Accompanying letter to -

"*Work Design, Fatigue and Sleep*" – a Report by the Centre for Sleep Research

As the peak industry organisation representing Australia's exploration, mining and minerals processing industry, nationally and internationally, the Minerals Council of Australia (MCA) considers the safety and health of the industry's workforce as its number one priority.

The achievement of a safe workplace is a constant challenge, which requires the design of appropriate work practices, the training of employees and securing the more elusive attitudinal compliance coming together to achieve the desired result.

To assist the industry to achieve its goals, the MCA encourages the dissemination of good science. In this context, to promote a better understanding of the relationship between working hours, fatigue management and employee health, safety and welfare, the MCA commissioned Dr Angela Baker and Dr Sally Ferguson of the Australian Centre for Sleep Research at the University of South Australia, to document the relationship between sleep, working arrangements and fatigue, drawing on their own experience and research and the publicly available literature.

Working hours and fatigue management are not new to the minerals industry. Given the diversity of minerals production and processing operations and working environments and the complexity of social and cultural factors, it is simply not possible to design generic roster systems. As the researchers concluded, there is no such thing as a perfect roster, nor is there such a concept as "no risk" – risk management is the key.

These resource documents prepared by Drs Baker and Ferguson present information in a non-prescriptive manner relevant to managing fatigue in the workplace with the intention of assisting those responsible for the design and management of working arrangements. The objective of this work is to promote those relevant elements a minerals company should take into account when designing shift roster systems within their risk management strategies. The documents do not cover fatigue management strategies for fly-in fly-out operations.

The publication *Work Design, Fatigue and Sleep* is presented as two documents – a summary booklet, and a larger volume providing the underlying scientific evidence. They are provided as a resource to assist those responsible for designing working arrangements.

This information is made available to assist companies in striving towards establishing a safe and secure workplace free of industrial accidents. It is a matter for each company to decide what specific risk management arrangements are appropriate in individual circumstances.

MINERALS COUNCIL OF AUSTRALIA

July 2004

WORK DESIGN, FATIGUE and SLEEP
A resource document for the minerals industry

By Dr Angela Baker and Dr Sally Ferguson

Contents

Glossary

Circadian rhythms
Human beings are programmed to sleep during the night hours and to be active during the day. The sleep/wake cycle is a circadian rhythm. The term circadian comes from two Latin words, circa – about, and diem – a day. Thus circadian rhythms refer to physiological functions that cycle over a day. Examples are the sleep/wake cycle, alertness and performance, body temperature, production of hormones like melatonin and cortisol, and heart rate. These rhythms are generated by a clock in our brains, which controls their timing. Circadian rhythms do not generally adjust easily to shiftwork.

Fatigue
A state of impaired physical and/or mental performance and lowered alertness arising as a result of inadequate restorative sleep. Other mediators of fatigue are time of day and length of time awake.

Forbidden zones
The times at which the circadian rhythm inhibits sleep are known as the forbidden zones. They are approximately between 5pm and 9pm and between 8am and 12 noon.

NREM sleep
Non-rapid eye movement sleep. Can be divided into four stages that relate to the depth of sleep (Stages 1 to 4). Stage 1 is the lightest and Stage 4 sleep is the deepest.

REM sleep
Rapid eye movement sleep, or dreaming sleep.

Sleep debt
Occurs when an individual does not achieve adequate restorative sleep. A sleep debt can accumulate over a period of days of inadequate sleep or a night without sleep. This debt may result in impaired performance, reduced alertness and higher levels of sleepiness and fatigue. A sleep debt can only be repaid with recovery sleep.

Sleep deprivation
Loss of sleep. This occurs in two forms – total sleep deprivation (a whole night's sleep loss) or partial cumulative sleep deprivation (some sleep lost each night over a period of nights). Both forms of sleep deprivation result in reduced levels of alertness and performance.

Sleep duration
The length of time an individual sleeps in a single sleep period.

Sleep opportunity
This describes the time within a 24-hour period that a person has available for sleep. Work time and commute time are not considered available for sleep and are therefore not included. Within a sleep opportunity period a person may sleep, eat, socialise, relax carry out home duties or other such activities. The balance between these activities will determine the amount of actual sleep the person gets. Hours of work, together with commute times, primarily dictate the duration of the sleep opportunity, and the type of work (e.g. 9am to 5pm, or shiftwork) will dictate whether the sleep opportunity is regular or irregular, predictable or unpredictable.

Working time arrangement
This term refers to design of work arrangements and the management of work hours, including overtime. It also encompasses breaks, scheduling of tasks etc.

Perhaps the best advice that can be offered to organisations considering a change in working time arrangements is that there is no 'perfect roster'. Nevertheless, with good management and open discussion, the working time arrangement can begin to reflect the needs of both the employees and the organisation.

'The whole of human organisation has its shape in a kind of rhythm … The larger rhythms of night and day, of sleep and waking hours, of hunger and its gratification, and finally the big four, work and play and rest and sleep, which our organism must be able to balance even under difficulty. The only way to attain balance in all this is actual doing, actual practice, a program of wholesome living as the basis of wholesome feeling and thinking and fancy and interest'

(Meyer, 1922, p6)

Acknowledgements
The authors gratefully acknowledge the input from the Horwood Working Group, Rob Rawson, Del Da Costa, Phil Turner, Steve Pickett, Drew Dawson, Chris Jones, Greg Roach and Nicole Lamond.

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Dr Sally Ferguson is a research fellow with the Centre for Sleep Research, University of South Australia. Her PhD examined the circadian 'body clock' and neurotransmission. Sally's recent work has focused on human circadian function, sleep and fatigue, particularly in its relation to the minerals and medical sectors.
She studied at Adelaide University in the School of Medicine.

Caveat
This work was commissioned to assist people in the minerals industry to assess existing or proposed working time arrangements, audit the effectiveness of those arrangements, and identify fatigue related issues and concerns.

This document may help people identify areas that require corrective action or continual active management and those that would benefit from review and monitoring. Ultimately the in house audit process might help operational sites to manage hours of work in relation to fatigue.

Further, this document does not seek to address fatigue management strategies for fly in fly out (FIFO) operations as there is a paucity of valid research in this area.

1 Introduction

1.1 Background

Work Design, Fatigue and Sleep is a comprehensive resource developed for the Australian Minerals Industry to provide guidance in the development, assessment and/or modification of working time arrangements.

It has been designed to provide a practical, easy to use process to assess and develop working time arrangements that minimise sleep loss and work-related fatigue.

The approach taken to create this document is unique. The document provides a functional and scientific basis for making decisions about the management of fatigue and work design. The basic premise is that individuals need a minimum amount of sleep each 24 hours in order to maintain performance. Using this 'sleep focused' approach it will be possible for those responsible for working time arrangements to provide structures that protect sleep and reduce and moderate work related fatigue.

In order to develop working time arrangements that aid sleep, health and wellbeing, this resource document provides detailed information about the interaction between human physiology and the working time arrangement.
One key area of omission in the document is fly in/fly out (FIFO) operations as there is a paucity of validated research on the management of fatigue in FIFO work. While the general principles associated with the development of fatigue in humans do not vary with work settings such as FIFO, the effective management of fatigue in these cases may require different strategies and approaches than those applied in community-based operations. Further research on FIFO operations is needed.

Work Design, Fatigue and Sleep is presented as two documents:

> The booklet, which contains the basic questions that should be addressed by those administering working time arrangements. These questions will provide guidance for the user with respect to modifying existing arrangements or designing new arrangements. There is also summary information about managing fatigue inherent in the working time arrangement.

> This larger volume, which provides the underlying scientific evidence describing the importance of sleep and its effect on fatigue. It also provides more detailed information about managing fatigue on an organisational level and designing working time arrangements that minimise fatigue by maximising the opportunity for sleep.

1.2 Rationale and framework

This section outlines the framework for the development of the resource, with sleep as the major focus of any fatigue management system.

The impact of fatigue on individuals, organisations and the community is significant. An obvious area in which fatigue plays a major role in injuries and fatalities is the road. While the risks associated with alcohol and speeding on the road are well understood by the community, the risks associated with fatigue are not as widely understood or managed. This is despite statistics indicating that between 5 and 15 per cent of all vehicle accidents in Australia that involve fatalities are fatigue related. In the road transport industry (ie, heavy vehicle freight), fatigue related road crashes represent between 10 and 40 per cent of the total crashes. Fatigue related accidents are also reported in the rail, air and maritime sectors of the transport industry, as well as in industries such as nuclear power generation, minerals, medical, and emergency services. In response to such statistics, and together with improved knowledge of the causes of and contributors to fatigue, the management of fatigue in the workplace is becoming a priority.

As in other industries in Australia, the minerals industry has dealt with a number of challenges in recent years. These include but are not limited to:

- Pressure to enhance capital utilisation.
- Heightened competition.
- Increasing financial expectations of employees.
- Management pressure to decrease employee numbers.
- Increasing perceived value of high hours of work and flexibility from employees.

One of the major outcomes of such challenges is a shift in work hours. As a result, the workforce now works longer, more flexible hours and this in turn means more shiftwork. There is little doubt that the benefits of flexible hours are many and varied. However, poorly managed working time arrangements have the potential to undermine the benefits associated with flexible hours. Mutually beneficial working time arrangements will be difficult to develop without an understanding of the financial, biomedical, physiological and psychosocial impacts of shiftwork and fatigue.

Fatigue management should be viewed as a shared responsibility. Employers have a duty of care to provide safe work schedules that permit adequate time for an individual to sleep, rest and recover, as well as to fulfill their social and domestic responsibilities. Conversely, employees have a duty of care to use their time away from work in a safe and responsible way. That is, they should ensure that they obtain sufficient sleep and recovery to complete their duties safely and responsibly.

At the most basic level, fatigue can be viewed as the consequence of inadequate restorative sleep. Sleep deprivation and fatigue are largely dependant on working time arrangements. Long and irregular work hours significantly affect the time available for sleep, or sleep opportunity. Figure 1.1 illustrates some aspects of work design that directly affect sleep opportunity, each of which is discussed in more detail in section 7.

In brief however, longer shifts reduce the amount of time available for sleep. Night work requires individuals to try to sleep at biologically inappropriate times in the 24-hour day, also affecting the restorative value of sleep periods. However, there are a number of other factors in an individual’s life outside work that also interfere with sleep and these are described in Figure 1.1. For example, social and domestic responsibilities can affect the time available for sleep, while environmental factors can directly affect the quality and quantity of sleep. In order to develop work patterns that aid both wellbeing and health, it is important to have an understanding of physiology and the human condition and its interaction with the business.

Inadequate restorative sleep is the major cause of fatigue. Figure 1.2 demonstrates the relationship between sleep, fatigue and performance. Increased fatigue levels are associated with impaired performance with obvious implications for safety in the workplace.

The next section will help the user to identify areas of concern, if any, in the design of their working time arrangements, and to consider whether a redesign might be worthwhile. It provides a series of suggestions to address issues revealed by the questions in Section 2.

If a redesign is appropriate, subsequent sections provide information about fatigue and its management, together with possible processes for change. The scientific evidence that supports this information is also contained in this document.

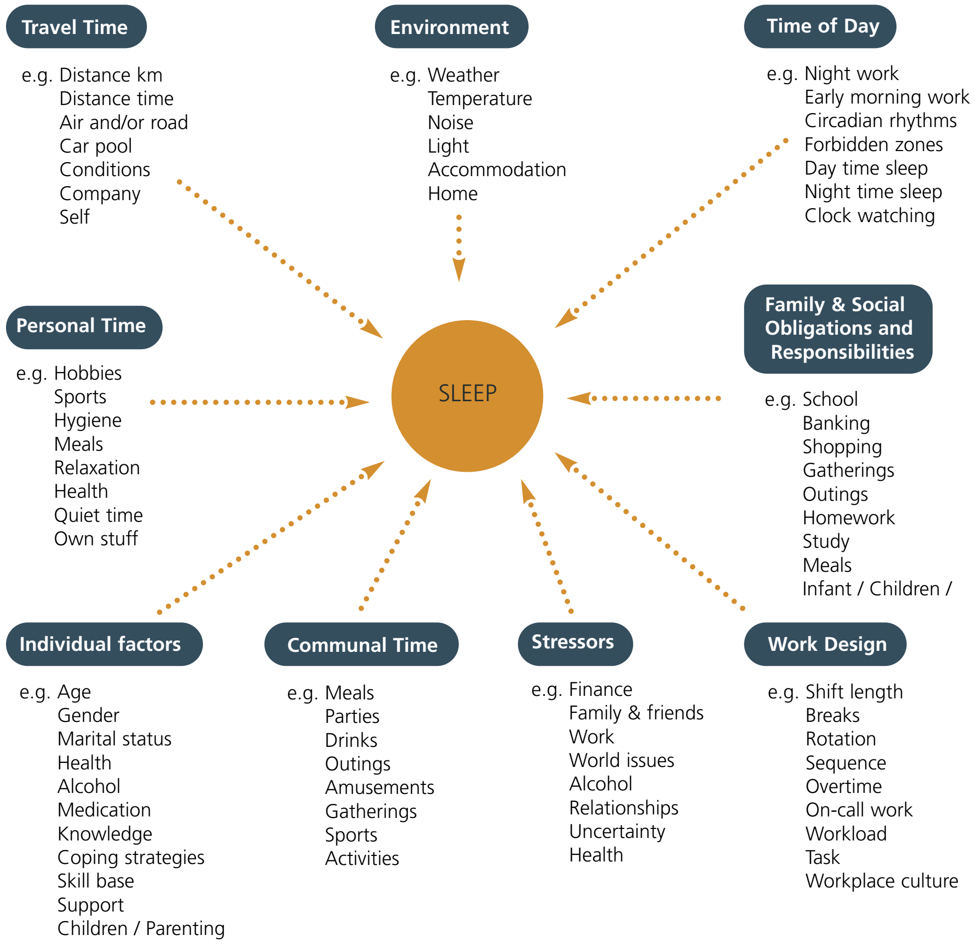

Figure 1.1 The schematic illustrates the many things which can impact on an individual's sleep. This occurs either by reducing the time available/ allocated for sleep (e.g. social obligations), or reducing the quality/quantity of the sleep (e.g. environment).

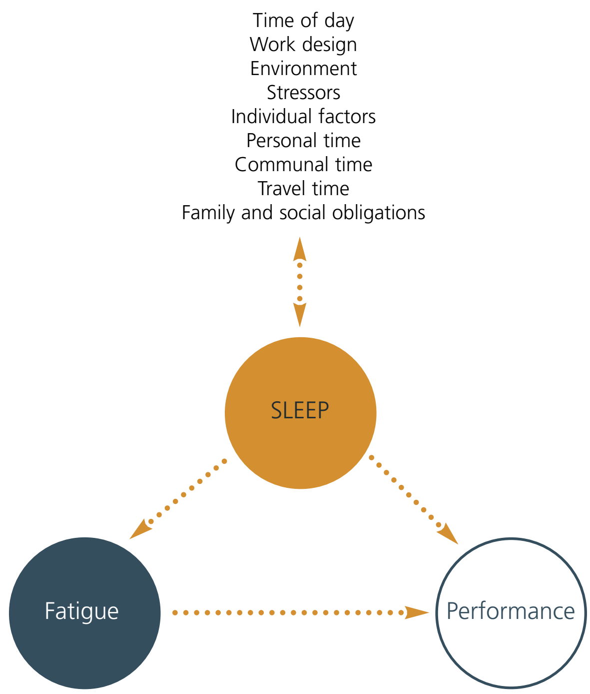

Figure 1.2 Sleep Fatigue Performance diagram

2 Working time arrangements

This section will help you to design working time arrangements that provide opportunities to obtain recovery sleep.

The questions in this section may challenge you to consider a review of working time arrangements. If you decide to do this you will find helpful information in Section 3, Designing working time arrangements, and in subsequent sections dealing with fatigue, its management and countermeasures, and the scientific evidence which supports this document.

If you continue with your existing working arrangements, or if you have to use them until you can make wider changes, a number of specific suggestions are included to help reduce the impact of sleep loss and fatigue.

In the past, traditional approaches to managing fatigue in the workplace have been prescriptive – measures such as regulating hours, breaks and time off duty. However, much of the research into fatigue has found these measures can be functionally problematic and restrictive, and may sometimes make the problem worse. Prescriptive measures are not based on knowledge about human physiology. A more recent approach in Australia and elsewhere is to focus on performance-based outcomes for managing fatigue. The Western Australian and Northern Territory governments regulate their commercial trucking industries in this fashion and railways in the United Kingdom use a similar technique to provide flexibility.

An outcomes approach recognises the range of needs of different organisations in different environments, with different operational requirements and exposures. The emphasis is on reducing fatigue related risk rather than focusing solely on hours of work.

This document provides different strategies based on decisions to maintain your current working time arrangement as it is, alter working time arrangements to better manage fatigue, or develop a new working time arrangement.

Apart from the suggestions under each topic, some issues and measures are universal.

Always keep in mind that:

> A minimum amount of sleep is required to maintain performance. It is recommended that individuals obtain between seven and eight hours per 24-hour period. However this does vary between individuals.
Section number: 6.1; 6.3; 6.5; 6.6

> Not all times of the day are equally conducive to sleep. There are ‘forbidden zones’ for sleep between 8am-12 noon and 5pm-9pm during which it can be more difficult to get to sleep. A 12-hour break starting at 7am will generally produce less quality sleep than a 12-hour break starting at 7pm.
Section number: 6.3; 7.2.1

> A fatigue management plan is a very valuable tool. It enables a company or organisation to ensure all stakeholders are working to minimise the risks of fatigue.
Section number: 4; 5

> Inadequate rest and recovery between work shifts might mean that an individual has to resume work in an unrested and therefore an unfit state.
Section number: 6.6

> Breaks are important. In some circumstances it can be beneficial to allow breaks to be self-selected. In an eight-hour shift three breaks should be made available; at least one 30-minute minimum meal break and two 10-minute ‘coffee’ breaks. In a 12-hour shift there should be allowance for longer coffee breaks, ie, 20 minutes.
Section number: 7.2.6

> 'Sleep opportunities' span more than just sleeping time. They cover the time in which a person has an opportunity to sleep, to eat and to socialise and relax. Work time and commuting time are not available for sleep and therefore are not included in the sleep opportunity.
Section number: 7.2.3; 7.3.6

2.1 Sleep

Things you should know:

> A minimum amount of sleep is required to maintain alertness and performance.
Section number: 6.5; 6.6

> Inadequate sleep over a series of nights/days results in a sleep debt.
Section number: 6.5

> Partial sleep loss over several days can have a worse effect than a single, whole night's sleep loss.
Section number: 6.5

> Daytime sleep is lighter and shorter and less recuperative than night sleep.
Section number: 6.3; 6.4

> Travel time to and from work affects the time people have for sleep.
Section number: 7.2.10

> People often sacrifice sleep in favour of other non-work activities.
Section number: 7.3

Things you can do:

Does the schedule provide opportunities for a continuous seven to eight hour sleep each 24 hours?

and

Does the schedule provide for at least 50 hours' sleep in every seven days?

If the answer to either question is NO, consider:

> Changing working time arrangements to provide more sleep opportunity. Refer to section 3, Designing working time arrangements.

> Maintaining the present working time arrangements, but helping individuals get adequate sleep by:
- Having no less than a 12-hour break between shifts.
- Avoiding overtime on 12-hour shifts.
- Providing facilities for individuals to rest at work.
- Promoting self-selected rest breaks. These are more beneficial than scheduled breaks.
- Protecting breaks as much as is practical if there are emergencies, unplanned events, or absences.
- Under extenuating circumstances or in a crisis, providing more frequent breaks during the work period, and providing longer breaks away from the workplace when the crisis is over.

2.2 Consecutive night shifts

Things you should know:

> People don't adapt fully to night work.
Section number: 7.2.2; 7.2.5

> Night work requires sleep during the day, which is shorter, lighter, and less restorative.
Section number: 6.4

> Inadequate or poor sleep over a series of days results in accumulated sleep loss and a sleep debt.
Section number: 6.5

> At least two full nights' sleep are needed to recover fully from a night without sleep.
Section number: 6.7

> Research indicates two or three consecutive night shifts require one to two days for recovery and seven consecutive night shifts require three or more recovery days. This may vary if other risk management strategies promote recovery
Section number: 7.2.2

> Alertness and performance are lowest at night. Accident risk is highest between 3am and 5am.
Section number: 7.2.1

> Accident risk is significantly higher on the third night shift and higher still on the fourth night, compared with the first.
Section number: 7.2.2

> The longer it takes to recover from night shift, the less useable non-work time is available.
Section number: 7.3

Things you can do:

Does the work design include four or more consecutive night shifts?

If YES you should consider:

> Changing the work design to reduce the number of consecutive night shifts. Refer to section 3, Designing working time arrangements.

or

> Keeping the present system and helping promote proper rest by:
- Ending shift times no later than 8am.
- Allowing individuals to choose their break times but observe the minimum breaks for the shift length.
- Limiting each night shift to 12 hours or less, including overtime.
- Providing at least a 12-hour break between shifts.
- Taking into account commute times.

2.3 Early work start times

Things you should know:

> Work start times before 6am require people to wake up early and therefore truncate their sleep in the morning. Also, there is a 'forbidden zone' in the evening that makes it difficult to get to sleep earlier than normal to compensate for early awakening.
Section number: 6.3; 6.4; 7.2.2

> An early start can cause people to worry about not being able to wake up in time, resulting in disturbed sleep or 'clock watching'.
Section number: 6.3; 7.2.10

> Inadequate or poor sleep over a few nights/days results in accumulated sleep loss and a sleep debt.
Section number: 6.5

> A sleep debt reduces alertness and performance, which increases accident risks.
Section number: 6.5; 6.6

> Early starts may require people to work at the low point in the circadian performance and alertness rhythm, with implications for safety.
Section number: 7.2.1

> Early starts may require commuters to drive at the low point in their performance/alertness rhythms.
Section number: 7.2.10

Things you can do:

Does the morning or day shift start before 6am?

