol. 22, 169-172.
- Wedderburn, A. (2000) 'Working time in the retail sector', *Best*, Vol. 2, 1-13.
- Whitmore, J. & Fisher, S. (1996) 'Speech during sustained operations', *Speech Communication*, Vol. 20, 55-70.
- Wilkinson, R.T. (1965) 'Sleep deprivation'. In O.F. Edholm & A.L. Bacharach (Eds) *Physiology of human survival*, 399-430, Academic Press: London.
- Williamson, A.M. & Feyer, A.M. (2000) 'Moderate Sleep Deprivation Produces Impairments in Cognitive and Motor Performance Equivalent to Legally Prescribed Levels of Alcohol Intoxication', *Occupational Environmental Medicine*, Vol. 57 (10), 649-655.
- Wimmer, F., Hoffman, R.F., Bonato, R.A. & Moffitt, A.R. (1992) 'The effects of sleep deprivation on divergent thinking and attention processes', *Journal of Sleep Research*, Vol. 1, 223-230.
- Work and Family Unit (1998) *Work and Family*, Issue 17, August.
- Wu, J.C. & Bunney, W.E. (1990) 'The biological basis of an antidepressant response to sleep deprivation and relapse: A review and hypothesis', *American Journal of Psychiatry*, Vol. 147, 14-21.
- Yamada, S. (2001) *Development of Activities of National and Local Centers for Health and Safety of Working People to Foster a New Current in the Labor Movement in Japan*, Japan Center for Health and Safety of Working People: Japan.
- Yassouridis, A., Steiger, A., Klinger, A. & Fahrmeier, L. (1999) 'Modelling and exploring human sleep with event history analysis', *Journal of Sleep Research*, Vol. 8, 25-36.
- Yates, J., Harley, M. & Jayes, B. (2000) 'Consultant work patterns. Blade runners', *Health Services Journal*, Vol. 110 (5702), 20-23.
- Yedidia, M.J., Lipkin, M. Jr., Schwartz, M.D. & Hirschhorn, C. (1993) 'Doctors as workers: work-hour regulations and interns' perceptions of responsibility, quality of care, and training', *Journal of General Internal Medicine*, Vol. 8 (8), 429-435.



## **APPENDICES**

Appendix A: The Psychosocial Impact of Long Working Hours

Appendix B: Overview of Case Studies

Appendix C: The Australian Rail Industry: A Case Study in Coordinated Program Development

Appendix D: Mobil Australia: A Case Study

Appendix E: Fatigue Modelling

Appendix F: A quantitative model of work-related fatigue: background and definition

Appendix G: A quantitative model of work-related fatigue: empirical evaluations

Appendix H: The Psychosocial Index

Appendix I: The European Community Directive on Working Time

Appendix J: Beyond the Midnight Oil: Managing Fatigue in Transport

Appendix K: ACTU Test Case on Reasonable Working Hours





Centre for Sleep Research University of South Australia @ TQEH, 28 Woodville Rd, Woodville SA