If YES consider:

> Changing this arrangement to eliminate or minimise starts before 6am. Refer to section 3, Designing working time arrangements.

or

> Keeping a pre-6am start and helping individuals get adequate rest by:
- Not adding any overtime to the BEGINNING of a day shift with a pre-6am start.
- Making sure individuals don't have more than five consecutive pre-6am start shifts.
- Providing transport for long commutes.

2.4 Shift Length

Things you should know:

> Long shifts reduce the time available for sleep. Inadequate sleep over a series of nights or days results in accumulated sleep loss.
Section number: 6.5

> Maintaining a balance between work and non-work activity can be difficult and sleep is often sacrificed for other non-work activities.
Section number: 7.3

> A longer time at work maintaining mental and physical effort needs longer recovery time.
Section number: 6.7

> Longer shifts reduce time available for non-work activities such as family, social and leisure activities.
Section number: 7.3

> Shifts longer than 12 hours are associated with very high accident risk. Research has shown that risk rises after nine hours, and rises exponentially after 12 hours. Research has also shown that accident risk increases when 4 or more consecutive 12 hour shifts are worked.
Section number: 7.2.4; 7.2.7

> The nature of the work and the workload will largely dictate the appropriate shift length at a particular site.
Section number: 7.2.3.2

> A risk management approach can determine whether shifts longer than eight hours are appropriate for individual sites.
Section number: 3.3

> The positive aspects of extended shifts include prolonged periods of time off, providing opportunity for complete recovery before a return to work. **Section number:** 7.3

Things you can do:

Is the normal shift length more than eight hours?

If YES consideration should be given to the following to help individuals get proper rest, including:

- Ending night shifts no later than 8am.
- Allowing individuals to choose their break times, but observing the minimum breaks for the shift length.
- Limiting single shifts to 12 hours, including overtime.
- Ensuring breaks of at least 12 hours between shifts.
- Limiting the number of consecutive 12 hour shifts.

2.5 Direction of rotation

Forward rotation means morning shift is followed by afternoon shift then night shift. Backward rotation means morning shift is followed by night shift then afternoon shift.

Things you should know:

> Forward rotating shifts match the body's natural rhythmic changes and therefore reduce performance impairment due to desynchronisation.
Section number: 7.2.5

> Forward rotating shifts result in fewer disturbances to biological rhythms, including sleep.
Section number: 7.2.5

> Shift systems that rotate forward maximise the quality and quantity of sleep.
Section number: 6.3; 7.2.5

Things you can do:

Is the rotation of shifts in a forward pattern?

If the answer is NO then you should consider:

> Changing the working time arrangement to a forward rotation (refer section 3, Designing working time arrangements).

or

> If you continue operating under a backward rotating regime, you can help to maximise sleep opportunity and reduce fatigue by ensuring:
- A minimum 12-hour break between shifts.
- Night shifts that end no later than 8am.
- Allowing individuals to choose their break times but observe the minimum breaks for the shift length.
- A minimum 48-hour break after a block of night shifts, this will provide for two night period sleeps.

2.6 Overtime

Things you should know:

> Overtime added to the end of a shift can dramatically reduce time available for sleep, resulting in sleep debt.
Section number: 6.5

> Overtime on scheduled days off can affect the opportunity for recovery sleep, which people may use to 'repay' their sleep debt.
Section number: 6.5

> A minimum amount of sleep is required to maintain alertness and performance.
Section number: 6.1; 6.6

> Unplanned overtime can disrupt non-work time. Therefore voluntary unplanned overtime might be better than mandatory unplanned overtime.
Section number: 7.3

> People who work beyond 12 hours might not be fit for work.
Section number: 7.2.4

Things you can do:

Is overtime worked?

If YES, assess the possibility of eliminating overtime.

If eliminating overtime is not practical, you can minimise and manage fatigue by:

- Avoiding overtime at either end of a 12-hour shift.
- Allowing individuals working overtime at the end of a regular shift to take a break before beginning overtime.
- Providing opportunity for people working overtime on days off to have 50 hours' sleep in every seven-day period.
- Allowing individuals to choose their break times, but observing the minimum breaks for the shift length.
- Ensuring breaks of at least 12 hours between the end of one work period and the beginning of the next, whether it has been a regular shift or overtime.
- Recording and monitoring the individual overtime of all employees and contractor staff.
- Using overtime records to assign overtime based on recent hours of work and sleep opportunities.

2.7 On-call work

Things you should know:

> Being called into work reduces the opportunity for sleep.
Section number: 6.3

> The anticipation of being called out can reduce sleep quality.
Section number: 7.2.9

> Depending on the time of day the on-call period occurs, sleep quality can be greatly affected. On-call work often occurs at night, when the best quality sleep is achieved.
Section number: 6.3

> Being on call for consecutive days or nights might interrupt successive sleep periods, resulting in cumulative sleep loss.
Section number: 6.5

> At least two full nights' sleep are required to recover fully from a night without sleep.
Section number: 6.7

> If an individual is called out between work shifts they might not recover adequately before recommencing work.
Section number: 6.7

> Impaired alertness and performance are common when people first wake from sleep.
Section number: 7.2.9

> On-call work often occurs at night when alertness and performance are lowest.
Section number: 7.2.1

> Being on call might restrict access to non-work time and limit a person's activities in the non-active on-call period.
Section number: 7.3

Things you can do:

Do you require people to be on call?

If YES, modify the working time arrangement so that cover is achieved without the need for on-call work;

or

Help individuals who are on call to maintain their fitness for work by:

- Limiting the number of consecutive 24-hour periods that an individual is on call.
- Being flexible about the time individuals who have been called out are required to start work again.
- Rostering more than one person to be on call at any time so that someone who is not well rested is not required to work.
- Avoiding individuals on call having to transport themselves to and from the workplace. Arrangements could include use of taxis or pickups by shift supervisors.

2.8 Returning after a break

Things you should know:

> Shiftworkers often sleep longer and later on days off to catch up on sleep lost while on shift. Thus, after time away from work for annual or long service leave, sleep patterns might change significantly from those established while on shift.
Section number: 7.2.8

> Readjusting to the shift pattern might affect sleep quality and quantity on return to work.
Section number: 7.2.8

> Inadequate sleep, caused by circadian rhythms being out of synchrony with the shift pattern, might impair performance on return to work.
Section number: 6.6

> Alertness and performance might also be out of synchrony, especially in night work or after early starts.
Section number: 6.6; 7.2.1

Things you can do:

In general, employees should be reoriented to the workplace after a break from work (annual leave, extended sick leave, long service leave, etc) via tool-box meetings. Information should include changes to terrain, machinery or practices (this information should also be provided after rostered days off). Consideration should be given to reduce the negative impact of fatigue on individuals returning after a break.

Strategies could include:

- Ensuring that individuals who have been away from work for an extended period do not return to work on night shift.
- Ensuring individuals start no earlier than 6am on their return from a long break.
- Ensuring overtime is not worked in the first week back, to ensure they get proper sleep.
- Allowing individuals to choose their break times but observe the minimum breaks for the shift length.
- Providing a break of at least 12 hours from the end of one shift to the beginning of another.

2.9 Commuting

Things you should know:

> Commuting to work affects the amount of time available for sleep.
Section number: 7.2.10

> Where people commute, early starts might require them to drive during the low point of their performance and alertness rhythms.
Section number: 7.2.10

> Motor vehicle accident reports indicate a clear peak in accident risk at 0200hr, with a smaller peak at 1500hrs.
Section number: 7.2.10

Things you can do:

> Is the average commute time for employees greater than 45 minutes one way?

If YES you should revise your working arrangements to minimise the risk of a long commute. The most effective controls are shortening shifts or providing company transport (refer section 3 – Designing working time arrangements).

Other fatigue management strategies include:

- Promoting self-monitoring so that individuals who have long drives are able to assess how tired they are before they leave the workplace and during the drive.
- Promoting rest before the drive home, and providing facilities for that rest.
- Providing kitchen facilities for people to prepare drinks and meals.
- Promoting the use of company transport or taxis if individuals are unfit to drive.
- Allowing individuals to self select their roster types. For example, they could choose the shift best suited to their personal preferences where this was possible.
- Determining the nature of travel – the time taken, distance, road conditions.
- Tracking accidents and near misses to and from work and sharing this information in the workplace.
- Encouraging car pooling so individuals do not travel alone.

3 Designing working time arrangements

The information about designing working time arrangements refers to all aspects of the working time arrangements, which includes the roster, overtime, on-call work, task scheduling and much more. This section is designed to help you to develop new working time arrangements or to change an existing structure. A process for change that will cause minimum disruption to all stakeholders is described in detail. Some examples of successful change processes, together with one unsuccessful example, from Australian organisations are provided in Appendix 3. However, this section does not provide a blueprint for a working time arrangement as there is 'no perfect roster' for every situation (see page 24). However, when you implement the new working arrangements it is important to have considered all the scientific evidence referred to in Sections 6, 7 and 8, ensuring that you maximise sleep opportunity, thereby reducing the risks associated with fatigue.

3.1 Introduction

If you had already begun a process to change your working time arrangements prior to reading this document, this section may help you with information on the process and some lessons from the experiences of others. You should not discount your current process but use this section for support and direction.

It is important to ensure that all stakeholders are consulted and have an opportunity to take part in any change to working time arrangements. This will mean that the results are a compromise between the functional and operational needs of the organisation and the desires and needs of its employees.

To promote discussions and to aid development it is first important to:

> Establish a working time arrangements design committee with representatives from all stakeholder groups.

> Identify and clarify the reasons for change.

> Determine the required staff mix for the operation.

> Determine required staffing levels for the operation.

> Understand the existing system and why it was established in its current form.

> Determine short and long-term goals for the organisation and its people.

> Comply with legislation and regulations.

> Comply with internal policies.

3.2 Background

As globalisation and competition force organisations to constantly adjust to the demands of the market place, a myriad of working time arrangements have emerged. These evolving working time arrangements are generally based on increased flexibility and 24-hour operations (Harma, 1998; The Industrial Society, 2000).

There is little doubt that flexible working time arrangements have benefits for productivity. Furthermore, flexible, non-standard working hours are also attractive to employees whose home responsibilities and commitments prevent them or restrict them from working Monday to Friday office hours.

No Perfect Roster:

It is important to understand that there is no perfect roster that will cater for every organisation, every work type, or every individual.

A roster that suits a single person might not be right for someone with a young family. Similarly, a roster that suits you today might not be right for you in another 10 or 15 years.

What is most important to understand when designing or modifying a working time arrangement is that both the employee and the organisation are jointly responsible for managing the working time arrangement.

The organisation must consider the sleep opportunities that are provided within the working time arrangement to ensure that employees have enough time away from work to get recovery sleep. On the other hand, employees need to use their time away from work (or sleep opportunity) to get recovery sleep and return to work in a fit state.

Thus, each working time arrangement should be evaluated according to all the factors that will affect the sleep opportunity. Some of these factors include the actual roster, the amount of overtime worked by employees, travel time to the site and travel arrangements for the workforce. These factors will be unique to each operation, and may therefore require the design of working time arrangements to reflect this uniqueness.

Thus, more efficient working time arrangements are being developed to meet ever-changing organisational requirements and employee needs. A study by the Industrial Society found that 84 per cent of male professionals in the UK believed that organisations should offer flexible working hours and 62 per cent indicated a preference for flexibility in full time employment.

However, some working time arrangements may be potentially hazardous for employees or employers. Hazardous schedules may be based on unsound or limited knowledge of the financial, biomedical and psychosocial impacts of shiftwork that significantly compromise health and safety.

The best schedule is generally considered to be a compromise between the needs, responsibilities and commitments of the organisation and its employees. However, there will be always be working time arrangements that are viewed as either 'better' or 'worse' than others depending on the industry, organisation and the individuals concerned.

The individuals who are most familiar with the working time arrangement (ie, those who work it) should be engaged in its design and development in conjunction with other stakeholders. When combined with individual and operational parameters this can ensure the working time arrangement is more widely accepted by the workforce. Thus, potential and actual changes to working time arrangements may be perceived as beneficial by both employees and the operation.

To assist organisations and people to develop and manage their own systems, in-house training and educational programs might have to be created where managers, supervisors and employees can learn about shiftwork and its impact on themselves, their significant others, the organisation and the community (Tepas, 1993).

3.3 Fatigue-proofing

A detailed analysis of working time arrangements may enable an operation to better target areas of higher fatigue with fatigue proofing strategies. Fatigue proofing refers to strategies that are focussed on the task being performed rather than the hours of work specifically. For example, lower risk tasks may be scheduled in periods when fatigue risk is higher, and more complex tasks in times when the risk of fatigue is lower.

Fatigue reduction and fatigue proofing countermeasures are important defences against latent failures, reducing risk of active failures. Latent failures are the underlying contributory system failures that build up before an incident. Active failures are the direct causes of the incident. Thus, fatigue reduction and proofing mechanisms should be inherent in fatigue management plans.

Fatigue reduction strategies may include the design of the roster, length of shifts and timing of shifts, task rotation, placement of breaks and overtime scheduling practices (Section 7.2).

Fatigue proofing strategies may include no work in isolation, double check lists, high risk activities assigned to daylight hours or lower risk activities assigned to times of circadian low points (Section 8.1.9.2). Working under conditions of high fatigue could lead to latent failures if not managed effectively.

3.4 Developing a working time arrangement

Despite the stress inherent in a major change of working time arrangements, it is possible to change a system if the process of change is initiated and supported in the workplace (Dawson, 1997). It is also important that there is a clearly defined framework for change. The framework assumes that any working time arrangement is a 'best fit' solution to the current needs of the business and its employees. Consequently, the system should be continually evaluated against the changing needs.

There are five stages common to successful changes in working time arrangements:

Stage 1. Starting off

Stage 2. Informal consultation

Stage 3. Formal consultation

Stage 4. Detailed implementation

Stage 5. Evaluation and assessment.

Each is described in more detail below.

3.4.1 Stage 1 - Starting off

The essential goal of Stage 1 is to ensure a representative decision-making process. The best way to ensure that a change is accepted is to involve all stakeholders in the decision. This is achieved through a committee of stakeholder representatives whose members are generally elected by peers and who act as messengers between the committee and the people the committee members represent.

It is beneficial if management, employees and OHS people make up this committee. While the OHS representative or committee have obligations under the legislation for safety in the workplace, it may be a worthwhile process to broaden the traditional scope to provide a wider range of views on hours of work beyond purely safety concerns. This should not be seen as undermining the established procedures.

Many workplaces require a committee to work through problems in the working time arrangement and to assess the benefits of change. It is crucial that a committee that discusses and subsequently designs the arrangements clearly understands the consultative process. In addition, this committee needs the skills, time and resources to fulfil its role and to function efficiently.

It is important to realise that a roster can only ever be a 'best fit' solution to the differing needs of the organisation, the employees, their families and the community. No arrangements can ever solve all problems. Different individuals have different needs. Thus, what is considered a good schedule by one may not necessarily work for or be considered appropriate by another.

For these reasons, the criteria used to determine the success or failure of a working time arrangement will be different for different people. Generally, a majority position is the criterion used; consensus on roster selection and the criteria for determining success or failure is unlikely. An arrangement that suits one organisation might not meet the business needs of another. The 'best' arrangement will attempt to balance the current needs of all stakeholders. In addition, as the needs of the organisation and its employees change over time, so will the optimal working time arrangement.

Therefore, the best approach to shiftwork is to view the working time arrangement as dynamic – an evolving solution to the changing needs of the organisation and its people. The 'best fit' arrangement will always reflect the needs of all stakeholders.

3.4.2 Stage 2 - Informal consultation

In general, many working time arrangements are designed to a limited set of parameters. Stage 2 aims to broaden the basket of measures that determines the ‘best fit’. It defines and discusses the parameters that determine the success or failure of any potential working time arrangement.

People in the committee should speak to all stakeholders. This makes it more likely that everyone’s needs are identified and represented. Examination of all parameters will help shape the final arrangement. This stage helps both employers and employees to understand and recognise parameters outside their day-to-day involvement with the organisation.

Stage 2 promotes discussion that might produce a subset of potential working arrangement designs. Normally between two and five potential designs are developed during this stage.

3.4.3 Stage 3 - Formal consultation

The goal is to document the potential impact of the arrangements developed in Stage 2 and to help all the stakeholders make informed decisions. Generally an organisational impact assessment is required to outline the specific details of any potential change.

These details might include the effect of an arrangement on hours of work, shift duration, shift flexibility, shift rotation, number of weekends off per month, shift length, shift sequencing, overtime, productivity, financial matters including income and superannuation and family factors.

It is necessary to develop a variety of outcome and performance indicators for the change, such as absenteeism, injury rates, accidents, near misses, productivity, and general health index. It is important for management to define the factors that will indicate success or failure.

Table 3.1 illustrates outcome measures that might help an organisation to establish clearly defined short and long-term goals for all stakeholders. Users of the table should fill in all panels to ensure the organisation addresses all areas of concern and that everyone has had the opportunity to participate in the design process.

3.4.4 Stage 4 - Detailed implementation

The goal of Stage 4 is to ensure that all stakeholders make a well informed decision. To do this, committee members must provide stakeholders with detailed outlines of all the potential arrangements produced in Stage 2.

In essence all the information available to the organisation (from an information matrix such as Table 3.1) forms the basis for the development of the system and implementation strategy.

The committee should circulate a draft that covers each proposal. Once all managers, supervisors and employees fully understand each and have had their questions answered, a vote can be taken.

Following the vote, it is essential to set an implementation date. This gives everyone time to adjust to the changes and to structure their lives accordingly. Note that industrial agreements might contain specific procedures that have to be followed on work hours.

Table 3.1. EXAMPLE OF AN INFORMATION MATRIX

POTENTIAL PARAMETERS OF WORK DESIGN CHANGES								
	FINANCE		OHS WORK PERFORMANCE		PSYCHOSOCIAL		INDUSTRIAL RELATIONS	
	Short term	Long term	Short term	Long term	Short term	Long term	Short term	Long term
Line managers	Additional cost	Adequate resources and time	No increase in injuries	Incidents↓	Morale↑ Consultation↑	Staff turnover↓	Overtime↓	Develop Enterprise Bargaining Agreement (EBA)
Senior managers	Win-win, no additional costs	Production↑ Efficiency↑	Develop procedures	Injuries↓	Absenteeism↓ Single days off↓	Morale↑	Disruptions↓ Disputes↓	Internal communication↑
Organisational support	Stable state	Resources↑	OHS rep	OHS shiftwork policy	Appropriate networks and information	Internal communication↑ Information↑	Adherence to guidelines	Information sharing
Facility support	Canteens Accommodation	Appropriate personnel↑	Medical checks	Health clinics	Counseling confidentiality	Employee Assistance Program (EAP)	Access to information and resources	Access to time, computers and technology
Employees	No↓	Retain penalty rates Super↑	Information sessions Procedures	Accurate reporting	Education and training	Employee relations↑	Resolution of issues	Fitness for work
Families	No↓ More dollars↑	Stable and predictive	Injuries↓ Stress↓	Fatigue↓	Time at home↑	Work stress↓ Time at home↑	Included in discussions	Treated as stakeholders
Unions	No fall in penalty rates	Aggregate salaries	Safety record↑	Accidents↓ Incidents↓	Need for counseling support	Involved with members on site	Representative on site	Membership↑

3.4.5 Stage 5 - Evaluation

The evaluation stage is to ensure that changes benefit individuals and the organisation. It is important to monitor error rates and injuries and accidents following implementation.

Initially, the committee informally but continuously monitors the performance indicators developed in Stage 3. However, the committee must evaluate the changes formally every three to six months. Throughout the entire change process it should be remembered that there is no 'perfect blueprint' for any organisation.

Using this approach, changing hours of work or a working time arrangement could take from six to 18 months. While the first change might seem to take a long time, subsequent changes may be quicker. This can provide greater flexibility in industries where business needs change constantly.

Overall, the impact of working time arrangements on an organisation, an individual and his or her family can be significant. Adverse effects can be minimised if employers and employees have access to information and techniques that increase their awareness of these effects and provide strategies to deal with them. Organisations should develop training and education packages specifically tailored for shiftworking organisations and individuals, and should evaluate their implementation (Tepas, 1993).

Appendix 3 contains three case studies that explore in some detail the process through which each organisation changed or developed a working time arrangement. Two of the case studies describe successful outcomes and one describes an outcome that was unsuccessful.

4 Management of fatigue

4.1 Summary

Fatigue Management Plans (FMP) enable organisations to tailor their approach to reducing fatigue to suit their operational needs and the workplace environment. A minimum four fundamental processes support fatigue management strategies:

1. **Policy** - A document formally outlining the approach, commitment and accountability in which individual officeholders are named, including a requirement for internal and external auditing processes (see Appendix 1 for policy outline).

2. **Training** - A training and education program to enable people to identify the signs and symptoms of fatigue and to adopt coping strategies and mechanisms in and outside the workplace (see Appendix 2 for a training and education template) (McCulloch et al., 2002, page 8).

3. **Tracking Incidents** - A program or process for the tracking of all incidents, accidents and near misses for time of day, day of roster, hours of wakefulness and sleep length to determine the role of the roster and sleep.

4. **Support** - Medical and wellbeing support that includes diagnosis of sleep disorders, treatment of sleep problems and, where necessary, referrals to general practitioners, sleep psychologists, counselors or sleep clinics.

4.1.1 What is a fatigue management plan?

Fatigue Management Plans (FMP) are becoming more common across a broad range of industries in Australia including rail, heavy vehicle road transport, mining, aviation, maritime and emergency services. A number of components are necessary for any FMP. These generally address operational and personnel concerns within a proactive preventative framework. The emphasis on each component will vary between organisations but the outcome is consistent.

In general, the goals of a FMP are to maintain and, when possible, enhance safety, performance and productivity in operational settings, and manage the risk of fatigue in the workplace. Once organisations have acknowledged that fatigue is a workplace hazard they can put safeguards in place to minimise the risk.

4.1.1.1 Components of a FMP

It has been suggested that there are six major areas in a fatigue management plan (Rosekind et al., 1996). Specific areas might have specific legislative or regulatory requirements.

These include:

> *Education and training*. Training materials should include information on the physiological mechanisms that underpin fatigue, address some of the misconceptions about fatigue and make specific recommendations for countermeasures.

> *Hours of service.* These are often prescriptive and set by industrial agreements and organisational policies or procedures. Rosekind et al (1996) suggest that each operational setting should be encouraged to develop principles and guidelines for duty and rest scheduling that reflect the demands of that working environment.

> *Scheduling practices.* These incorporate a number of factors, including agreement and award considerations, labour contracts, economics, changing markets and seasonal demands.

> *Countermeasures.* Generally fatigue countermeasures involve a range of strategies that include personal, corporate and regulatory practices. It is suggested that a first step is to provide:

- Support for preventive and operational countermeasures (eg, training).
- Sufficient resources (eg, personnel, expertise and time).
- An appropriate environment for implementation (eg, proactive, progressive, risk minimisation).

Emergencies:

An organisation should have a Fatigue Management Plan (FMP) with enough flexibility to cover employees in cases of emergency or extenuating circumstances.

While a company might have guidelines for maximum number of hours to be worked, or minimum break times between shifts, occasions can arise that necessitate people to work past the recommended limits. For example, in cyclone-prone areas, evacuation situations or during rescue operations, people might have to work outside the guidelines to ensure the safety of their workmates, the public or equipment.

For such cases it is worthwhile for an organisation to have a contingency plan that ensures that:

- People who have to work past recommended hours are fit for work.
- Those called in before they have had their recommended break are fit for work.
- People known to have the most rest are called upon first.
- Fitness for work is monitored throughout the emergency period.
- People work in pairs or teams if they are working beyond recommended guidelines.
- They are rested where the emergency situation, such as firefighting, allows.

> *Design and technology*. Potential technological areas include scheduling algorithms and alertness monitoring and management systems (refer to Section 8 on fatigue devices). Issues such as validity, reliability and sensitivity of the technologies have to be determined.

> *Research.* It was suggested that more research is needed to identify and generate data that address specific operational issues. Research could combine methodologies (field, simulator and laboratory) and use a range of measures (performance, physiology, behaviour) to address fatigue issues in an organisation. (Rosekinderal 1196)

Now more than ever, organisations are expected to address fatigue in the workplace. These components provide guidance for the development of fatigue management plans. Fatigue minimisation requires commitment from managers, unions, employees and customers.

Not surprisingly, the components which organisations develop to manage workplace fatigue will vary because of a myriad of factors, including:

> The size of the organisation (cost prohibitive strategies, perceived relevance, perceived cost benefit).
> The type of work.
> The work environment.
> The perceived size of the fatigue problem.
> Legislation (OHS) and industry-specific regulations.
> Workplace culture.
> Management commitment.
> Available resources.
> Accident, incident and injury rates.
> Insurance premiums.
> Community expectations.
> Operational requirements.
> Research support and findings.
> Understanding and acknowledgement of fatigue as a workplace hazard.
> Risk assessment findings.

There is no single best FMP. Even though the goal of all FMPs is generally the same – improved safety by managing the fatigue risk – there is no standard plan. A FMP will generally be specific to a workplace and will take into consideration site factors. Thus, there is great opportunity and scope for companies and organisations to develop a FMP with the components tailored to meet their unique requirements.

5 Countermeasure to fatigue

Operations can design and implement fatigue countermeasures that best suit their situation. Countermeasures will generally involve personal and company practices, together with a Fatigue Management Plan.

The management of fatigue is not an exact science and the impact of fatigue factors will vary from person to person. The best countermeasure to fatigue is sleep. In the absence of sleep or sleep opportunities some of the strategies below may provide a functional approach to fatigue concerns.

5.1 Personal countermeasures

Personal countermeasures may include but not be limited to:

> Using naps to prepare for or recover from work (e.g., before a night shift or after an early start), before driving home, at work where appropriate.

> Seeking diagnosis and treatment for sleep disorders or problems.

> Adopting healthy lifestyle choices which protect sleep periods.

> Setting up a sleep environment.

> Seeking assistance with sleep difficulties and health concerns such as insomnia, weight gain, functional restrictions, and gastrointestinal problems.

> Pausing during a task or while driving, particularly to and from work, if fatigued. In these circumstances individuals should tell their supervisor of their condition and the need for a recovery break.

> Following all workplace rules and instructions, including OHS and other legislation.

> Attending fatigue and sleep training sessions and applying the knowledge where appropriate.

> Letting family know about fatigue and how they can help to minimise it outside the workplace.

> Recognising the signs and symptoms of fatigue in themselves and others and acting in accordance with that observation.

> Advising the workplace supervisor of sleep periods of less than six hours in any 24-hour period. Under these circumstances management and the employee should discuss possible reasons for the sleep loss. The employee should be given time to rest and recover before resuming work.

5.2 Business countermeasures

Business countermeasures may include but not be limited to:

> Analysing working time arrangements in accordance with Section 2.

> Developing a Fatigue Management Plan and communicating to relevant site personnel.

> Managing overtime processes based on previous work and future scheduled work.

> Capturing incident, accident and near miss data, and linking the data to work designs and time of day factors.

> Confining higher risk activities to times when two or more people are present.

> Avoiding higher risk activities during the low point in the circadian alertness and performance rhythm (3am to 5am).

> Allowing self-selected breaks.

> Promoting self monitoring and self assessment.

> Minimising or eliminating the times people have to work alone.

> Maintaining radio communication contact at all times.

> Implementing checklists and double checks for higher risk tasks.

> Ensuring lighting is effective, premises are well ventilated and temperatures are not extreme.

> Providing access to drinking water.

> Undertaking wellbeing surveys and monitoring and managing hours of work.

> Providing rest facilities.

> Implementing regular rotation of tasks in areas of reported boredom and reduced variation.

> Recognising that fatigue will affect everyone at a work site regardless of role and title.

> Training of workforce in fatigue and sleep issues.

> Conducting health checks – e.g. blood pressure, weight, sleep problems.

> Providing an employee assistance program including support services to the spouses of workers away from home on night shift.

> Encouraging people to tell their supervisor if they have a fatigue problem while at work and providing a mechanism to support the individual.

> Encouraging employees to tell their supervisor of sleep periods of less than six hours in any 24-hour period. Under these circumstances, discussing the possible reasons for sleep loss and options for rest and recovery time before resuming work.

> Providing kitchen facilities.

> Utilising working time arrangement analysis tools to determine work related fatigue levels associated with different work designs before they are worked.

6 Scientific Evidence - Sleep

6.1 Function of sleep

Sleep is defined as 'a reversible behavioural state of perceptual disengagement from, and unresponsiveness to the environment' (Carskadon and Dement, 2000) and is one of the basic physiological processes of life. Despite the obvious importance of sleep, its specific function is not fully understood. In a broad sense it is thought that sleep serves a recovery and regenerative purpose in most organisms. That is, during sleep the mind and body 'recover' from the stresses of the day and 'prepare' for those to come. Information about the function of sleep has mainly come from studies depriving animals and humans of sleep.

Prolonged sleep deprivation of experimental animals over two to three weeks resulted in skin lesions, weight loss and ultimately death (Bonnet, 2000). In humans, prolonged sleep deprivation leads to symptoms such as hand tremor, slurring of speech, increased sensitivity to pain, and reduced cognitive and physical performance (Bonnet, 2000). Although the function of sleep is not fully understood, the evidence indicates that sleep serves to recover from previous wakefulness and/or to prepare for functioning in the following wake period (Borbely, 1982). Horne (2002) suggests that with mammalian advancement, sleep has become more directed towards cerebral recovery. In sum, however, there can be little doubt that sleep is essential for the health and wellbeing of organisms and indeed is essential for life.

From a historical perspective it seems that we are sleeping less. A healthy adult group of 50 to 65 year olds reported sleeping 8 to 8.9 hours per night in 1959 and 7 to 7.9 hours per night in the mid 1980s. About 27 per cent of the sample slept 6 to 6.9 hours per night (Ferrara and De Gennaro, 2001). There remains some debate in the literature as to the amount of sleep required to maintain normal functioning. Horne suggests that we only need 4. 5 to 6 hours of core sleep and any more night sleep is optional. However, Bonnet et al (2000) contend that we are chronically sleep deprived and that we perhaps should be getting 9 to 10 hours per night. More information about the effects of sleep loss is provided in sections 6.5 and 6.6.

Circadian Rhythms:

The term circadian comes from two Latin words - circa, which means 'about', and diem, which means 'a day'. Thus circadian rhythms refer to physiological functions that occur once a day.

Some examples are the sleep/wake cycle, alertness and performance, body temperature, the production of hormones like melatonin and cortisol and heart rate.

These rhythms are generated by a clock in our brains which controls the timing of the rhythms. The clock is also wired to receive information from our environment, primarily in the form of sunlight. This ensures that we are in synchrony with our environment, and also allows us to adjust to different environments, for example if we travel overseas.

However, our circadian rhythms do not generally adjust easily to shiftwork. The resulting desynchronisation between our body clock and the environment often results in what is sometimes referred to as shiftwork syndrome, not unlike jet lag.

6.2 REM and NREM sleep

There are two separate states of sleep: non rapid eye movement (non-REM) sleep and rapid eye movement (REM) sleep. Non-REM sleep is characterised by 'a relatively inactive yet actively regulating brain in a movable body' (Carskadon and Dement, 2000). Non-REM sleep can be divided into four stages (stages 1, 2, 3, and 4) which relate to the depth of sleep. Stage 1 sleep is the lightest and stage 4 sleep is the deepest (Carskadon and Dement, 2000). In contrast, REM sleep is not divided into stages and is characterised by 'a highly activated brain in a paralysed body' (Carskadon and Dement, 2000). The importance of both non-REM and REM sleep is demonstrated by the specific rebound that occurs after sleep deprivation (Bonnet, 2000). Figure 6.1 shows a typical pattern of sleep stages in a normal sleep period. Throughout the sleep period, human beings cycle through non-REM and REM sleep stages in 90-minute cycles.

6.3 Quality and quantity of sleep

The length and quality of a sleep period will determine its restorative value. The amount of sleep required for full recovery, ie, an amount sufficient to maintain normal cognitive and physiological functioning, will be discussed in detail in 6.6 – Sleep deprivation and performance. Briefly, both the quality and quantity of sleep are determined largely by the timing of that sleep in the 24-hour day. Human beings are programmed to sleep during the night hours and to be active during the day. The sleep/wake cycle is a circadian rhythm, which means that even without external environmental cues the cycle continues with a period of approximately 24 hours (Zee and Turek 1999). Sleep propensity is greatest during the night hours and lowest during the day hours. Sleep length and architecture also follow this circadian (or daily) pattern. For these reasons, sleep during the night is naturally longer and of better quality (ie, more deep sleep, fewer arousals) than sleep during the day. In contrast, day sleep is often shorter and of lower quality than night sleep. Figure 6.2 shows the typical 24-hour pattern of sleep propensity for humans and demonstrates that regardless of the timing of work within the 24-hour day, sleep is most likely to be obtained during the night hours.

Escriba et al (1992) examined sleep of nurses on different shifts using diaries. Fewest hours were spent asleep during the day while working the night shift and most hours on the afternoon shift. Rotating workers and permanent night workers both sleep less than day workers. Akerstedt and Gillberg (1981) report that the length of sleep clearly varied with the time of day. Maximum length sleeps occurred after evening bedtimes and the minimum after morning/noon bedtimes.

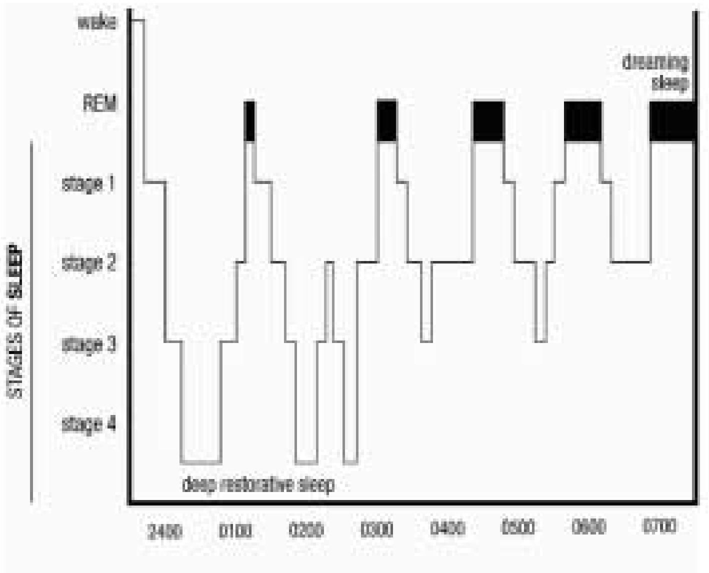

Figure 6.1 - The cycles of REM and Non-REM sleep across a normal night's sleep. The majority of REM sleep occurs in the latter half of the sleep period. In contrast, deep sleep (stages 3 and 4) is in highest proportion in the first half of the night (adapted from Harold Zepelin (1993). Mammals, In: Encyclopedia of Sleep and Dreaming. M.A Carskadon (Ed), Macmillan Publishing Company, page 346)

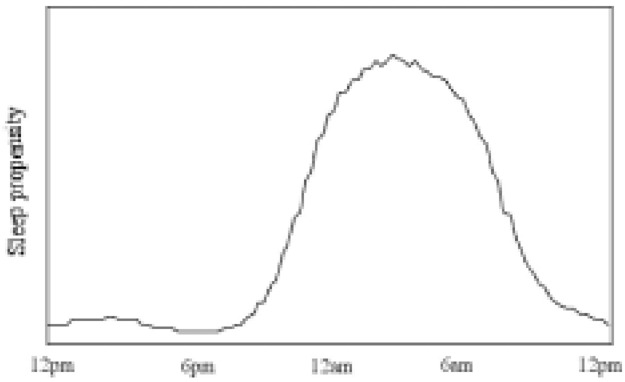

Figure 6.2 - A schematic representation of the daily rhythm of sleep propensity. The data is derived from a field study of Australian train drivers working irregular hours. Irrespective of the timing of the work in the 24-hour day, drivers were still inclined to obtain sleep during the night hours. (reproduced from Roach, 2001)

6.4 Best times for sleeping

Akerstedt and Folkard (1995) report that sleep occurs as a function of the circadian component, as described, and a homeostatic component, which builds up with time awake. Increasing time awake equates to increased sleep pressure. These processes interact to control sleep. The circadian component drives sleep during the night and inhibits sleep during the day. The times at which sleep is inhibited are known as the forbidden zones. The forbidden zones (Lavie, 1986) for sleep are approximately between 5pm and 9pm and between 8am and 12 noon. The timing of the sleep gates (at the end of the forbidden zone) varies for individuals.

6.5 Sleep deprivation and sleep debt

Sleep deprivation can occur either acutely (total night's sleep lost) or partially (some sleep lost each night over a period of nights). Both forms of sleep deprivation result in reduced levels of alertness and performance. However, partial, cumulative sleep deprivation is more common. As described, both the quality and quantity of a sleep period affect the restorative value (Section 6.3). Partial sleep loss can also arise from a series of low quality sleep periods. Studies have shown that subjects who attained eight hours of sleep later in the night than normal would have altered sleep patterns (lower quality) that were associated with adverse mood outcomes. Therefore, a change in the circadian timing of sleep can also result in a form of partial sleep deprivation (Ferrara and De Gennaro, 2001). Sleep deprivation, or sleep loss results in a sleep debt.

A sleep debt arises when an individual does not achieve adequate restorative sleep. A sleep debt can accumulate over days of inadequate sleep. For example, if a person typically sleeps for eight hours and then has two successive nights of six hours' sleep, they have accumulated a four-hour sleep debt. This debt may result in impaired performance, reduced alertness and higher levels of sleepiness and fatigue. A sleep debt can only be repaid with recovery sleep (Section 6.7 – Recovery sleep). Shiftworkers routinely carry a sleep debt due to the timing of their sleep periods. As described in Section 6.4, the best time for sleeping is during the night hours. If sleep is attempted during the daylight hours then the sleep is shorter and of reduced quality. A series of night shifts can therefore result in a significant sleep debt, with implications for health and safety.

A sleep debt can also accumulate if a person has to work a series of day shifts with early starts. A shift start time before 6am (which requires a wake time earlier than 6am and is dependent on travel time, etc) results in the truncation of the sleep period. As described in Section 6.4, there are forbidden zones for sleep in the early

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Early Starts:

In order to be at work for a 6am start, a person must be up earlier than that. How early will depend on how far they have to travel, how long they take to eat breakfast, shower, get the kids ready, etc.

Therefore, a start time of 6am might require a wake-time of 5am or even earlier. This has two major ramifications for performance and alertness.

The first arises as a result of the sleep period being shortened because the alarm goes off early and people find it difficult to get o sleep earlier to compensate. They have tried to sleep in the 'forbidden zone' in the early evening.

The second relates to the requirement to drive during the daily low point in the alertness and performance (ie, 3am to 6am). Start times earlier than 6am might have significant ramifications for sleep and performance and should be examined carefully, particularly in light of travel times to the site.

evening. For this reason it is difficult to initiate sleep earlier to allow for the early rise. One study looked at people working a rotating three-shift pattern of two to seven consecutive shifts (Folkard and Barton, 1993). Sleeps between two consecutive morning shifts were reliably shorter than those between afternoons or rest days but longer than those between night shifts. Workers woke 2.7 hours earlier on morning shift than rest days. Sleep duration was truncated between morning shifts because of an inability to compensate for the early rise. Thus, both night shifts and early morning shifts can result in a significant sleep debt. Reducing the number of consecutive nights or early starts, and allowing days off for recovery sleep (Section 6.7) will reduce the sleep debt.

6.6 Sleep deprivation and performance

Dinges et al (1997) showed significant effects of a week of sleep reduced to five hours on subjective and objective sleepiness, mood disturbances, fatigue, stress and performance. Performance only decreased after two days of partial sleep loss at which point it levelled off until day five. This suggests some form of adaptation to the sleep deprivation, however, the subjects were still performing below their normal standard. On days six and seven of partial sleep deprivation, performance became increasingly worse. Carskadon and Dement’s (2000) study of sleepiness in individuals restricted to five hours' sleep per night for seven nights mirrors previous performance data indicating that subjects became very sleepy and less alert as their sleep debt accumulated.

Belenky et al (2003) looked at three, five, seven or nine hours in bed for seven days. With three hours of sleep, performance became steadily worse across the week. With five and seven hours' sleep, speed of response declined initially then stabilised, while lapses in the five-hour group increased across the week. Lapses on performance tasks are highly indicative of impaired safety. A lapse in concentration, potentially preceding the onset of sleep (microsleep) can have severe consequences in the workplace. This data indicate that with sleep reduced to five hours per night, performance may have reached critical safety levels. It is also important to bear in mind that the subjects were sleeping at night, so what sleep they did achieve would have been good quality. Five hours of sleep during the day would be likely to produce even more severe performance effects.

Pilcher and Huffcutt (1996) performed a meta-analysis of sleep deprivation studies and used five hours' sleep as the cut off. Partial sleep deprivation (PSD) had the least effect on motor performance tasks, while both cognitive performance and mood were largely more impaired. This indicates that both physical and mental performance are affected by sleep deprivation. Section 8.3 describes the range of performance parameters that are affected by sleep deprivation and the resultant fatigue.

6.7 Recovery sleep

Recovery sleep after a whole night of lost sleep contains a large proportion of NREM sleep (Horne, 2002). Stages 3 and 4 of NREM sleep are also called deep sleep or slow wave sleep (Ferrara and De Gennaro, 2001). Slow wave sleep is considered to be a primary marker of sleep homeostasis and an increase in slow wave sleep can reflect an increased need for sleep. Recovery sleep after a period of sleep restriction (partial night's sleep lost) shows characteristic and predictable features: decreased sleep onset latency, increased sleep efficiency and a marked REM sleep rebound. Slow wave sleep rebound is generally not reported as this part of sleep is preserved during partial sleep loss. Recovery from sleep loss does not occur instantaneously. Dinges et al (1997) reported that their subjects took two nights of recovery sleep to recover from a week of partial sleep loss. Belenky et al (2003) examined the rate of recovery in people who slept for only three hours per night for a week. While the first recovery sleep did produce some improved performance, two more sleeps did not. Therefore, with severe sleep loss, a number of full nights' sleep may be required to return to normal levels of physiological functioning.

6.8 Hours of wakefulness and performance

Van Dongen and colleagues (2003) restricted people to 14 nights of four, six or eight hours in bed. Four and six hours resulted in significant cumulative, dose dependant deficits in cognitive performance. Regardless of the mode of sleep deprivation, lapses in behavioural alertness were almost directly related to the cumulative duration of time awake in excess of 15.8 hours. There is some variability in the amount of time awake it takes to affect performance between individuals but this suggests that after approximately 16 hours of being awake, performance starts to decline. This result was pre-empted by a series of studies comparing the effects of sleep deprivation on performance with the effects of alcohol intoxication on performance. Dawson and Reid (1997) demonstrated that 16 to 17 hours of wakefulness was associated with performance impairments similar to those seen at a blood alcohol concentration of 0.05 per cent. They further showed that after 24 hours of wakefulness, performance was as poor as that seen at 0.1 per cent. These conclusions were reiterated by Lamond et al (1999) using a more complete battery of performance tasks. As described in Section 6.4, increasing time awake equates to increasing sleep pressure. This in turn translates to higher levels of sleepiness and fatigue and lowered alertness and performance.

The nature of the work and the workload can also affect the degree to which sleep deprivation and fatigue affect performance. Higher levels of workload serve to further increase performance impairments associated with hours of wakefulness (Doran et al., 2000). The nature of the work is further discussed in the next section.

Forbidden Zones:

Human beings are programmed to sleep during the night hours and to be active during the daylight hours.

It is generally easier for us to fall asleep in the evening, after about 9pm, although this does vary from person to person. There are also times of the day when it can be very difficult to fall asleep due to the timing of our daily biological rhythms.

The timing of the zones is approximately 8am and 12 noon and again between 5pm and 9pm, many people have a lot of trouble getting to sleep. These times are known as 'forbidden zones' for sleep.

The forbidden zones can have a big impact on how much sleep people get before early starts. This is because an early start truncates sleep in the morning due to early wake-up time and, because of the forbidden zone in the early evening, we find it hard to get to sleep earlier than normal to compensate for the early start.

6.8.1 Modifying factors

A number of factors modify human performance in a state of sleep deprivation or fatigue. These factors fall into two groups – task characteristics (duration, complexity, pacing) and non-task factors (interest, motivation, personality, age).

6.8.1.1 Task duration

Bjerner (1949) stated that:

> "*the essential difference between the mental functioning of the rested and fatigued is one of endurance, not of quality . . . while a subject is able to give test results of the same quality when he is tired as when he is rested, he can only do so for a short period of time*".

The longer the task, the more likely it is that a sleep deprived or fatigued individual will suffer performance impairment. An example of this is a study by Lee and Kleitman (1923) who showed that while sleep deprived subjects could perform a task of two to three minutes in length without error, the same task extended to 15 minutes did indicate performance impairment. This type of finding emphasises the importance of task rotation in some work environments in combating the performance impairment associated with fatigue (Section 8.3).

6.8.1.2 Task complexity

There is some debate still about the degree to which task complexity modifies the effects of fatigue on performance. A simple addition task was used to examine the effect of task complexity on performance. The speed at which the task was done was increased and this also increased the complexity. The results showed that increasing difficulty of the task revealed previously undetected effects of sleep loss (Williams and Lubin, 1967). A number of studies report that performance on complex tasks declines to a greater degree and more rapidly with increasing sleep loss than does performance on simple tasks (Bonnet, 1994; Lisper and Kjellberg, 1972). This does not mean, however, that some very simple tasks are unaffected by sleep deprivation and fatigue (ie, reaction time tasks such as the psychomotor vigilance task (PVT)).

6.8.1.3 Motivation

Motivation to perform can be a powerful combatant to the effects of sleep deprivation and fatigue. If a task is interesting, stimulating or varied then performance is reported to be less affected due to the increased motivation and willingness to perform well (Horne and Pettitt, 1985; Wilkinson, 1964). Further, interesting or stimulating tasks capture the attention more vigorously and increase the likelihood of sustained performance. Other ways of increasing motivation levels are through competition or rewards. Horne and Petit (1985) used both rewards (financial) and competition (between and within subjects) to assess the effects of high incentive during a 30-minute auditory vigilance task performed over three days of total sleep deprivation. With incentive, subjects were able to maintain normal performance longer and even when performance levels did fall, they remained higher than the control group. On the third day of zero sleep, however, further incentives could not improve performance. These reports again point to the benefits of task rotation in maintaining interest and motivation in the workplace.

6.8.1.4 Pacing of the task

Self-paced tasks are those in which the subject controls the rate of the stimuli presentation and can respond at leisure. In paced tasks, the speed and duration of the stimuli presentation are determined by the experimenter (or job type). In general, on self-paced tasks, speed is often impaired but accuracy remains high - that is, the individual makes a trade-off in his or her performance. Paced tasks on the other hand are associated with more lapses (ie, physical or mental functioning cease due to a break in concentration or attention, possible preceding sleep). An individual cannot defer their response if they are experiencing a lapse and this results in an error or omission.

6.9 Ways to promote sleep

The three major environmental factors that affect sleep quality and quantity are temperature, light and noise.

> *Temperature.* The ideal temperature for a sleeping environment is approximately 18° to 24°C. If sleep is attempted in a room that is too hot or too cold, the human body will regulate temperature in preference to initiating sleep. The regulation of body temperature is more efficient when in the wake state.

> *Light.* The body's biological clock is sensitive to any type of light. Even light from a light bulb will give a signal to the brain that it is daytime, therefore a period for activity. Importantly, light can also penetrate the eyelids to reach the brain. Some practical measures to reduce the impact of light on sleep include:
- Heavy, dark or blockout curtains.
- Eye masks.
- Pull-down blinds that seal at the edges to prevent light getting through.
- Roller shutters on the outside of the window.

> *Noise.* Many noises can disturb sleep and often without the individual being aware of the disruption. External noises can result in arousal from a deep stage of sleep into a lighter stage. It is possible for such disturbance to occur many times in a sleep period. The result is a lighter and less restorative sleep. Practical strategies to reduce noise interference include:
- Using earplugs.
- Installing double-glazed windows or shutters on the windows.
- Letting your neighbours know work times.
- Using a form of 'white noise' (or background noise) to dampen out other noises, for example a fan, air conditioner, or a radio or TV tuned in between stations.

6.10 Sleep disorders

Sleep disorders are quite common. Inadequate or disordered sleep can result in impaired daytime functioning, accidents at work or on the road, or disturbed mood and social interactions. Patients who report with insomnia frequently have symptoms such as an inability to fall asleep, frequent awakenings across the night, or early morning waking. Sleep disorders such as insomnia can arise as a result of a number of internal or external factors.

Examples of external factors include life stresses such as a death in the family, or inadequate sleep hygiene such as late night exercise or going straight to bed from work. Another external factor that can cause disordered sleep is the misalignment of the body's biological rhythms with the environment such as occurs with international travel (jet lag) or shiftwork. Insomnia-like symptoms can present themselves when sleep is attempted outside the optimal times for sleeping.

Internal factors that can precipitate sleep disorders also exist. For example, some insomnias are the result of an internal desychronisation of biological rhythms, commonly known as circadian disorders of the sleep/wake cycle. The reasons the biological rhythms become desynchronised from each other and from the environment are not well understood. Individuals who believe they may suffer from insomnia should consult their general practitioner or a sleep psychologist.

Another common sleeping disorder is obstructive sleep apnea. Loud habitual snoring can be an indicator of obstructive sleep apnea, while occasional quiet snoring may not be symptomatic. Obstructive sleep apnea involves the obstruction of the upper airway so that breathing ceases for more than 10 seconds at a time. In severe cases breathing may cease for more than 60 seconds and this may occur dozens of times in a single sleep period. After breathing ceases, a snort, gasp or choking noise generally signals the resumption of normal breathing, and this is more often than not reported by the bed partner. This pattern of sleep, apneic event and arousal results in a highly disturbed sleep pattern. Sufferers of severe sleep apnea report excessive daytime sleepiness, placing them at increased risk of falling asleep whilst driving or at work. Individuals who believe they may suffer from obstructive sleep apnea should consult their general practitioner for a referral to a sleep clinic (Aldrich and Naylor, 2000).

7 Scientific evidence - work and non-work time

Employers and employees for centuries have been altering hours of work and the way non-work time is structured across the hours of the day and days of the week. Over time the emphasis, priority and placement of work and non-work activities have changed. The relative importance of work and non-work have also varied over time.

Changes to working time arrangements continue with a myriad of patterns now being developed. Hours of work can now be designed taking human physiology, circadian rhythms, social and community impacts and organisational and operational requirements into consideration. In reality, however, the most frequently considered factors are increased flexibility, 24-hour operations, financial viability and market share, and employee attraction.

There has been an understanding that if an individual was either serious or frivolous all day there were adverse consequences (The Maxims of Ptahhotpe, maxim no.25, as cited in Bartlett, 1980, p.3) (Bartlett, 1980). This sentiment was still being acknowledged by James Howell in 1659 when he stated the now well-recognised and oft-repeated saying

'All work and no play make Jack a dull boy' (Howell, 1659, In: Bartlett, 1980, p.271).

The idea that daily life requires a balance between activities that generate an income by requiring an individual to concentrate and be serious (work) and other activities that are undertaken for an individual's fun and personal enjoyment (leisure) continues today (Blakelock, 1960; Primeau, 1995; Shaw, 1985). The definition and position of each of these activities (work and non-work) in an individual's life will vary depending on circumstances, life stage, expectations, employment status, rewards, security, social framework, culture and time (Casey, 1995; Grint, 1991). Nevertheless, it has been recognised that achieving a balance between these two factors is essential for an individual's health and wellbeing (Argyle, 1996; Primeau, 1995).

7.1 Work time

Over the last two to three decades work has been perceived and defined in terms other than pure economics. In recent times paid work has been shown to influence:

> Self esteem (Csikszentmihalyi and LeFevre, 1989; Mutran et al., 1997; Peetz et al., 1999; Pugliesi, 1995).
> Self identity,(Beck, 1994; Pease and Wilson, 1991).
> Self worth and belonging (Australian Bureau of Statistics, 1997; Dempsey, 1997).
> Social status (Beck, 1994; Casey, 1995; Grint, 1991).
> Enjoyment (Tinsley et al., 1993).
> Influence over others (Dempsey, 1997; Grint, 1991).
> Learning experience (Tinsley et al., 1993).
> Health (Bryson, 1998; Colligan and Tepas, 1986; Walters et al., 1996); and
> Wellbeing (Gramm, 1987; Makowska, 1995).

7.2 Hours of work

7.2.1 Time of day

7.2.1.1 Sleep impact

The time of day at which work occurs naturally dictates the timing of the opportunity for sleep. Section 6.4, Best times for sleeping, describes the effect of the timing of sleep in the 24-hour day on the amount of sleep obtained and the quality of that sleep. In brief, day sleep is shorter, lighter and is associated with more awakenings than night sleep. Therefore, when considering the time of day that work occurs one must also examine the implications for an individual's sleep.

7.2.1.2 Performance perspective

Alertness levels fluctuate across the 24-hour day in a circadian pattern. Alertness levels are highest in the early evening hours (6pm to 9pm) and lowest in the early morning hours (3am to 6am) although this does vary between individuals. It is obvious therefore why night shift presents the greatest challenge. Not only are alertness levels naturally lower during the night hours, but the opportunity for recovery sleep during the day also results in shorter sleep of lower quality. These two factors in combination result in higher risk of accident on the night shift.

Sleep Opportunity:

The time someone has available for sleep is dictated primarily by hours of work and commute time.

An office worker in a 9am to 5pm Monday to Friday job has regular work hours and therefore regular and predictable sleep opportunities. Shiftworkers on the other hand work hours that vary from week to week and sometimes day to day.

This directly affects their sleep opportunity. If someone has to be at work from 7pm to 7am the only time in the day that is technically available for sleep is from 7am-7pm. But there are many other things in a person's life that affect sleep they can get in any given sleep opportunity.

Things like travel time to and from work, spending time with family and friends, meals, showering, sport, recreation and relaxation time all affect the when and how much people actually sleep in their sleep opportunity.

The timeline below shows how the sleep opportunity is broken up. The only time that is technically not available for sleep is the work and travel sections. The rest of the 24 hours could be spent sleeping. However, we do not just work and sleep, other things occur in our day. Thus, we only spend a portion of our daily sleep opportunities sleeping.

: travel :	work	: travel :	meals, family etc	: sleep :

It is up to the organisation to design a working time arrangement that provides adequate opportunity for sleep but it is up to each employee to manage his or her sleep opportunity to achieve adequate sleep.

When people do not get adequate sleep their fatigue levels increase and alertness and performance are impaired.

Folkard's review (Folkard and Tucker, 2003) reports an increased risk of 18.3 per cent on the afternoon shift and a 30.4 per cent increase on the night shift as compared to the day shift for eight-hour shift systems. Smith et al (1994) also states that the injury rate on night shifts is higher than morning shifts.

Interestingly, self-paced workers had a higher risk of more moderate / severe injuries on the night shift than machine-paced workers. An individual working on a self-paced task may be more likely to succumb to the effects of fatigue than one working on a machine-paced task. The timing of tasks within a shift should also be a consideration in shift design.

7.2.2 Consecutive shifts

7.2.2.1 Sleep impact

As discussed in Section 6.5, consecutive days of inadequate sleep can result in a sleep debt. As the sleep debt accumulates, performance and alertness levels decrease, in turn affecting safety. Sleep debt accumulates differently according to the type of shift being worked. Night shift generally produces a more severe sleep debt because of the reduced quality and quantity of day sleep. Afternoon shift on the other hand generally provides the best opportunity for sleep and therefore the smallest sleep debt. Further, the amount of time required to recover fully from night shifts is also dependent on the number worked. When only a few consecutive night shifts are worked, less disruption to circadian physiological functions occurs, ie, the body remains 'closer' to normal. Kecklund and Akerstedt (1995) reported that shiftworkers needed three days to recover from seven consecutive night shifts. Reducing the number of consecutive night shifts to three decreased the number of recovery days required by one. This has significant implications for an individual's fatigue levels in addition to their ability to utilise non-work time (Section 7.3).

7.2.2.2 Performance perspective

A series of studies has examined the relative accident risk associated with consecutive work shifts. Assessment of relative risk requires a large number of accidents or incidents to be assessed in order to produce statistically and functionally meaningful results. Therefore, studies examining relative risk of accidents generally take into account data from more than one site or organisation. They also take into account the number of individuals working at the time to eliminate any bias.

> *Night shift.* The risk of being involved in an incident is 6 per cent higher on the second night of a night shift than the first, 17 per cent higher on the third night and 36 per cent higher on the fourth night (Folkard and Tucker, 2003 Figure 7.1). There is a paucity of data looking at any number of consecutive shifts longer than four.

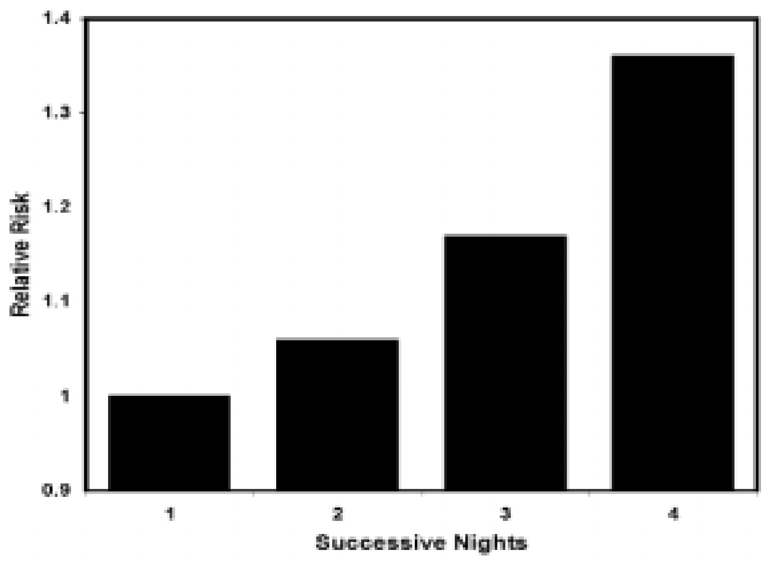
> *Morning/afternoon shift.* Of the seven studies that reported increased risk over successive night shifts, five also reported that the risk increased over successive morning or day shifts. There was some increased risk over successive day/afternoon shifts but it was substantially smaller than the night (17 per cent on the fourth day).

Smith et al (1998) cite a study looking at consecutive shifts and shift length. Compared with an equivalent number of successive eight-hour shifts, there were significant decreases in productivity on five to seven consecutive 12-hour shifts. After four weeks of six or seven consecutive 12-hour shifts, there were even greater decrements in productivity. The authors strongly warn about the risks of more than three or four consecutive 12-hour shifts based on their empirical data.

In a *Injuries and Worktime* article by Smith et al (1997) 1500 injuries were recorded for a two shift system over a 12 month period. Shift duration in this study was 10 hours both during the day and night, there were no handovers on either shift. This study demonstrates an interaction between day of week and shift. Specifically, the risk of injury on the fourth night shift was shown to be 44% greater than the shift average. Overall, Smith concludes that more injuries were reported on the night shift compared to the day shift and there are more injuries towards the end of the week or the fourth consecutive night shift.

In a *Fatigue and Performance* study Heslegrave used both subjective and objective measures to determine the performance of air traffic controllers over five different day shift schedules. Each schedule had shifts of 8 hour duration and five consecutive day shifts. He found that after the first

Figure 7.1 - The relative risk of having an accident on successive night shifts. (Reproduced from Follard and Tucker, 2003).



shift, performance became impaired on each successive shift showing a 10-17% drop on most measures (reasoning, spatial orientation, reaction time tasks and pattern recognition). Heslegrave cautions that these results may be conservative due to the controllers being able to self select their own test times. Overall, he suggests that there is performance impairment as a result of working more than five consecutive 8-hour day shifts.

Knauth (1997) outlines some of the most basic ergonomic recommendations regarding the design of shifts. Knauth recommends avoiding permanent night shifts because of the potential long-term health effects, accumulation of sleep deficits and the effect on social contacts. Recommendations are also made for few consecutive morning shifts because these lead to sleep deficits (early starts) and few consecutive afternoon shifts because of the social disruption they cause.

The injury rate on night shift was examined across five consecutive shifts. Injury rates rose towards the end of the week, calling into question the likelihood of circadian adjustment occurring with consecutive night shifts and lending further support to a system of rapidly rotating shifts (see section 7.2.5).

7.2.3 Shift length

7.2.3.1 Sleep impact

The length of any work shift will greatly dictate the opportunity available for recovery sleep in that 24-hour period. In very basic terms, an eight-hour work period provides 16 hours of non-work time, while a 12-hour work period provides only 12 hours of non-work time. Table 7.1 indicates how a 24-hour period may be broken into sleep, work, non-work (social, family, leisure, personal) and travel time. Presuming travel time is kept constant, as work time increases both sleep time and non-work time decrease. Bartolomé (2000) demonstrates a calculation for determining total work time that is based on factors including sleep, commute and shift length. Knauth (1997) reports that with increasing shift length and decreasing break time, it is actually sleep length that is most affected. Individuals tend to sacrifice sleep for other non-work activities such as those cited above. Therefore, longer shifts can translate to shorter sleep periods. Having said that, however, if the extended shift system is well designed it may actually result in better sleep outcomes for employees. Smith et al (1998) highlight the fact that on a compressed schedule, ie, 12-hour shifts, generally 75 per cent of the rotation allows for normal night time sleeping. In contrast, on an eight-hour shift system, this proportion is greatly reduced. Rosa and Colligan (1989) looked at sleep of computer operators before and after a change from eight-hour shifts to 12-hour shifts. The eight-hour schedule required up to seven consecutive shifts, while the 12-hour schedule required up to four consecutive shifts. Total sleep time was shortest after day shifts on all schedules. However, awakenings were most frequent after night shift and highest overall after the 12-hour night shifts. Self reported sleep time declined progressively with 12-hour shifts but depth of sleep increased across the 12-hour week, suggesting a higher quality sleep.

Sleep patterns were studied in a group of chemical plant workers after a change from eight-hour shifts to 12-hour shifts. Sleep during the day was higher quality on 12-hour shifts

Table 7.1 - Breaking the 24 hour day into work and non-work periods.

	Non-work time		
Work time	Sleep time	Personal time	Travel time
8h	8h	7h	1h
10h	7h	6h	1h
12h	5h	6h	1h
15h	4h	4h	1h

than eight-hour shifts resulting in decreased sleepiness at the beginning of the shift. Further, day shift on the 12-hour system started later than on the eight-hour system, thereby increasing the length and quality of night sleep. The overall design of the 12-hour system facilitated better quality and longer sleep (Lowden et al., 1998). Smith et al (1998) also report that 12-hour shifts allow more time away from work during blocks of days off. This pattern allows for full recovery between blocks of time on, reducing the potential for chronic build-up of fatigue through inadequate sleep (see also Section 7.2.8., Days away).

7.2.3.2 Performance perspective

A number of studies have looked at the effects of a change from eight-hour shifts to 12-hour shifts. Duchon et al (1994) examined underground mine workers before and after a change from eight to 12-hour shifts and reported no changes in fatigue levels. This was supported with continuous physiological measurements of heart rate and exertion in a subset of six employees (Duchon et al, 1997). In manufacturing and engineering employees, there were no differences reported in alertness levels between eight and 12-hour shift workers.

Rosa and Colligan (1989) also looked at performance and alertness in computer operators before and after a change from eight-hour shifts to 12-hour shifts. While the 12-hour schedule did not result in better performance and alertness scores, performance did improve across the week in 12-hour shifts. Thus, some of the disadvantages of the longer workday may be offset by the shorter workweek. This is further highlighted in a study by Williamson et al (1994), which reported improvements in computer operators' wellbeing and reduced levels of tiredness throughout the work period with a change from eight-hour shifts to 12-hour shifts. Despite the increased shift length, the compressed work week actually provides adequate sleep opportunity to sustain performance. Further, the off duty period (generally three to four days) provides adequate opportunity for full recovery before return to work. Laundry and Lees (1991) studied incident rates on 12-hour shifts and found lower rates of most minor injuries on the job, but higher rates of more major injuries off the job in the 10-year period of 12-hour shifts. There are a number of other factors that must be considered in the design of any shift system, including number of consecutive shifts, overtime, direction of rotation, etc.

The general conclusion with regard to shifts in excess of eight hours is summed up by Knauth (1997). Extended shifts are only acceptable if:

> The nature of the work and the workload is suitable.
> There are sufficient breaks.
> The shift system is designed to minimise the accumulation of fatigue.
> There are adequate arrangements for cover of absentees.
> Overtime will not be added.
> Toxic exposure (to chemicals, heat, noise, etc) is limited.
> A complete recovery after work is possible.

7.2.4 Hours on shift

7.2.4.1 Performance perspective

Section 6.8 highlights the effect of increasing time awake on alertness and performance levels. A recent review (Folkard and Tucker, 2003) pools the results of a number of studies examining accident risk associated with hours on shift. Beyond eight hours at work, the relative risk (ie, corrected for number of people at work) of having an accident rises significantly. Specifically, risk increases in the ninth hour then plateaus in the tenth to twelfth hours and increases again exponentially after 12 hours. Interestingly, there is also a period of increased risk from the second to fifth hours at work. Nachreiner (2000) concludes that shifts longer than eight hours should be avoided, although the more recent review suggests that in order to reduce the relative risk associated with shiftwork, a number of factors should be taken into account, the length of shift being just one of many.

A national survey of truck drivers in Australia reported that drivers felt the effects of fatigue in the first 10 hours of driving. This fatigue translated into impaired driving performance in the form of slowed reactions, impaired gear changing and steering, and reduced speed (Williamson et al., 2001). It is imperative that the type of task being carried out is considered carefully when determining the appropriate shift length.

7.2.5 Direction of rotation

7.2.5.1 Sleep impact

The biological rhythms of human beings are synchronised to the external environment via light signals to the body's clock. The body's biological clock is highly sensitive to light. However, in the absence of synchronising signals it will revert to its own internal period. This period is generally slightly longer than 24 hours (24.5 hours). Therefore the natural tendency is for the body's rhythms to drift later each day. Backward rotating shifts (ie, morning to night to afternoon) work against the body clock's natural tendency. This results in disrupted sleep. Forward rotating shifts (ie, morning to afternoon to night) on the other hand work with the natural tendency of the body's rhythms to drift later, thereby facilitating sleep. Jaffe et al (1996) looked at petrochemical workers working either backward rotating shifts or permanent day work. Subjective sleep quality was significantly lower in backward rotating workers than day workers.

7.2.5.2 Performance perspectives

Knauth (1997) recommends forward rotation due to the reduced disruption to the body's circadian rhythms.

7.2.6 Breaks in a shift

7.2.6.1 Performance perspective

The timing and length of breaks within a shift can significantly affect the accumulation of, and recovery from, fatigue. Section 6.8 describes the effects on alertness and performance of consecutive hours of wakefulness. While sleep is the only effective way to reduce one's fatigue levels, recuperative breaks can help to restore mental and physical functioning in the short term. Tucker et al (2003) recently reported that regular rest breaks are an effective way of reducing accident risk. Smith et al (1998) further recommend that in 12-hour systems, shorter and more frequent breaks should be used.

7.2.7 Overtime

7.2.7.1 Sleep impact

Extension of work shifts with overtime reduces the time available for recovery sleep. This is a major consideration when overtime is added to extended shifts, ie, those longer than eight hours. Further, overtime worked on days off may also affect sleep quality and quantity, particularly if it is worked at night.

7.2.7.2. Performance perspective

Rosa (1995) reviews the literature specifically addressing overtime and extended shifts. With regard to overtime, studies have associated overtime work with a number of health and safety results, which may be related to increased fatigue levels. However, as the fatigue effects of overtime occur in conjunction with other personal factors, the specific role of sleep loss and fatigue is not clear.

Smith et al (1998) cite clear recommendations for 12-hour shifts. Overtime should be covered without holding individuals back after a 12-hour shift or calling a worker who has had fewer than three rest days after four consecutive 12-hour shifts.

7.2.8 Days away

7.2.8.1 Sleep on days away from work

Shiftworkers typically obtain significantly more sleep on rest days than on workdays, regardless of the type of shift being worked (Fischer et al., 1993; Tepas and Carvalhais, 1990). Sleep on days off is generally taken at night as shiftworkers revert to a day active, night sleeping pattern. Therefore, sleep is typically longer and of higher quality on days off. For example, sleep length on rest days has been shown to be significantly greater than on workdays for shiftworkers on day (513 and 434 minutes respectively), afternoon/evening (512 and 463 minutes) and night (527 and 409 minutes) shift (Tepas and Carvalhais, 1990). The extra sleep on rest days is probably taken in an attempt to recover the sleep debt accumulated on workdays. The pattern and length of sleep obtained on days off, especially during extended periods of time off (ie. holidays), may make it difficult for shiftworkers to resynchronise their biological rhythms to work conditions. For example, beginning night shift immediately after a holiday period may not allow adequate adjustment of sleep and alertness patterns to ensure safe work practices.

7.2.8.2 Return to work

There is very little published evidence looking at sleep or safety aspects of employees returning to work after holidays. Smith et al (1998) suggest that long blocks of days away from work, as found on the compressed work weeks, may affect communication and transfer of information. It also requires reorientation to the workplace on return after break. Active efforts should be made to reorient workers after days away.

7.2.8.3 Holidays and health

It has been suggested that holidays are one of the objectives of life. We work in order to fulfill our need to find and fund periods of enjoyment outside the workplace. Studies have shown that enjoyment that comes from both daily life as a whole and leisure is correlated with relaxation, total life satisfaction and happiness. Enjoyment that is associated with work was correlated with life satisfaction and hope for the future (Haworth, 1997).

The value of a leisure period or holiday was said to be enhanced if it was taken in the company of others, whether family, friends or work colleagues (Green, 1997). Further, paid holidays may be seen as a reward for past effort. In fact researchers have suggested that employers view holidays as a means to ensure that their workers are refreshed and more productive on their return (Green, 1997). Thus the provision of holidays by employers may be justified as a cost-effective means to retain staff while boosting morale and productivity. Holidays are special. They are generally considered as extended periods of time away from the workplace as opposed to regular time away such as weekends or days off roster. Even a three-day weekend may have more intrinsic value than the standard or regular two-day break. Holidays may also allow individuals to escape from a hectic ‘work’ schedule whether it was paid or unpaid work (Deem, 1996). The balance between work and non-work time influences the health, welfare and economical security of employees and their families. If too much time is spent in the workplace through long hours, extended hours, excessive overtime or poor workplace planning this will have negative consequences for social and family relationships. Too little time spent working will also have negative consequences with a reduction in the standard of living and limited economic wellbeing.

Health, as mentioned earlier, is affected by the equilibrium between work and non-work periods. Health is not just the absence of sickness but involves mental, physical and emotional wellbeing. More specifically researchers suggest that just the *‘mere existence of leisure in a person’s everyday life has consequences for health’* (Haworth, 1997, p.132).

Thus holidays may provide workers with the time necessary to promote recovery, recuperation, the planning of and participation in leisure activities and preparation for the next period of work. Holidays generally involve a number of different activities either in isolation or in combination. Such activities may include social interaction that has a positive influence on mental health and psychological wellbeing (Argyle, 1996); physical activity and/or exercise which has a positive association with general psychological wellbeing and life satisfaction (Wankel & Berger, 1990); challenging leisure such as rock climbing which promotes self esteem and self concept (Iso Ahola et al., 1989); curiosity and intellectual activity that may stimulate neural tissue (Diamond, 1984); and relaxation may promote communications and interactions (Watts, 1960; Argyle, 1996). Finally, the more positive the mood state the more effective will be the immune system (Stone et al., 1987). Hence the potential impact of any holiday taken in the company of family or friends involving physical activities and stimulation is a healthy individual who may be more productive in the workplace.

7.2.9 On-call periods

There are a number of different forms of on-call work that fall under this category.

An example of on-call schedules is that of electricians or other maintenance people who are required to be on call (ie, standby) for certain shifts. Anecdotally, this generally involves the employee 'standing by' away from work and often involves the interruption of sleep. Consideration needs to be taken of the amount of sleep an employee obtains in the non-active, on duty period, prior to returning to work for the subsequent active, on duty period.

Another example of employees working an on-call schedule that involves non-active periods of on duty time is hospital doctors. A comprehensive review examined on-call schedules for hospital doctors, but the variation in study design makes definitive conclusions difficult (Rosa 1995). However, an increasing number of hours worked within the on-call duty period was associated with lower self-reported levels of work efficiency.

Kecklund et al (1997) addresses 'apprehension of difficulties awakening' in a study of early morning start times in cabin crew. The authors suggest that the 'apprehension of difficulties awakening' may be associated with the difficulty in terminating sleep during the early morning hours (when sleepiness is highest). Anecdotal evidence indicates that individuals worry that they will sleep through the alarm, or that the alarm won't actually work. On-call work that requires individuals to rest at home may produce similar sleep disturbances as a result of employees 'keeping an ear out' for the phone. Therefore, sleep obtained during an on-call period may not be as restful or recuperative. There are no scientific studies reporting sleep patterns associated with on-call work, however, scheduling practices should facilitate adequate sleep (Section 6.6).

Another major factor to be considered with on-call work is that of sleep inertia. Sleep inertia results in impairment of alertness and performance immediately upon waking from a major sleep period or a nap. The severity and extent of the impairment is dependent on the length of time the individual has been asleep, at what stage of sleep the individual was woken (ie, NREM or REM) and the time of day the sleep (or nap) occurred (Jewett et al., 1999). If on-call time is spent on standby, resting or recuperating, employees may be required to awaken from sleep to attend a job. In such a situation, the effects of sleep inertia on performance and alertness should be considered.

7.2.10 Commute

7.2.10.1 Sleep impact

Section 7.2.3 broadly describes the breakdown of a 24-hour period into sleep, work time, personal time and travel. Travel to and from work is a basic requirement for all employees. In some community-based settings travel time one way may be less than 30 minutes, with little impact on the time available for sleep. In fly in fly out operations travel time between shifts is obsolete, ensuring that all non-work time can be divided between personal time and sleep. However, in environments where travel takes up a significant proportion of non-work time, travel time must be considered.

7.2.10.2 Performance perspective

Smith et al (1998) cite recommendations for 12-hour shifts. The round trip to and from work should be less than three hours per day because any longer than this would reduce the opportunity for adequate sleep.

There is a clear relationship between time of day and vehicle accidents that have been reported (Howarth & Rechnitzer, 1993; Hartley & Arnold, 1995; Folkard, 1997). An overall picture of this relationship can be observed from a meta-analysis of transport accident risk (Folkard, 1997). The analysis of a range of motor vehicle accident reports indicates a clear peak in accident risk at 0200hr, with a smaller peak at 1500hr.

7.3 Non-work time

Non-work time has been defined as time spent away from the workplace and therefore can easily be contrasted to work (Argyle, 1996). Non-work time may include time spent by individuals in a variety of activities, such as sleeping, socialising, family activities or involvement in leisure and/or hobby activities.

7.3.1 Leisure

The need to balance work and leisure time has been recognised for many years. Leisure has been viewed as a means for workers to escape from the 'unpleasant and exhausting' nature of work (Argyle, 1996). At different times in human history leisure has been viewed as:

> A right (Argyle, 1996; Henderson, 1990).
> A privilege (Primeau, 1995).
> A requirement for health (Bartlett, 1980).
> Any time left over after work (Primeau, 1995).
> Life satisfaction (Tinsley et al., 1993).
> A source of happiness/pleasure (Gramm, 1987; Henderson, 1990; Tinsley et al., 1993).
> Play (Blakelock, 1960; Shaw, 1985).
> Social cohesion (Argyle, 1996).
> Better than work (Primeau, 1995).
> Personal fulfillment (Blakelock, 1960; Csikszentmihalyi and LeFevre, 1989; Tinsley et al., 1993).
> Self definition (Neulinger and Breit, 1971).
> During the Reformation (1500s) leisure was proclaimed to be unimportant and even feared as a temptation (Primeau, 1995).

According to the Australian Bureau of Statistics (1997), people in Australia spent less time in recreation pursuits in 1997 compared to 1992. On average, this decrease was about 90 minutes per day during this period (Australian Bureau of Statistics, 1997). Generally, it was suggested that men and women spend their leisure time in different ways. Men, for example, spend more time watching TV, reading and relaxing than women. These specific leisure activities appear to increase with age.

7.3.2 Social

Human beings are intelligent social animals (Robertson, 1977). We can create and determine our own social environment. This includes the development and sharing of rules and patterns of behaviour that influence and define our lives. Robertson (1977) suggests that we, as humans, conform so easily to these norms that we forget they exist. However, he goes on to say that if there is a departure from the 'norm' it is likely to be noticed.

The shared understandings and behavioural patterns passed on through families and communities result in a 'culture' that makes it possible for us to have a 'social' life. Because we are essentially co-operative social animals, most social behaviour occurs within the context of groups (Robertson, 1977). Therefore, group membership is vital for social belonging, activity and structure. However, there have recently been changes to the way people perceive themselves within society. The Western industrialised world is now embracing a process of individualism that began during the Renaissance (Maybury Lewis, 1992). Originally individualism was viewed as antisocial; now the rights and dignity of the individual are regarded as the most important aspect of society.

Generally, social time was considered to be synchronised with those working a standard working week and not shiftworkers (Jamal and Jamal, 1982; Rutenfranz et al., 1976). Several studies have shown that evenings and weekends are highly valued times for social interaction and participation (DeLaMare and Walker, 1968; Hornberger and Knauth, 1993; Wedderburn, 1981). Specifically, Wedderburn (1967) suggested that the weekend was a focus of social life, including community entertainment and activities. It should be remembered that no difference was found between shiftworkers and non-shiftworkers in their perceptions of time (Blakelock, 1960; DeLaMare and Walker, 1968). Hence, shiftworkers have been considered relatively 'poorer' in time when compared to non-shiftworkers because their work reduces their access to those highly valued social times (Wedderburn, 1967).

7.3.3 Family

We all live in families, are part of a family or have been part of a family. Whether we choose to acknowledge it or not, families influence our place in the world. Essentially, family is instilled within the concept of self and how we orientate ourselves to a world where being alone is seen as an aberration and a thing to be pitied (Bittman and Pixley, 1997).

David Maybury Lewis (1992) suggests that the idea of a family made up of a father, mother and assorted offspring is not universal. He found that there were many systems of kinship that were viewed as family, which extended to include the entire society, or uncles, aunts and cousins with immediate family members or the nuclear family of Western industrialised countries (Maybury Lewis, 1992). It is essentially within these systems that we define ourselves in relation to those around us, seek support and comfort, responsibility and belonging, and identity. In many cases family life appears to offer an opportunity for leisure and respite from the commitments of the external environment. Nevertheless, depending on gender the reality of family is one of hard labour and endless repetition (Beck, 1998; Sekaran, 1983).

Family households change over time. They pass through a series of stages as children leave home, start new households, have children, divorce (maybe), age and ultimately die (Bittman and Pixley, 1997). How an individual works generally will influence each of these stages. It is well known that family life is affected by hours of work (Gadbois, 1981; Mott et al., 1965; Walker, 1985). Gender also plays a significant role in how working arrangements influence family relationships (Beck, 1998; Bittman and Pixley, 1997; Levine and Pittinsky, 1997).

The desire to balance family and work has been seen as a source of conflict (Cooke and Rousseau, 1984). Furthermore, this conflict has been shown to lead to poor marital adjustment and inadequate role performance (Cooke and Rousseau, 1984). These inter-role conflicts increase as either the demands of work or family increase (Cooke and Rousseau, 1984).

According to Cooke and Rousseau (1984), having a family role may be linked to better physical health as the social support implied by family roles can moderate the negative impact of work related stress. Furthermore, the dual roles of worker and family member may be difficult to juggle constantly and act as a source of conflict, but it has been suggested that this may in fact alleviate stress that emerges from poverty and social isolation (Ayers et al., 1993).

7.3.4 Shiftwork

It has been suggested that the origins of the eight-hour work day came from the idea that the 24 hours of the day should be evenly split between work, recreation and sleep (Rutenfranz et al., 1976). Furthermore, the normal daily sequence of these activities should be sleep, work and leisure (Costa, 1997). However, this order alters during shiftwork to one of sleep, leisure and work when employees work afternoon, evening or night shift (Costa, 1997). Morning shift however, does not change this sequence, as the daytime hours worked are generally similar to those of a standard working week. An alteration in the ordering of activities makes life problematic for those who are considered out of step with the rest of society. It has been observed that the actual amount of leisure time available to shiftworkers, because of their schedules and sequencing, is equal to that associated with day work (Costa, 1997). However, it has been found that it is more the placement of the leisure periods across the day and week that makes it difficult or frustrating for a shiftworker (Knauth and Costa, 1996). Studies have shown that the evenings and weekends are considered important for leisure and social activities (DeLaMare and Walker, 1968; Hornberger and Knauth, 1993; Wedderburn, 1981) and shiftworkers often have to work at these times. Thus in recognition for working at these 'unsocial' times, employees are usually financially compensated. This compensation varies in rate depending on the day and the shift being worked, the higher rates are generally found for night and weekend work.

It should be remembered that

> *'social and domestic activities are not luxuries. They are essential features of life in our society'* (Australian Council of Trade Unions, 1999, p2)

Furthermore, shiftwork has been recognised as an occupational health and safety problem since 1906 (Harma, 1998), but only within the last decade has this been taken seriously by Australian industry (Quinlan and Bohle, 1991).

Measurement of the psychosocial impact of hours of work across rosters and work places has been well documented (Ernst et al., 1988; Monk et al., 1997; Primeau, 1995; Wedderburn, 1981). In addition, anecdotal evidence suggests that the psychosocial costs of shiftwork are high (ACIRRT, 1997; Berger, 1994).

Much of the shiftwork literature supports the notion that working 'unsocial' hours creates family and social stresses that may be avoided by those working a more standard working week (Baker, 1980; Colquhoun et al., 1996; Quinlan and Bohle, 1991).

It has been suggested that not all rosters are totally without advantages for families and activities outside the workplace. For example, 12-hour shift systems demonstrate several advantages for families and leisure time (Colligan and Tepas, 1986; Lowden et al., 1998; Rosa and Colligan, 1989). Specifically, these advantages are related to the uninterrupted blocks of time away from the workplace. Nevertheless, it should be remembered that even when the long breaks are viewed as a bonus there is a considerable downside. That is, on the days worked the employee essentially has little time for anything else. Hence, there may be family difficulties in terms of child care and involvement in daily family life (Anderson and Bremer, 1987; Colligan and Tepas, 1986).

It is not surprising that personal perception regarding time and its value and use will influence the acceptability or rejection of a working time schedule.

7.3.5 Summary

Much of the literature suggests that the social impact of non-traditional hours of work may be responsible for a number of commonly recognised family and community issues. These include:

> Domestic disharmony (Lushington et al., 1997; Quinlan and Bohle, 1991).
> Increased divorce rate (Mott et al., 1965).
> Increased workloads for women (Oginska et al., 1993).
> Learning difficulties for children of shiftworking parents (Ernst et al., 1988).
> Social alienation of shiftworkers (Baker, 1980; Frese and Semmer, 1996).
> Communication difficulties both at home and work (Smith and Folkard, 1993).

7.3.6 Example of how a 24-hour period may be influenced by changing shift lengths.

As work time increases the most commonly reported scenario is that individuals will trade sleep time to ensure non-work time is only marginally affected when travel time is held constant. Ideally sleep time should be protected and given high priority.

"*Because the effects of inadequate sleep accumulate, the six-hour minimum sleep requirement is adequate for one day, but not sufficient on an ongoing basis. Schedules should permit two consecutive nights of unrestricted sleep on a regular basis (preferably weekly), to provide drivers with the opportunity to recuperate from the effects of accumulating sleep debt*" (Fatigue Expert Group, Feb 2001, page 31, ATSB).

There is a simple relationship between the length of one's work hours and the time available for sleep. The greater the number of hours worked, the less time is available for sleep (Bartolomé, 2000). The reduction in sleep has been associated with increased levels of fatigue and reduced alertness. High levels of fatigue and/or reduced alertness have in turn been associated with reduced workplace performance and productivity and increased risk of accident and injury (Dawson et al, 2001).

8 Scientific evidence - Fatigue

8.1 What is fatigue?

There is no universally accepted definition of fatigue. However, for the purposes of this document fatigue will be defined as the increasing difficulty to perform physical and mental activities as the consequence of inadequate restorative sleep.

The human biological timing system is programmed for sleep during the dark hours and for activity during the daylight hours. For shiftworkers, achieving adequate sleep is difficult because of the time at which sleep opportunities occur. Research into shiftworkers' sleep, using both subjective measures (sleep diaries and questionnaires) and objective measures (activity monitors and sleep recording equipment) indicates that shiftworkers get significantly less sleep depending on the time of the particular shift (Siebenaler and McGovern, 1991; Smith Coggins et al., 1994; Smith Coggins et al., 1997). On night shift, an average length sleep was 6.8 hours (Tepas and Carvalhais, 1990), and on early morning shift the average sleep length was as low as 5.2 hours (Kecklund et al., 1997). Afternoon shift is reported as the best shift for sleep length, with workers averaging 7.7 hours (Tepas and Carvalhais, 1990). In addition to sleep length, the timing of the sleep opportunity also affects the quality of sleep.

In addition to sleep loss, other contributing factors to increased fatigue levels include but are not limited to:

> Long periods awake.
> Inadequate amount or quality of sleep over an extended period.
> Sustained mental or physical effort.
> Disruption of circadian rhythms.
> Inadequate rest breaks.
> Environmental stressors such as heat, noise and vibration (Fatigue Expert Group, Feb 2001, page 21).
> Health and emotional issues.
> Time of day when work is performed and sleep obtained (Fatigue management for commercial vehicle drivers, Transport, 1998, page 5).

And can result in:

> Impaired performance (impaired judgment, poorer performance on skilled control tasks, slower reaction times and increased probability of falling asleep).
> Subjective feelings of drowsiness or tiredness (Fatigue Expert Group, Feb 2001, page 21).

The accumulation and reduction of fatigue can be seen as a dynamic process with the forces that produce fatigue in opposition to those that reverse its effects (recovery). Two types of fatigue have been identified: Work related and non-work related.

WORK related fatigue is that fatigue which is associated with work time arrangements and can be monitored and managed at the organisational level. Akerstedt (1988) cites several studies that report higher levels of fatigue in shiftworkers than day workers. Generally the fatigue is widespread on the night shift, almost absent on afternoon and is intermediate on the morning shift.

An electroencephalography (EEG) and electrooculography (EOG) study was done in a paper mill. In 25 per cent of individuals studied an episode of sleep was seen, generally in the second half of the night shift and only the night shift. Train drivers were also much sleepier at night though no sustained sleep happened.

NON-WORK related fatigue is that fatigue which is associated with activities outside the workplace such as family and social responsibilities and obligations, social activities and events. These factors can be best monitored and managed at the individual level.

Overall, effective monitoring and management of both work and non-work related fatigue are likely to have beneficial outcomes to the organisation, workforce and their families and the wider community (Queensland Government, 2001).

8.2 Causes

The principle cause of fatigue, as mentioned earlier, is the lack of restorative sleep. However there are other factors that will influence fatigue levels (Figure 1.1, Section 1.2). Other factors that influence fatigue include:

> Time of day
> Work design
> Travel time
> Personal time
> Communal time
> Stressors
> Environment
> Family and social obligations and responsibilities

8.3 Signs and symptoms of fatigue

NOTE: Humans have a limited ability to predict the onset of sleep and by continuing to undertake high risk activities such as driving when sleepy place themselves and others at risk (refer to sleep evidence, Section 6).

Some recognisable signs and symptoms of fatigue include:

> Not feeling refreshed after sleep
> A greater tendency to fall asleep at work
> Increased errors
> Reduced performance and alertness
> Loss of concentration at work
> Blurred vision
> Difficulty keeping eyes open
> Head nodding
> A drowsy relaxed feeling
> Microsleeps

8.4 Consequences of fatigue whether work or non-work related

The consequences of fatigue include:

> Decreased alertness
> Slowed reaction time
> Poor hand-eye co-ordination
> Poor communication
> Higher error rates
> Reduced vigilance
> Reduced decision-making ability
> Nodding off
> Mood swings
> Impaired short-term memory
> Underestimation of performance
> Easily distracted
> Impaired judgment
> Lethargy
> Loss of situations awareness

8.4.1 Testing for fatigue – devices

Obviously fatigue cannot be identified using any sort of biochemical measure or test. There are two ways in which fatigue can be managed under a fitness for work policy:

> Devices capable of detecting performance impairment before or during a work shift, or monitoring real time performance in a vehicle.

> Predicting fatigue with models that calculate the amount of sleep opportunity and extrapolate from that the likelihood of fatigue and recovery.

Hartley (2000) outlines a number of devices that purport to either detect or predict fatigue related impairment. For the most part, the technologies monitor operator vigilance, operator attention/inattention, operator alertness/drowsiness, operator microsleeps, operator hypovigilance, operator performance variability, or operator vulnerability to error. Some of the technologies are 'biologically based' – that is, they measure involuntary responses to stimuli. Other technologies measure performance using specific tasks or devices that provide a good indicator of performance on task.

8.4.1.1 Psychomotor Vigilance Task (PVT)

The Psychomotor Vigilance Task (PVT) assesses reaction time using a hand-held device, over a period of time, generally 10 minutes. The PVT device consists of a small hand-held box with a digital display and two buttons (for left and right handed subjects). The digital display counts up from zero in milliseconds at random intervals during the testing period. When the display illuminates and begins counting upwards, the subject is required to push the button as quickly as possible. The display ceases counting and indicates the time taken to respond to the stimulus. The PVT has been used primarily as a research tool, having proven sensitivity to the impairing effects of fatigue on performance (Dinges et al., 1994). It has also been used to validate other impairment detection devices for fatigue related performance impairment. The device has potential for the detection of fatigue related impairment in the field.

8.4.1.2 FACTOR 1000

FACTOR 1000 is one of the earliest critical tracking tasks developed. The system uses hand-eye co-ordination to assess the level of impairment. A series of trials being conducted in the US has shown that FACTOR 1000 is sensitive to factors other than alcohol and drugs, for example fatigue, stress and illness. It may have advantages therefore over OSPAT and FIT2000 that have not yet been widely validated for use in detecting impairment associated with a variety of factors.

8.4.1.3 Two part reaction/vigilance test

The test battery developed by Williamson and Feyer (2000) consists of a simple reaction time test and a simple vigilance task with low cognitive demand called the Macworth Clock test. The reaction time test lasts for two minutes and requires the subject to press a key when the outline of a circle, moving randomly around the screen, changes from a solid to a dotted outline. The Macworth clock test is a vigilance task and comprises a series of 24 points positioned in a circle, which flash consecutively in a continuous loop. The subject is required to press a key immediately a point in the circle fails to illuminate. Importantly, the testing equipment is portable, with the tasks capable of being run from a palm top computer. The tests have also been validated against performance under the influence of alcohol. Dr Williamson has suggested that the tasks could be applied to all modes of transport and indeed may be modified as a 'side of the road' random fatigue test.

8.4.1.4 OSPAT

The Occupational Safety Performance Assessment Test (OSPAT) measures performance impairment using a critical tracking task. Using a trackball, the subject is required to keep his or her cursor on a randomly moving target. The performance on a particular task, administered before or during a shift, can be compared to the individual's baseline, reducing the chance of individual variability interfering with results. One of the major commercial selling points of the OSPAT device is that it detects impairment, and makes no judgment on the reason for the impairment.

In some cases the system has been introduced as a pilot scheme, incorporating training and education packages and other methods of determining sleepiness/fatigue, such as the Stanford Sleepiness Scale. A number of mines in Australia employ the OSPAT system as part of fitness for duty (FFD) testing, including BHP Blackwater and BHP Goonyella Riverside, both open cut mines (Cliff, 2001).

8.4.2 Biological measures for fatigue

8.4.2.1 FIT2000

The FIT2000 system is a biological measure of performance potential, developed on the basis of the changes that occur in the reaction of the eye pupil to light as a person becomes impaired (PMI Incorporated, 2001). A controlled dose of normal visible light is administered by the device to the eye, and then makes a series of measurements of the eye's saccadic velocity (ie, the speed at which the eye moves between points in the field of vision). As with other performance tests, the measurements are compared to the individual's baseline recording, established at the time of implementation of the testing protocol. Each new test is then compared to the baseline and the deviation from the baseline is determined as the individual's current FIT index. A deviation threshold will be set and indices above the threshold indicate impaired performance. In the case of an individual being defined as 'high risk' as a result of the measurement being above the threshold, further investigations are recommended. The FIT2000 has been validated primarily as a tool for the assessment of fatigue related impairment, rather than across a range of variables such as alcohol and drugs.

This type of device, capable of storing all workers' test scores, can also be used to keep track of impairment daily, weekly and yearly. Performance trends can then be mapped and 'trouble spots' identified and dealt with early. However, Hartley and colleagues (2000), in their review of fatigue detection technologies, suggest that the FIT2000 only detected impairment in 80 per cent of people with a BAC of 0.06 to 0.08 per cent. Further, only 40 per cent of the subjects who had been awake for 48 hours were assessed as 'high risk' by the FIT2000 system. The majority of the literature supporting the use of the FIT2000 system pertains to the scientific rationale and principles behind its use, rather than field or laboratory trials examining its validity as an indicator of fitness for work. Importantly, the literature predominantly consists of 'in house' publications. Despite the lack of strong scientific evidence, the FIT2000 system is being trialled by the US military and also by mines in Queensland, Australia.

At the Callide coal mine in Queensland the FIT2000 system has been installed as part of a holistic approach to managing fitness for duty (Cliff et al., 2000). After establishing a baseline for each individual with a series of initial measurements, all employees presenting for work for each shift were screened by the FIT2000 device. Where impairment was detected the employee was precluded from commencing work for the sake of their own, and their workmates', safety. A six-month trial of the system was undertaken under a protocol of no prejudice, and no follow-up testing was carried out during the trial to determine the reason for the impairment. A review of the trial concluded that the 'FIT2000 instrument was a potentially valuable tool for enhancing safety behavioural change'. Subsequently the Personal Fitness for Duty Procedure was implemented as a whole at the Callide Mine in September 1999, with the FIT2000 system as the screening device. A well designed procedure for following up 'high risk' readings has also been put into place. High risk readings are followed by a breath alcohol test, a saliva drug test, an impairment questionnaire and further testing by a medical officer to determine the cause of the impairment. The initial saliva tests are purely screens , and in the case of a positive saliva screen a NATA certified laboratory conducts a further test. The false positive rate is reported at approximately 5 per cent. The program has been very well accepted by the workforce and according to anecdotal evidence it appears that the risk-taking behaviour of some employees, in terms of alcohol and drug consumption, has been reduced. The FIT2000 system has also been implemented in a second Queensland mine, under similar, holistic conditions. A report from the trial period at Burton mine indicates that the program has caused a change in employee behaviour, and has also resulted in an increased awareness about the causes and risks of fatigue. Some correlation data showed that saccadic velocity correlated well with self-reported alertness levels at the start of the day shift but not the start of the night shift. Length of sleep, as measured by diaries, was correlated negatively with constriction latency of the pupil only for night shift (Esson et al., 2000). Thus far, the program appears to be successful in terms of assessment of impairment at the start of a work period. The report also indicated that the initial implementation of the system was very labour intensive. Interpretation of the outputs of the system required a certain level of training as well as maintaining and updating information. Daily maintenance is required but this is generally a fairly simple and short task (Esson et al., 2000). There is a series of follow-up procedures to determine the reason for the positive or high risk result.

8.4.2.2 PERCLOS

The PERCLOS system is a biological measure that assesses the percentage of time the eyelid is closed over the pupil, across a period of time. Specifically, the PERCLOS system gives an indication of slow eyelid closures, or droops, as opposed to normal blinks. The Federal Highway Administration and the National Highway Traffic Safety Administration in the United States both identified PERCLOS as among the most promising systems of measuring real time driver alertness. PERCLOS was developed based on the fact that drowsy drivers exhibit certain facial characteristics that are readily observed. Particularly, fatigued drivers have slower eyelid closures and longer eyelid closures, as well as other characteristic eye movements. The slow eyelid closures indicate drowsiness, but also suggest an interruption to visual information gathering (Wierwille and Ellsworth, 1994). The device has particular relevance for driving tasks but could probably be applied in situations such as computer monitoring. A study investigated a number of drowsiness detection devices, including PERCLOS, and validated them against lapses in the psychomotor vigilance task (PVT). The PVT is well recognised and well validated as being extremely sensitive to fatigue arising from sleep deprivation and time of day effects (Dinges et al., 1994). Subjects were kept awake for 42 consecutive hours and participated in a 20-minute PVT session every hour, as well as being assessed by each detection device. Scores were calculated for each drowsiness detection device and correlated to the PVT data (Dinges et al., 1998). Each hour of data was randomised so that scorers were not aware of the timing of the data collection. The study time-locked PVT sessions to each of the six technologies and both the suppliers who scored the records from their own devices, and the investigators who scored the PVT lapse data, were blind to the other outcomes.

PERCLOS had the highest correlation with vigilance lapses throughout the study (between 0.8 and 0.9). Studies are under way to examine the potential for real time gauges attached to the PERCLOS system, which will allow drivers or operators to monitor their own alertness levels, in addition to alarms and warnings of drowsiness, and alerting stimuli. The potential exists for such a device to be installed in vehicles or at consoles to serve as an early warning system for impaired performance due to inattention, reduced vigilance or even sleep bouts. There are issues with what to do when a warning is sounded.

When the system alerts the operator of an impending microsleep, the issue remains as to what the appropriate response should be. Ideally, the operator should have a break or be relieved immediately. This is often not practical in environments such as heavy vehicle transport where there is a single driver and a lack of immediate opportunity for rest (ie, inadequate rest stop). However, in environments such as open cut mines and quarries, in which drivers operate machinery for long periods, the potential for relief by a colleague, or for rest, is more realistic. A warning of drowsiness may require that countermeasures be employed, such as caffeine, a walk around the vehicle or a short nap. The contention is that the device may encourage operators to work through their own well recognised barriers with the false sense of security that the device will warn or wake them in time to prevent incidents. Further research is required in the field to validate the use of the PERCLOS system in environments requiring extended operations of vehicles.

Nissan, Toyota and Mitsubishi are all in the process of incorporating these types of facial/eye assessment into their advanced safety vehicles. The technology therefore is also being developed for use in private as well as commercial vehicles.

8.4.3 Performance

8.4.3.1 Stimulus response reaction tests

Stimulus response reaction tests are aimed at assuring attentiveness during the conduct of a work task. A stimulus is presented periodically, in either audio or visual form, to which the operator must respond as quickly as possible. With this type of test it is vitally important that the required response to the stimulus does not interfere with the task, or increase the workload of the operator beyond what is reasonable. Failure to respond to the signal, generally a light, by either touching a keypad or engaging a foot pedal, will result in an audible alarm, and potentially the shutdown of the vehicle or system. The rail industry has used this approach to ensure that drivers remain alert. If there is no reaction to the stimulus, a visual signal followed by an audible signal both attempt to alert the driver. If the driver does not respond to any of these signals the train is stopped automatically. A series of studies from the rail industry indicates drivers can operate the vigilance system in a largely automatic manner.

Nevertheless, the provision of a secondary task may itself increase the level of arousal and attention of the operator, especially in cases where the operation is extremely monotonous. An investigation of stimulus reaction tests for increasing alertness of train drivers showed that devices which required the engineers to choose a response rather than just responding automatically to the signal (ie, tasks that required more cognitive processing) increased the alertness of the operators in a simulator (Devoe and Abernathy, 1977). In the field, however, using video monitoring and physiological measures, it was clear that the drivers could operate the devices at very low levels of alertness (Fruhstorfer et al., 1977). Further, such a device would need to be altered for use in haul trucks in mining operations. For example, it would be important that the device did not require a response from the operator while the vehicle was reversing or unloading (Mabbott et al., 1999).

8.4.3.2 The ARRB Fatigue Monitoring Device

This fatigue monitoring device was developed to measure changes in operator performance that might precede a fatigue related lapse or error. The device has been used in the field in a number of mining operations in Australia.

The ARRB device can be hard wired into the cabin of a vehicle and is a forced reaction time task. It provides an audio and visual stimulus to which the driver must respond. The device records the reaction time and tests each reaction time against personal baseline measures of performance. A slower response suggests a more fatigued state and the device warns both the operator and a supervisor of the potential that the driver is becoming tired. At all times that an operator is working within the system, the fatigue monitoring device has the capacity to send warning messages to a central point (usually a dispatch or control room) that an operator is becoming tired.

8.4.3.3 SAVE project

The system for effective assessment of the driver state and vehicle control in emergency (SAVE) operates on the basis of impairment detection of the operator, followed by a driver warning and, if required, system shut down. The system measures factors such as eyelid closure, head position and grip force on the steering wheel as well as vehicle speed, steering wheel angle, the distance to a lead vehicle and the lateral position of the vehicle.

8.4.3.4 Head nodding

A number of devices measure the nodding of the operators' head to indicate high levels of fatigue and drowsiness and provide a warning signal. As the operator gets sleepier, the eyelids droop and the head starts nodding. The systems are designed to detect when the head nods past a pre-determined angle and then to sound an audible or vibrating alarm to alert the operator. This device is relevant mostly to driving operators, and most are in the very early stages of development.

An alternative way of detecting head nodding is with a device worn around the neck. When the chin of the operator falls downwards as the head nods, an electrical circuit is closed and an alarm is sounded. This particular device is much cheaper than the head nodding detectors but is obtrusive and not yet taken seriously by drivers and operators.

Currently, a mining organisation in Australia is investigating such a device for its truck operators. The head nodding detector is to be fixed to the rear of the driver's hard hat in order to alert the driver if the head should nod beyond a certain angle.

8.4.3.5 EMG, EEG, EOG

Measurements of physiological parameters such as brain waves (EEG – electroencephalography), muscle tone (EMG – electromusculography) and eye movements (EOG – electrooculography) have long been used to assess sleep state. EEG monitors that record brain waves can provide a real-time indication of alertness levels. However, the EEG monitors require a series of electrodes to be attached to specific points on the scalp and are therefore not very practical for workplace settings. A variation on that idea has been used to develop a headband style contraption that has electrodes embedded at appropriate points. This is slightly more convenient than a series of wires but a working prototype is a long way off. Those being developed vary a lot between electrode placement, the nature of the recording and whether it takes into account eye movement (EOG measurements). In addition, the nature of the drowsiness / hypovigilance algorithm varies quite dramatically between systems.

8.4.4 Prediction technologies

8.4.4.1 Fatigue Audit InterDyne (FAID)

The FAID (Fatigue Audit InterDyne) model essentially allocates fatigue or recovery value to work and break periods based on four factors:

> Duration of shifts and breaks.
> Timing of shifts and breaks.
> Prior (seven-day) work history of individuals.
> Biological limitations on sleep and recovery.

The information on which this model is based has been produced as a result of significant experimental studies into the effects of shift lengths, the timing of shifts and the importance of work periods at different times in the past. This experimentation has been undertaken over the previous decades at various facilities throughout the world. In addition to this information, the model has been developed and validated using simulated work environments and in field-based situations at the University of South Australia. The development and validation work is considerable and has been published in international peer-reviewed journals and books (Dawson and Fletcher, 2001; Fletcher and Dawson, 2001; Fletcher et al., 2000).

The model does not make decisions on which work schedules are most appropriate in specific workplaces. The model provides information that can be useful when decisions about fatigue management need to be made. Tracking fatigue scores in relation to incident frequency, absenteeism levels, employee sick days or other organisationally meaningful data would allow a clearer illustration of the relationship between hours of work and its related costs.

8.4.4.1.1 Defining the scores produced

To differentiate between schedules, four levels of work related fatigue scores are defined. Standard fatigue represents fatigue scores up to the maximum fatigue scores produced for a Monday to Friday 9am to 5pm standard work week; that is, a score of approximately 40. Moderate fatigue scores are those which are up to 200 per cent of the maximum score produced by the standard work week; that is, a score of approximately 80. High fatigue scores are those between 200 and 250 per cent of the maximum scores produced by the standard work week; that is, a score of approximately 100. Very high fatigue scores are those between 250 and 300 per cent of the maximum scores produced by the standard work week; that is, a score of 120 or greater.

A recent study indicated that scores between 80 and 100 (that is, high fatigue) are equivalent to the predicted level of work related fatigue achieved after 23 to 24 hours of continuous sleep deprivation (starting at 8am). This result was observed when the sleep deprivation started at 8am on a Monday, following a week working Monday to Friday from 9am to 5pm and with Saturday and Sunday off. Performance impairment at such a level of sleep deprivation has been associated with blood alcohol concentration over 0.05 per cent in a recent study (Dawson and Reid, 1997).

The main advantage of this type of model is that only the start and end times of work shifts are required as the input, rather than employee sleep periods, as used in other models. Thus, the model allows comparison of the fatigue levels that different working time arrangements may impose on an employee population. Finally, organisations can set a threshold fatigue level considered appropriate for their operation. For example, a score of 80 may be acceptable for some tasks in which a fatigue induced incident or accident would have minimal impact (ie, photocopying), but unacceptable for a task in which an incident would have a wide reaching impact (ie, flying a jumbo jet). The negative aspects of the system are that there is no capacity for non-work related fatigue or social effects to be taken into account, nor any consideration for individuality.

8.4.4.2 Sleepwatch

The US Army is trialling a system that monitors a person's sleep levels and alerts them if they have not achieved adequate recovery. The individual wears on the wrist an actigraphy device that continuously monitors sleep patterns and predicts performance based on the amount of sleep obtained. Using information gathered by the device, the sleep watch system can predict periods of high fatigue and make suggestions for optimising sleep and performance. The device incorporates the sleep measures with circadian periodicity variables into a sleep and performance algorithm. The algorithm determines how much in need of sleep the individual is at any point in time. The information can be downloaded and checked using a palm top computer. In the future, the system ideally will also include a stimulant drug to be self-administered when sleep is not an option, and a hypnotic/alerting agent combination to ensure sleep is achieved quickly when the opportunity arises and that the individual awakens just as quickly (Belenky et al., 1998). On line real-time information will be available to both the individual and their superior as to the performance level of the individual. Finally, education and training on the best way to maximise the benefits of the system in the specific work environment will be necessary.

8.4.4.3 Three Process Model

The three process model of Akerstedt and Folkard uses sleep data as the input (Akerstedt and Folkard, 1997), as opposed to work hours as used by the FAID model.

The model is based on three main premises:

> Alertness and performance fluctuate on a circadian basis.
> Lack of sleep reduces the levels of alertness and performance in an essentially linear fashion.
> Prior time awake also affects alertness and performance levels.

The model identifies the levels of predicted alertness that increase the risk of impaired performance (Akerstedt and Folkard, 1997; Folkard et al., 1999). The authors state that the predictions of alertness determined by the model are difficult to reconcile with published information on accident and incident data (Folkard et al., 1999). The specific sleep inputs of the model are the time of going to bed and the time of rising. However, the accuracy of these inputs is dubious without appropriate EEG monitoring. As the system requires individuals to track their own sleep patterns there may be a problem in obtaining correct or accurate sleep data that will be subjective at best. Nevertheless, continuing work on the model will ultimately increase the predictive power and allow trends in accident risk, specifically on abnormal sleep schedules, to be anticipated.

References

ACIRRT (1997) Vickery Mine Report. University of Sydney.

Akerstedt, T. (1988). "Sleepiness as a consequence of shift work." Sleep 11: 17 34.

Akerstedt, T. and Folkard, S. (1997). The three process model of alertness and its extension to performance, sleep latency, and sleep length. Chronobiology International 14: 115 123.

Akerstedt, T. and Folkard, S. (1995). "Validation of the S and C components of the three-process model of alertness regulation." Sleep 18: 1-6.

Akerstedt, T. and Gillberg, M. (1981). The circadian variation of experimentally displaced sleep. Sleep 4: 159 169.

Aldrich, M. and Naylor, M. (2000). Abnormal Sleep: Impact, Presentation and Diagnosis. Principles and Practice of Sleep Medicine. Third Edition. M. Kryger, T. Roth and W. Dement. Philadelphia, WB Saunders Company: 521 525.

Anderson, J., R.M and Bremer, D.A. (1987). Sleep duration at home and sleepiness on the job in rotating 12 hour shiftworkers. Human Factors 29: 477 481.

Argyle, M. (1996). The Social Psychology of Leisure. London, Penguin Books.

Australian Bureau of Statistics (1997). "Working Arrangements." Canberra.

Australian Council of Trade Unions (1999) Interim Health and Safety Guidelines for Shift Work and Extended Working Hours. ACTU OHS Unit, Trades Hall

ATSB (2001) Fatigue expert group: Options for regulatory approach in drivers of heavy vehicles in Australia and New Zealand. Australian Transport Safety Bureau, Land Transport Safety Authority and National Road Transport Commission

Ayers, L., Cusak, M. and Crosby, F. (1993). Combining work and home. Occupational Medicine 8: 821 831.

Baker, D. (1980). The use and health consequences of shiftwork. International Journal of Health Services 10: 405 421.

Bartlett, J. (1980). Familiar Quotations. Boston, Little Brown.

Bartolome, F. (2000). The Work Alibi, when it's harder to go home. In: Harvard Business Review of Work and Life Balance. Harvard Business School Press. p. 81-101.

Beck, B. (1998). A survey of Women and Work. The Economist July: 3 16.

Beck, U. (1994). Destandardisation of labour. Risk society, towards a new modernity. T. B. M. Ritter. London, Sage Publications: 139 150.

Belenky, G., Balkin, T.J., Redmond, D.P., Sing, H.C., Thomas, M.L., Thorne, D.R. and Wesesten, N.J. (1998). Sustaining performance during continuous operations: The US army's sleep management system. Managing Fatigue in Transportation. L. Hartley. Oxford, Elsevier Science Ltd: 77 86.

Belenky, G., Wesesten, N.J., Thorne, D.R., Thomas, M.L., Sing, H., Redmond, D.P., Russo, M.B. and Balkin, T.J. (2003). Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose response study. Journal of Sleep Research 12: 1 12.

Berger, Y. (1994). Shiftwork: Maladaptation and Deprivation, A window Into Some Workplaces. Shiftwork and Irregular hours of Work: Current Developments., Sydney, Australia.

Bittman, M. and Pixley, J. (1997). The Double Life of the Family. Sydney, Allen and Unwin.

Bjerner, B. (1949). Alpha depression and lowered pulse rate during delayed actions in a serial reaction test: A study of sleep deprivation. Acta Physiologic Scandinavia 19: 1 93.

Blakelock, E. (1960). A new look at the new leisure. Administrative Science Quarterly, pp: 446-467.

Bonnet, M.H. (1994). Sleep Deprivation. Principles and Practices of Sleep Medicine. M. Kryger, T. Roth and W. Dement. Philadelphia, WB Saunders Company: 50 67.

Bonnet, M.H. (2000). Sleep Deprivation. Principles and Practice of Sleep Medicine, Third Edition. M. Kryger, T. Roth and W. Dement. Philadelphia, W.B. Saunders Company: 53 71.

Borbely, A.A. (1982). A two process model of sleep regulation. Human Neurobiology 1: 195 204.

Brown, I. (1997). Prospects for technological countermeasures against driver fatigue. Accident Analysis and Prevention 29: 525 531.

Bryson, L. (1998). The women's health Australia project and policy development. Australian Journal of Primary Health 4: 59 71.

Carskadon, M.A. and Dement, W.C. (2000). Normal Human Sleep: An Overview. Principles and Practice of Sleep Medicine, Third Edition. M. Kryger, T. Roth and W. Dement. Philadelphia, W.B. Saunders Company: 15 25.

Casey, C. (1995). Critical analysis and the problem of work. Work, self and society, after industrialism. London and New York, Routledge: 7 25.

Cliff, D. (2001) Fitness for Duty. A Scoping Study: Issues and Research Needs. Queensland Mining Council.

Cliff, D., Beach, R. and Leveritt, S. (2000) Safety performance related to shiftwork in the Queensland mining industry. Queensland Mining Council Ltd.

Colligan, M. and Tepas, D. (1986). The stress of hours of work. American Industrial Hygiene Association Journal 47: 686 695.

Colquhoun, W.P., Costa, G., Folkard, S. and Knauth, P. (1996). Shiftwork: problems and solutions. Frankfurt, Peter Lang Verlag.

Cooke, R. and Rousseau, D. (1984). Stress and Strain from family roles and work role expectations. Journal of Applied Psychology 69: 252 260.

Costa, G. (1997). The problem: shiftwork. Chronobiology International 14: 89 98.

Csikszentmihalyi, M. and LeFevre, J. (1989). Optimal Experience in Work and Leisure. Journal of Personality and Social Psychology 56: 815 822.

Dawson, D. (1997). Managing shiftwork: not just the roster. The Journal of Occupational Health and Safety – Australia and New Zealand 13: 411 413.

Dawson, D. and Fletcher, A. (2001). A quantitative model of work related fatigue: background and definition. Ergonomics 44: 144 163.

Dawson, D., McCulloch, K. and Baker, A. (2001) Extended Working Hours in Australia: Counting the Costs. Report Commissioned by the Department of Industrial Relations.

Dawson, D. and Reid, K. (1997) Fatigue, alcohol and performance impairment. Nature 388(6639): 235.

Deem, R. (1996). "No time for a rest – an exploration of womens work, engendered leisure and holidays." Time and Society 5: 5-25.

DeLaMare, G. and Shimmim, S. (1964). Preferred patterns of duty in a flexible shift working situation. Occupational Psychology 38: 203 214.

DeLaMare, G. and Walker, J. (1968). Factors influencing the choice of shift rotation. Occupational Psychology 41: 1 21.

Dempsey, K. (1997). Inequalities in Marriage: Australia and Beyond. Oxford, Oxford University Press.

Devoe, D.B. and Abernathy, C.N. (1977) Maintaining alertness in railroad locomotive crews. Federal Railroad Administration.

Diamond, M. (1984). A love affair with the brain. Discovery, May: 70.

Dinges, D., Pack, F., Gillen, K., Powell, J., Kribbs, N., Ott, G. and Pack, A. (1994). Cumulative effects of acute parital sleep deprivation on PVT lapses and SSS ratings. Journal of Sleep Research 23: 408.

Dinges, D., Pack, F., Williams, K., Gillen, K., Powell, J., Ott, G., Aptowicz, C. and Pack, A. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4 5 hours per night. Sleep 20: 267 277.

Doran, S.M., Van Dongen, H.P.A., Powell, J.W., Mallis, M.M., Konow, P. and Dinges, D.F. (2000). Effects of cumulative workload on vigilance decrements during total sleep deprivation. Sleep 23: A240.

Duchon, J., Keran, C. and TJ, S. (1994). Extended workdays in an underground mine: a work performance analysis. Human Factors 36: 258 268.

Duchon, J.C., Keran, C.M., Smith, T.J. and Koehler, E.J. (1997). Psychophysiological manifestations of performance during work on extended shifts. International Journal of Industrial Ergonomics 20: 39 49.

Dunham, R.B. and Hawk, D.L. (1977). The Four Day/Forty Hour Week: Who Wants It? Academy of Management Journal 20: 644 655.

Ernst, A.V., Nachreiner, F. and Hanecke, K. (1988). Common free time of family members under different shift systems. Applied Ergonomics 19: 213 218.

Escriba, V., Perez Hoyos, S. and Bolumar, F. (1992). Shiftwork: its impact on the length and quality of sleep among nurses of the Valencian region in Spain. International Archives of Occupational and Environmental Health 64: 125 129.

Esson, K., Bofinger, C. and Bauer, E. (2000). Monitoring and management of fitness for duty – mine site perspective. Queensland Health and Safety Conference, Queensland.

Ferrara, M. and De Gennaro, L. (2001). How much sleep do we need? Sleep Medicine Reviews 5: 155 179.

Fischer, F., Moreno, C., Fernandez, R., Berwerth, A., dos Santos, A. and Bruni, A. (1993). Day and shiftworkers' leisure time. Ergonomics 36: 43 49.

Fletcher, A. and Dawson, D. (2001). Field based validations of a work related fatigue model based on hours of work. Transportation Research Part F 4: 75 88.

Fletcher, A. and Dawson, D. (2001). A quantitative model of work related fatigue: empirical evaluations. Ergonomics 44: 475 488.

Fletcher, A., Roach, G.D., Lamond, N. and Dawson, D. (2000). Laboratory based validations of a work related fatigue model based on hours of work. Shiftwork in the 21st Century. S. Hornberger, P. Knauth, G. Costa and S. Folkard. Frankfurt, Peter Lang.

Folkard, S. (1997). Black times: temporal determinants of transport safety. Accident Anal. Prev. 29(4): 417-430.

Folkard, S., Akerstedt, T., Macdonald, I., Tucker, P. and Spencer, M.B. (1999). Beyond the three process model of alertness: estimating phase, time on shift and successive night effects. Journal of Biological Rhythms 14: 577 587.

Folkard, S. and Barton, J. (1993). Does the forbidden zone for sleep onset influence morning-shift duration? Ergonomics, 36: 85-91.

Folkard, S. and Tucker, P. (2003). Shift work, safety and productivity. Occupational Medicine 53: 95 101.

Frese, M. and Semmer, N. (1996). Shiftwork, stress and psychomotor complaints: a comparison between workers in different shiftwork schedules, non shiftworkers, and former shiftworkers. Ergonomics 29: 99 114.

Fruhstorfer, H., Langanke, P., Meizner, K., Peter, J.H. and Pfaff, U. (1977). Neurophysiological vigilance indicators and operational analysis of a train vigilance monitoring device: A laboratory and field study. Vigilance. Theory, operational performance, and physiological correlates. R. Mackie. New York, Plenum Press: 87 109.

Gadbois, C. (1981). Women on night shift. Interdependence of sleep and off the job activities. Proceedings of the Fifth International Symposium on Night and Shiftwork. V. Reinberg, N. Vieux and P. Andlauer. Oxford, Pergamon Press: 223 227.

Gramm, W.S. (1987). Labour, Work and Leisure; Human Wellbeing and the Optimal Allocation of Time. Journal of Economic Issues XXI: 167 188.

Green, F. (1997). "Union Recognition and Paid Holiday Entitlements." British Journal of Industrial Relations 35: 243-255.

Grint, K. (1991). What is work? The Sociology of Work. Cambridge, Polity Press: 7 40.

Harma, M. (1998). New work times are here – are we ready? Scandinavian Journal of Work and Environmental Health 24: 3 6.

Hartley, L., Horberry, T. and Mabbott, N. (2000) Review of fatigue detection and prediction technologies. National Road Transport Commission.

Hartley, L.R. and Arnold, P.K. (1995). Subjective and objective measures of fatigue when driving. Institute for research in Safety and Transport. Report No.109.

Haworth, J.T. (1997). Work, leisure and well being. London, Routledge.

Henderson, K.A. (1990). The Meaning of Leisure for Women: An Integrative Review of the Research. Journal of Leisure Research 22: 228 243.

Heslegrave, R (1998), Fatigue: Performance Impairment, sleep and ageing in Shiftwork Operations. In: Managing Fatigue in Transportation, (ed) Laurence Hartley, Pergamon, p 167-185.

Hornberger, S. and Knauth, P. (1993). Interindividual differences in the subjective valuation of leisure time utility. Ergonomics 36: 255 264.

Horne, J. and Pettitt, A. (1985). High incentive effects on vigilance performance during 72 hours of total sleep deprivation. Acta Psychologica 58: 123 129.

Horne, J.A. (2002). Why Sleep? Biologist 49: 213 216.

Iso-Ahola, S.E., La Verde, D. and Graefe, A.R. (1989). "Perceived competence as a mediator of the relationship between high risk sports participation and self-esteem." Journal of Leisure Research 21: 32-39.

Howarth, N.L. and Rechnitzer, G. (1993). Description of fatal crashes involving various causal variables. technical report CR 119, Canberra, Federal Office of Road Safety.

Jaffe, M.P., Smolensky, M.H. and Wun, C.C. (1996). Sleep quality and physical and social wellbeing in North American petrochemical shift workers. Southern Medical Journal 89: 305 312.

Jamal, M. and Jamal, S. (1982). Work and non-work experiences of employees on fixed and rotating shifts: An Empirical Assessment. Journal of Vocational Behaviour 20: 282 293.

Jewett, M.E., Wyatt, J.K., Ritz de Cecco, A., Khalsa, S.B., Dijk, D. and Czeisler, C.A. (1999). Time course of sleep inertia dissipation in human performance and alertness. Journal of Sleep Research 8: 1 8.

Kecklund, G. and Akerstedt, T. (1995). Effects of timing of shifts on sleepiness and sleep duration. Journal of Sleep Research 4: 47 50.

Kecklund, G., Akerstedt, T. and Lowden, A. (1997). Morning work: Effects of early rising on sleep and alertness. Sleep 20: 215 223.

Knauth, P. (1997). Changing schedules: shiftwork. Chronobiology International 14: 159 171.

Knauth, P. and Costa, G. (1996). Psychological effects. Shiftwork, problems and solutions. W. Colquhoun, G. Costa, S. Folkard and P. Knauth. Berlin, Peter Lang: 89 112.

Lamond, N. and Dawson, D. (1999). Quantifying the performance impairment associated with fatigue. Journal of Sleep Research 8: 255 262.

Laundry, B.R. and Lees, R.E. (1991). Industrial accident experience of one company on 8 and 12 hour shift systems. Journal of Occupational Medicine 33: 903 906.

Lavie, P. (1986). Ultrashort sleep waking schedule. III. 'Gates' and 'forbidden zones' for sleep. Electroencephalographical and Clinical Neurophysiology 63: 414 425.

Lee, M.A.M. and Kleitman, N. (1923). Attempts to demonstrate functional changes in the nervous system during experimental insomnia. American Journal of Physiology 67: 141 152.

Levine, J. and Pittinsky, T. (1997). Working Fathers: New Strategies for Balancing Work and Family. San Diego, Harcourt Brace and Company.

Lisper, H. O. and Kjellberg, A. (1972). Effects of 24 hour sleep deprivation on rate of decrement in a 10 minute auditory reaction time task. Journal of Experimental Psychology 96: 287 290.

Lowden, A., Kecklund, G., Axelsson, J. and Akerstedt, T. (1998). Change from an 8 hour shift to a 12 hour shift, attitudes, sleep, sleepiness and performance. Scandinavian Journal of Work and Environmental Health 24: 69 75.

Lushington, W., Lushington, K. and Dawson, D. (1997). The perceived and domestic consequences of shiftwork for female shiftworkers (nurses) and their partners. Journal of Occupational Health and Safety – Australia and New Zealand 13: 461 469.

Mabbott, N., Lydon, M., Hartley, L. and Arnold, P.K. (1999). Procedures and devices to monitor operator alertness whilst operating machinery in open cut coal mines. ARRB Transport Research.

Makowska, Z. (1995). Psychological characteristics of work and family as determinants of stress and wellbeing of women: A preliminary study. International Journal of Occupational Medicine and Environmental Health 8: 215 222.

Maybury Lewis, D. (1992). Millennium: Tribal wisdom and the modern world. New York, Viking.

McCulloch, K., Sletten, T., Baker, A. and Dawson, D. (2002). "The Management of Workplace Fatigue." Safety Australia.

Meyer, A. (1922). The Philosophy of Occupational Therapy. Archives of Occupational Therapy 1: 1 19.

Monk, T., Buysse, D., Reynolds, C.I., Berga, S.L., Jarrett, D.B., Begley, A.E. and Kupfer, D.J. (1997). Circadian rhythms in human performance and mood under constant conditions. Journal of Sleep Research 6: 9 18.

Mott, P.E., Mann, F.C., McLoughlin, Q. and Warwick, D.P. (1965). Shiftwork: the social, psychological and physical consequences., University of Michigan Press.

Mutran, E.J., Reitzes, D.J., Bratton, K.A. and 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 52: S98 S99.

Nachreiner, F., Akkermann, S. and Hanecke, K. (2000). Fatal accident risk as a function of hours into work. Shiftwork in the 21st Century. S. Hornberger, P. Knauth, G. Costa and S. Folkard. Frankfurt, Peter Lang: 19 24.

Neulinger, J. and Breit, M. (1971). Attitude Dimensions of Leisure: A Replication Study. Journal of Leisure Research: 108 115.

Oginska, H., Pokorski, J. and Oginski, A. (1993). Gender, ageing and shiftwork intolerance. Ergonomics 36: 161 168.

Pease, B. and Wilson, J. (1991). Men in Families. Issues facing Australian Families: 54 64.

Peetz, D., Gardner, M., Brown, K. and Berns, S. (1999). A Gender equity Index and Australian Workforce Performance., Adelaide, Australia, The Association of Industrial relations Academics of Australia and New Zealand.

Pilcher, J.J. and Hufcutt, A.I. (1996). Effects of sleep deprivation on performance: a meta analysis. Sleep 19: 318 326.

PMI Incorporated. (2001). Details on FIT2000 Fitness-for-Duty screener. PMI Incorporated.

Primeau, L.A. (1995). Work and Leisure: transcending the dichotomy. American Journal of Occupational Therapy 50: 569 577.

Pugliesi, K. (1995). Work and wellbeing: gender differences in the psychological consequences of employment. Journal of Health and Social Behaviour 36: 57 71.

Queensland Government. (2001). Guidance Note for Management of Safety and Health Risks Associated with Hours of Work Arrangements at Mining Operations, Natural Resources and Mines, page 7.

Quinlan, M. and Bohle, P. (1991) Managing Occupational Health in Australia: A Multidisciplinary Approach. MacMillan, South Melbourne.

Roach, G.D., Reid, K. and Dawson, D. (1998). "The effect of break onset time on the amount of sleep accumulated by shiftworkers during breaks between shifts." Sleep 21: 205.

Robertson, I. (1977). Sociology. New York, Worth Publishers.

Rosa, R. (1995). Extended workshifts and excessive fatigue. Journal of Sleep Research 4: 51 56.

Rosa, R. and Colligan, M. (1989). Extended workdays: effects of 8 hour and 12 hour rotating shift schedules on performance, subjective alertness, sleep patterns and psychosocial variables. Work and Stress 3: 21 32.

Rosekind, M.R., Gander, P.H., Gregory, K.B., Smith, R.M., Miller, D.L., Oyung, R., Webbon, L.L. and Johnson, J.M. (1996). "Managing fatigue in operational settings." Behavioural Medicine 21: 157-170.

Rutenfranz, J., Knauth, P. and Colquhoun, W.P. (1976). Hours of work and shiftwork. Ergonomics 19: 331 340.

Sekaran, U. (1983). Factors influencing the quality of life in dual income families. Journal of Occupational Psychology 56: 161 174.

Shaw, S. (1985). Gender and Leisure: Inequality in the Distribution of Leisure Time. Journal of Leisure Research 17: 266 282.

Siebenaler, M.J. and McGovern, P.M. (1991). Shiftwork: Consequences and considerations. AAOHN 39: 558 567.

Smith, L. and Folkard, S. (1993). The perceptions and feelings of shiftworkers' partners. Ergonomics 36: 299 305.

Smith, L., Folkard, S. and Poole, C.J.M. (1994). Increased injuries on night shift. The Lancet 344: 1137 1139.

Smith, L., Folkard, S. and Tucker, P. (1998). Work shift duration: a review comparing eight hour and 12 hour shift systems. Occupational and Environmental Medicine 55: 217 229.

Smith, L (1997), Injuries and Worktime; evidence for reduced safety on-shift, Journal of Health and Safety 12: 5-16.

Smith Coggins, R., Rosekind, M., Hurd, S. and Buccino, K. (1994). Relationship of day versus night sleep to physician performance and mood. Annals of Emergency Medicine 24: 928 934.

Smith Coggins, R., Rosekind, M.R., Buccino, K.R., Dinges, D.F. and Moser, R.P. (1997). Rotating shiftwork schedules: can we enhance physician adaptation to night shifts? Academy of Emergency Medicine 4: 951 961.

Stone, A.A., Valdimarsdottir, H., Jandorf, L., Cox, D.S. and Neale, J.M. (1987). "Evidence that secretory IgA antibody is associated with daily mood." Journal of Personality and Social Psychology 25: 988-993.

The Industrial Society, (2000). The Work Life Manual. London, Newnorth Print.

Tepas, D. (1993). Educational program for shiftworkers, their families and prospective shiftworkers. Ergonomics 36: 199 209.

Tepas, D. and Carvalhais, A. (1990). Sleep patterns of shiftworkers. Occupational Medicine State of the Art Reviews: Shiftwork. S. AJ. Philadelphia, Hanley & Belfus Inc. 5: 199 208.

Tinsley, H.E.A., Hinson, J.A., Tinsley, D.J. and Holt, M.S. (1993). Attributes of Leisure and Work Experiences. Journal of Counseling Psychology 40: 447 455.

Tucker, P., Folkard, S. and Macdonald, I. (2003). Rest breaks and accident risk. Lancet 361: 680.

Van Dongen, H.P.A., Maislin, M.A., Mullington, J.M. and Dinges, D.F. (2003). The cumulative cost of additional wakefulness: Dose response effects on neurobehavioural functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep 26: 117 126.

Walker, J. (1985). Social problems of shiftwork. Hours of Work: Temporal Factors in Work Scheduling. S. Folkard and T. Monk. Chichester, John Wiley: 211 225.

Walters, V., Lenton, R., French, S., Eyles, J., Mayr, J. and Newbold, B. (1996). Paid work, unpaid work and social support: a study of the health of male and female nurses. Social Science and Medicine 43: 1627 1636.

Wankel, L.M. and Berger, B.G. (1990). "The psychological and social benefits of sport and physical activity." Journal of Leisure Research 22: 167-182.

Watts, A. (1960). This is it and other Essays on Zen and Spiritual Experience. Rider and Company Ltd, London.

Wedderburn, A.A. (1967). "Social factors in satisfaction with swiftly rotating shifts." Occupational Psychology 41: 85-107.

Wedderburn, A. (1981). Is there a pattern in the value of time off work? Night and Shiftwork, Biological and Social Aspects. V. Reinberg, N. Vieux and P. Andlauer. Oxford, Pergamon Press: 495 504.

Wierwille, W.W. and Ellsworth, L.A. (1994). Evaluation of driver drowsiness by trained raters. Accident Analysis and Prevention 26: 571 581.

Wilkinson, R.T. (1964). Effects of up to 60 hours' sleep deprivation on different types of work" Ergonomics: 175 186.

Willamson, A.M. and Feyer, A. M. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. Occupational and Environmental Medicine 57: 649 655.

Williams, H.L. and Lubin, A. (1967). Speeded addition and sleep loss. Journal of Experimental Psychology 73: 313 317.

Williamson, A., Feyer, A. M., Friswell, R. and Sadural, S. (2001) Driver Fatigue: A survey of professional long distance heavy vehicle drivers in Australia. Australian Transport Safety Bureau.

Williamson, A.M. (1994). Changing the hours of shiftwork: a comparison of 8 and 12 hour shift rosters in a small group of computer operators. Ergonomics 37: 287 298.

Zee, P.C. and Turek, F.W. (1999). Introduction to Sleep and Circadian Rhythms. Regulation. F. Turek and C. Czeisler.

Appendix 1. Fatigue Management Plan Outline

Each company should develop an appropriate Fatigue Management Plan to identify, assess and manage the risks associated with fatigue. The plan should be developed in conjunction with employees and their representatives. This plan should emphasise that managing fatigue related risk is a shared responsibility.

Specifically, it would be the employer's responsibility that the working time arrangements:

> Ensured adequate opportunity to obtain sufficient rest before commencing work.

> Prevented periods of excessive wakefulness while working.

The employee's responsibility would be to:

> Be in a fit state to work at the commencement and during the shift.

> If not in a fit state then notify an appropriate individual to ensure that an appropriate risk mitigation process is implemented.

A Fatigue Management Plan may include:

Policy

A company should develop, implement and review a policy document pertaining to fatigue management.

This document should include and detail all of the following:

> Identification of individuals responsible for the policy and its implementation.

> Accountability for the development, implementation and review of the policy and any named procedures.

> Auditable systems that can be tracked by internal or external persons. Systems may include incident and accident reporting that incorporates hours of work, time of day, hours of wakefulness, allocation of overtime hours, selection of personnel for on-call demands, etc.

> An implementation date – when the policy is to be implemented and how policy information will be disseminated to all stakeholders.

> Communication with the workforce on developing a process individuals can follow when fatigued at work (such as informing supervisor, taking a rest break, rescheduling of work jobs or tasks, rotating tasks or jobs, etc).

Training and Education

The FMP should ensure that information is provided to all employees and that it promotes a common understanding and approach to fatigue management throughout the site. Training should occur at time of induction and should be reviewed and updated periodically (refer to appendix 2 for more information on training).

Tracking Overtime Accurately

The FMP should allow for accurate tracking of overtime and should:

> Record who is selected or given overtime hours.

> Record when overtime is added to a working time arrangement (such as at the end of an existing shift or an additional full or partial shift).

> Record the amount of time off before starting an existing scheduled shift again (the break between the end of one shift and the beginning of the next).

> Record how often an individual works overtime in a given period.

> Show the reasons that overtime is required to be worked.

> Assess the predictability of overtime schedules, the planning window for any overtime, and how this could be lengthened to facilitate planning by personnel.

Regular review of the working time arrangements

The best way to determine how a workforce is faring in relation to their working time arrangements is generally to ask them. Hence, undertaking a review of a working time arrangement will necessitate the use of tools such as surveys, focus groups and interviews. This activity may be viewed as part of any monitoring and evaluation process and could also be part of an audit.

It is important that any review of working time arrangements undertaken in this manner be confidential and independent of any performance appraisal.

Tracking incidents and accidents

Most companies have a procedure or policy that stipulates the types of incidents people are required to report, how this process occurs and a timeline for the reporting process. When investigating incidents or accidents in the workplace from a fatigue perspective the following should be incorporated into the process:

> Hours on job.
> Hours awake.
> Hours spent asleep in the previous 72 hours.
> Overtime in the last seven days.
> Working time arrangement for at least the last seven days.
> Time of day of accidents/incidents.
> Seasonal variation – wet, dry, peak, trough.
> Who is involved – mine personnel, contractors, visitors.
> What happened – a description of events.
> Type of accidents/incidents.
> Frequency of incidents.
> Companies should have the capacity to examine data to predict and prioritise areas of concern. This means having a database that accepts, stores and can generate reports on demand or customised.

Documentation

Companies should document and record all activities pertaining to the Fatigue Management Plan. There must be action, not just production of policies and documents.

Community Support

Engaging with the communities surrounding a workplace can allow the company and the community to enter dialogue that could potentially assist and support workers. It may be helpful to provide information to family and friends to promote understanding about sleep and fatigue. Strategies may include but not be limited to:

> Public awareness sessions on fatigue.
> Posters illustrating important facts about fatigue.
> Support for families who have shiftworking members.
> Information for children at school about parents who may work at night.

Timeframe

You should establish a timeframe for developing your Fatigue Management Plan. A timeframe may look something like this:

Six months
> Policy draft.
> Conduct and record training and education.
> Review and update the incident form to include time of day factors.

12 months
> Final policy.
> Final incident form.
> Evaluate roster (ask the workforce).
> Community involvement.
> Implement policy.
> Review of workplace practice.

18 months
> Review/update training and education.
> Finalise overtime practice.
> Ensure working time arrangements benefits workforce and business.
> Review policy document.
> Track and graph incident/accident on time of day, etc.
> Audit (internal at least) the FMP and the practice.
> Ensure discussions regarding working time arrangements and fatigue are part of any exit interview process.

Appendix 2 Training and education templates

Possible training approaches

Current OHS legislation requires management to supply information on all hazardous workplace risks to workers. In addition, training in hazard recognition and prevention is required to assist in the minimisation of known and potential risks such as fatigue.

In practice, appropriate training and education is most easily achieved through the use of competency-based materials and structured workplace training. The content of such a training session on fatigue could include : what is fatigue, causes and consequences of fatigue, signs and symptoms of fatigue, how to maximise sleep, the impact of food and water on alertness, commuting, napping, family and social factors and effects of caffeine and alcohol on sleep.

However, there are a number of different training approaches, techniques and methodologies that can be utilised to assist organisations to meet the training obligations. The following list provides a number of the different techniques currently used by a variety of Australian companies:

> Whole or half day training sessions – small workshop format with a maximum of 12 to 15 participants to enable active participation and involvement. Can cover in greater detail the content listed earlier.

> Competency-based approach using the ANTA Standard 'Applying Fatigue Management Strategies' to Certificate Level II. This requires structured training sessions followed by a formal assessment process using an array of different tools. These tools may include log books, examples of actions taken and factors identified in the workplace, individual and company strategies to manage fatigue in the workplace, knowledge-based questions either oral or written (or both), completing questions in a workbook over a stipulated time period.

> Awareness sessions – small workshop format with a maximum of 12 to 15 participants to encourage involvement. Not as comprehensive as a longer session due to time constraints and possibly not as much detail. Awareness training is not equivalent to competency training as there is generally very little or no formal follow-up or assessment process. An awareness session may highlight some of the important aspects of fatigue management but it will not provide the trainee with as much information as a more comprehensive training process nor will it provide a recognised certificate that may be required for the trainee to advance within a pay structure or career pathway.

> Online learning has the advantage of being independent of time and space, effectively being available to individuals at their convenience. Unlike traditional text-based learning, the medium of the Internet allows individuals to benefit from audio and video enrichments to learning, as well as allowing them to participate in online communities, and to receive online feedback to questions.

> CD-ROM: An online fatigue management course could also be created on a CD-ROM. This has the advantage of running much faster on computers and does not rely on an Internet connection (some remote locations may lack a connection or it may be very slow). The disadvantage is that without the Internet the possibility of interaction, via a computer, with a trainer or other workers is lost.

> Video can be used as an adjunct to any training session as a method to impart new or reinforce concepts and ideas in a visual and humorous way. Video is an important addition to the training process as it can used in remote or isolated environments, taken home and shown to the family, to repeat or reinforce earlier training and may be a more readily accessible and timely in environments where trainers are generally unavailable.

> Printed materials such as workbooks, information booklets, fliers, posters, leaflets, newsletters and bulletins may be distributed across the organisation and/or community to assist with establishing common understanding regarding fatigue. These materials could be used as follow-up and/or more detailed information, resources, pocket information (such as the example below) or refresher documents.

Example of information that could be provided in the workplace

Pocket Guide on fatigue:

The primary cause of fatigue is lack of sleep. If you do not get enough sleep it is difficult to stay alert and do your job safely.

Alertness is a shared responsibility, it is the company's intention to give you enough time off to obtain adequate sleep. It is your responsibility to use your time off to get the sleep you need. In addition, it is important that co-workers help by looking out for each other and notifying signs of reduced alertness.

How much sleep you need is a difficult thing to answer. Different individuals need different amounts of sleep.

By identifying the signs of reduced alertness you will be better at fighting them. Use the fatigue educational materials provided by the company. These will help you develop personal strategies for managing fatigue.

If you experience two or more of the following symptoms you may be experiencing fatigue or reduced alertness. Fatigue is not the only cause of these symptoms, but when they occur as a group they are more likely to be related to fatigue.

The following is a list of symptoms you may experience when you are fatigued:

Physical
> Yawning.
> Heavy eye lids.
> Eye rubbing.
> Head drooping.
> Falling asleep inappropriately.

Mental
> Difficulty concentrating on the task.
> Lapse in attention.
> Difficulty remembering what you are doing.
> Failure to communicate important information.
> Failure to anticipate events or actions.
> Accidentally doing the wrong thing.
> Accidentally not doing the right thing.

Emotional
> Quieter and more withdrawn than normal.
> Lacking in energy.
> Lacking in motivation to do the task well.
> Irritable or grumpy behaviour towards colleagues, family or friends.

To fight fatigue and to recognise its onset you should develop personal strategies. See…..website address/resource titles etc…….. (if relevant for your organisation insert details here).

Examples of individual strategies include:

1. Don’t use an alarm clock when you don’t have to.
2. Allocate the longest period of sleep to the best time of day for sleep.
3. Minimise the drugs that interfere with sleep (e.g. caffeine, alcohol, nicotine) in the five hours before sleep.
4. Establish a bedtime routine. This means that you do the same series of activities before you get into bed regardless of the time you try to sleep (helps to program the mind and body that you are getting ready to sleep), e.g., clean teeth, pyjamas, kiss kids, check locks, go to the toilet.
5. Allow enough time to get enough sleep.
6. Deal with worries and anxieties before you go to bed.
7. Even a bad night's sleep does not mean that you have a sleep problem. We all experience these things. Only if bad sleep is persistent and affects you during your waking hours may it be a problem. If this is the case you should seek help from your GP, counselor, psychologist or a sleep disorders clinic.
8. Cool, temperature controlled (thermostat) 18 to 24 degrees celcius.
9. Dark - blinds, drapes, shutters, black plastic over window, eye pillows or eye masks (eg, airline masks), no dim lights or night lights, no illuminated digital alarm clock, door stop to cut light around the door, etc.
10. Quiet - ear plugs, sound proofing, tell family and friends to keep the noise down when you are trying to sleep, double glazing for muffling and temperature control as well.

12. Mattress and pillows - comfortable to your preference. Ensure that your body is well supported.
13. Pain - reduce any pain from old or new injuries by ensuring your position minimises the discomfort, hot packs or cold packs, dependent on injury type, massage, relaxation exercises, for pain not resolved by positioning or heat/cold treatment or other non-medicated methods. Anti-inflammatory drugs or analgesics may have to be prescribed by your medical officer.
14. Anxiety - may be related to family, money, work, for example. Learn some form of relaxation, meditation. Write things down if they disrupt your sleep so you can remember them and hence begin to deal with them on waking. Talk to your partner, family and friends - those with whom you feel comfortable and confident.
15. Stress - learn some form of stress management. Use exercise, conversation, counseling, meditation, yoga, and balancing diet and nutrition.
16. Fitness levels - exercise may promote a better quality of sleep if taken some two to three hours before bedtime.

Appendix 3. Case Studies

3.5. Case Studies

Following are three case studies of working arrangement design changes by a variety of organisations.

The overviews show there are a number of ways to change hours of work. The mechanisms and strategies will be determined to a degree by the population involved.

The provision of education and information will serve to enhance worker and managerial understanding and participation. However, this does not mean that negotiations are easy, smooth and without vibrant discourse. On the contrary, information can be used and interpreted differently depending on need and circumstances. The roster outcomes reflect the magnitude of effort and resources committed to the process of change.

3.5.1. Case Study 1: Manufacturing firm. Successful.

The company was opened in 1982. In the first 10 years the industrial relations climate was one of trench warfare and confrontation resulting in strikes, work to rule campaigns and strict demarcation. The effect was reduced productivity and viability, with increased absenteeism, a reduced workforce and increased staff turnover.

In 1990 the company was close to shutting down. The militant nature of employees at the plant, use of old technologies and the costs of running an out of date plant all contributed to the plant’s demise.

In 1991 management changed. At the instigation of the union secretary, the new management began consultation with the union. In 1991 the union, government, management and employees met on site for two days.
It was decided that management required restructuring possibly more than the workers on the factory floor. It became evident that the company’s location hindered the employment of adequately qualified people in managerial positions.

It was recognised that middle management or the supervisory level was unnecessary and should be made redundant. For the workers on the floor this meeting demonstrated the strengths and success of the company's products and showed that change was possible.

The first six months of the change process were the most difficult. The process began over a weekend. On the Friday the old system was still in place but by Monday morning the new system was being established.

Middle management levels were immediately replaced by work teams. External training aimed to improve and facilitate employees' career paths.

These changes alone resulted in each section improving productivity by 15 to 20 per cent. As it became increasingly evident that the organisation severely lacked people with negotiating skills it began to train both management and union members in a closed shop environment.

Staff training incorporated courses that could help the change process . Both union members and management learned negotiation and enterprise bargaining skills, and studied changing world issues, global problems, decision making, 'towards autonomy' courses, leadership, management, accountability, responsibility and facilitation skills.

Much of this training – about 30 hours per person – was through the local TAFE institution.

At the time of writing the plant employed 217 full time permanent workers, 25 female and 192 male, an increase of 25 per cent since restructuring began in 1991.

Roster changes

Workers modified their rosters following consultation with management and union. Most agreed to a 12-hour roster trial. After a six-month trial several sections of the plant adopted the 12-hour roster permanently.

The roster change process involved the workers' families because of its wide-reaching impact. Management felt that if family members had access to information on hours of work they might be better equipped to understand and manage the change.

Results

The 12-hour roster system for continuous seven-day operations began on January 1, 1995. The enterprise bargaining agreement (EBA) of 1993 provided for changes to the state of the roster. The flexibility of the roster system increased, as did time away from the workplace, annualised salary and superannuation conditions. Relations between management and employees improved. A secure and competent workforce developed with the ability to participate, negotiate, plan, implement and evaluate changes in the workplace.

The shift arrangements in the EBA state that the parties must commit to working together to develop shift rosters flexible enough to meet changing production needs and market demands. In addition, they agreed that employees and the organisation should not be disadvantaged by changes to the roster system.

Main actions covered during the change process

1. Consultation between union and management on the organisation's future.
2. Recognition of onsite problems.
3. Establishment of work teams to help address the issues.
4. Extensive onsite training for everyone.
5. Consultation on the roster configuration so that the roster was designed and developed by all stakeholders.
6. A roster trial and specific outcome measures (eg, increased time away from the work place, increased shift length, etc.).
7. Evaluation of roster changes – increased staff retention, decreased absenteeism, expansion of roster to involve other sections of the plant.
8. The EBA reflected the consultation process and commitment to a roster change process that would meet both production and employee needs.

3.5.2. Case Study 2. Defence facility. Successful.

This defence facility had tried to change its shift schedules several times, but most attempts had failed. It was dealing with the governments of two countries, seven companies, 21 unions and 400 employees.

The failure was related to the size and complexity of the facility, the myriad of rules governing the constituent organisations and the lack of an obvious single suitable roster.

The administration had to deal with country-specific employees and apply labour regulations from each country. The need for consensus among the companies complicated many issues relating to changing hours of work.

Failure to achieve an amicable agreement on hours of work resulted in confrontation between management and the workforce.

In July 1993 a steering committee was established to look at issues of concern. The committee created three teams. They included the shift process re-engineering team to review attitudes to and concerns about shiftwork. Because of the magnitude of the task the team decided to review and restructure the shift schedule in two phases.
Phase One was data collection. Data was collected over six months and resulting discussions and direction took another 12 months.

The team gathered information from reference material, employees and management data on the existing system, the regulations and policies that governed its development and the development of any subsequent system. The Phase One report recommended a shiftwork consultant be found for continuing independent advice. Essentially, the shift process re-engineering team found that the regulations, directives and policies governing the site did not prohibit a roster change.

The shiftwork consultant established an environment of change that encouraged employees and management to discuss and develop alternative solutions and approaches to the problems of shiftwork. Consequently, the organisational emphasis moved from one of 'changing the roster' to one of identifying if the organisation had the best possible roster system for both employee and management requirements.

Shiftwork was viewed as an OHS concern that required resources and skills for effective management. This substantial shift in attitude reinforced the idea that the roster was only ever a 'best fit' solution.

Phase Two was primarily concerned with the management of shiftwork and the selection of a system that reflected organisational and individual needs. Employees and management successfully implemented and evaluated a new approach to shiftwork and a new system that benefited all stakeholders. The entire change involved 400 people and took two and a half years.

Results

Generally, the changes resulted in a compression of the working week, an increase in hours worked per shift and an increase in the number of days-per-block off.

Specifically, the changes resulted in:
> Single day absenteeism was reduced by 70 per cent.
> Staff morale improved.
> The number of people signing up for an extended tour of duty increased.
> The number of people 'bailing out' before the end of their two year tour of duty dropped significantly, reducing transfer costs of family and property between countries.
> People were happier with their rosters, gaining improved quality of life outside the workplace. In addition, employees had more representation and decision-making power on committees.
> Management recognised that shiftwork had an effect on people and the organisation. Consequently, they refocused many corporate support networks to co-ordinate and work around shiftwork hours. This encouraged a better understanding of the problems encountered by shiftworkers and therefore a more equitable working environment.
> An EBA incorporated hours of work and amalgamated the 21 unions into two. A new award structure was established.

Main actions covered during the change process

1. Establishment of a committee to identify workplace issues and to develop recommendations to resolve problems.
2. Consultant engaged to help organisation with roster issues.
3. Participation by employers and employees in roster discussions.
4. Commitment by management to provide the resources to manage the roster process.
5. Development of a roster that reflected employee and employer needs.
6. Outcome measures determined – eg, increased days off, decreased absenteeism, increased staff morale.
7. Establishment of an EBA to reflect shiftwork issues.

3.5.3. Case Study 3. Emergency Services. Unsuccessful.

This emergency service organisation had traditionally adopted a reactive management philosophy with crisis management being the dominant managerial model.

Long-term changes in the nature of the job and the organisational structure resulted in frequent short-term changes that accumulated over the years. Consequently, the roster system evolved through a series of logical short-term responses into a complicated system that was difficult to understand, impossible to administer efficiently and rarely executed as originally planned.

In 1987, full-time salaried officers were working from 6am to 6pm in 18 locations across a metropolitan area. Volunteers worked from 6pm to 6am to complement the service, providing the community with 24-hour cover. Following industrial disputes from 1987 to 1989 substantial organisational restructuring meant voluntary staff were no longer providing the night cover. This change led to salaried officers providing the service across 24 hours.

A period of integration at most stations combined salaried officers and volunteers working two to three afternoon shifts from 2pm to 10pm. Two metropolitan locations established shifts from 12 midnight to 8am. By the end of the transition period volunteer workers were phased out. At the same time salaried officers began to work four days on followed by four days off. The shifts varied from 10 to 14 hours – 10 hours during the day and 14 hours at night.

In addition, the organisation's restructuring changed the spread of stations across the metropolitan area, from a small number of large stations to a large number of smaller stations. The change in managerial style that accompanied the restructuring was from one of centralised military bureaucracy to one of manager as coach.

A lot of the internal turmoil experienced by the organisation and its employees as the restructuring took place was reflected in the roster and its acceptance. A shiftwork consultant was hired to provide independent expert advice on shiftwork problems identified by employees, the union and management.

The consultant emphasised the importance of treating the roster system as part of an integrated attempt to produce a coherent human resources policy. From this perspective, it was important to understand the impact of the organisational restructuring and ensure the roster system evolved to meet the long-term needs of the organisation. Management, employees and the shiftwork consultant determined that the roster system required fundamental overhauling and redeveloping within a coherent human resources framework. Having decided that change was essential, all stakeholders needed time to evaluate the social and financial costs of any new shift system. All stakeholders needed information and resources, but management failed to provide either.

Problems with the implementation of the new system

Problems included:

> Pairing of the shiftwork roster with pay schedules which meant that any shiftwork reform was related to financial remuneration.

> Responsibility for the roster devolved from the centralised roster department to individual stations. However, conflict developed between line management in the stations and the roster department because the roster department did not resource the local station managers to meet their new demands and added responsibility. In addition, the perceived loss of control and hence loss of employment by management hindered change and increased the sense of frustration and conflict between individual stations and the roster department.

> The devolution of responsibility for the roster to the local station level meant that local managers used shift allocation as a means of punishment and reward.

Results

Over 12 months from 1994 to 1995 there were additional changes to senior management, with the chief executive officer changing twice. This destabilised the roster review process. The two officers to hold this position over the 12 months had little knowledge of the service and came from unrelated fields of expertise. Consequently there were no noticeable improvements to the management of the roster system, nor to the rosters.

In early 1995, management decided to change the roster again, based solely on finances, without consultation with employees or union. This resulted in conflict, confrontation and industrial unrest. By late 1995 management put forward three new roster proposals in an attempt to win back employee support. However, these proposals were developed solely by management, without consultation with or participation of employees.

Discussions and debate continue, with rosters still designed by the central roster department and handed down to the station officers.

The organisation envisages that the development of the roster in the future will be devolved to station officers and be ratified by the central roster department. Employees would like to see a permanent, stable and predictable roster that incorporated individual needs as well as service requirements, and was developed at the local level.

Main actions covered during change process

1. Organisational restructuring resulted in management and employees viewing the roster as unacceptable.
2. Consultant engaged to assist with roster issues.
3. No resources provided to review roster system.
4. The design of roster handed from roster department to local stations without support or resources.
5. Conflict between roster department and stations about control of the roster.
6. No roster consultation with employees.
7. Management proposed and implemented their own roster solutions.
8. Conflict between management and employees and an unstable roster.
9. Results measured – eg, unpredictable roster, unstable roster, shorter shift length.
10. No roster resolution, hence continuing internal conflict.