

MANAGING FATIGUE THROUGH ROSTER DESIGN

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1.0 Introduction

Involvement of shift workers in shift roster design and review is not new. Indeed, field studies of shift work (e.g. Costa, Cesna, Kogi and Wedderburn, 1990) almost always require the active co-operation of the shift workers themselves in data collection (e.g. through survey questionnaires, interviews, and sleep diaries). Furthermore, because of the nature of shift work, particularly night working when daytime management is not present, shift workers have traditionally tended to function more as semi-autonomous work groups than have day workers (Smith, 1993). However, explicit recognition of the importance of employee participation in shift roster design is a more recent and growing trend (Kogi and Di Martino, 1995) with several studies indicating enhanced employee satisfaction with work time arrangements as a consequence of employee involvement (Knauth, 1998). Non-participatory roster design is rarely documented. It is typically associated with negative outcomes. Wedderburn (1996) reports, in a study of the impact of a shiftwork counselling intervention, that imposition of a negative roster change (i.e. 12 hour shifts of an “arduous” type - 4 day shifts, 4 off shifts, 4 night shifts, and 4 off shifts imposed with consent of only 51% of the workforce) was associated with several negative impacts, including increased GH12 scores (Goldberg, 1972). Smith, Di Milia, Wright, Mackay, and Milsop (1996) report negative impacts on fatigue, workload, work quality, family and social life, and free time following management imposition of 10 hour day shifts in the meat processing industry. These positive and negative results from participation and the lack of shift worker participation in roster design are not surprising since shift worker satisfaction with roster design is strongly linked to the impact of roster design on work and family life (Wedderburn, 1967; Colquhoun, Costa, Folkard, and Knauth, 1996).

Participation in decision making about work design and its operational practice encompasses a continuum of involvement from information exchange, though consultation, to active influence over decision outcomes, and finally to full authority in decision-making (Evans and Fischer, 1992; Maberly, 2000). The research evidence from the wider literature on employee participation shows the importance of managing participation in decision-making in the workplace in a manner which makes clear to participants the extent and limits of involvement (Dachler and Wilpert, 1978). This is of particular importance when decision-making impacts on occupational health and safety (OHS), as it does in shift roster design.

Roster design requires the consideration and integration of at least three design goals: good ergonomic design to maximise employee health and safety in and outside the workplace (Knauth, 1996); integration of work hours with social and family life (Barton et. al., 1993); and securing flexibility and efficiency in meeting production and service criteria (Smith and Wedderburn, 1998). It is also important to recognise that these roster design goals are typically set in a context in which both management and shift workers give greater priority to the financial benefits of roster design alternatives than they do to considering their impact on health and well being (Smith, 1993 and Costa, et. al., 1990).

Managing roster design with the direct involvement of shift workers is therefore a significant and complex management task. This paper suggests that in the light of this complexity roster design is best undertaken as a continuous process of total quality management including:

- (a) A process of education for shift workers and their managers with particular emphasis on the hazards of fatigue (Di Milia, 1998) for organisational performance and employee well being.
- (b) A structure for participation in decision-making about roster design which ensures effective representation of three key outcome criteria: OHS; production and organisational needs; and employee satisfaction and well being.
- (c) A process to enable trial of new shift roster designs with data based evaluations of their impact and an ongoing data based quality management monitoring of shift rosters, which are accepted for long-term operation.

2.0 Best Practice criteria for roster design

An example of best practice criteria for roster design (adapted from Knauth, 1996) is shown in Table 1. It suggests no more than three consecutive 12-hour nights shifts. Table 2 shows an example of excess hours overtime limits being used at one of the ocean outfall sewage treatment plants that will shortly be coping with the Olympics. Excess hours overtime limits must necessarily work in tandem with roster design. These criteria and limits are underpinned by an understanding of shift work as a socio-biological stressor (Bennett, McBrearty and Smith, 1984; Smith, 1982) with a particular emphasis on three sources of stress: sleep and fatigue, circadian rhythmicity and family and social life. They seek to address both chronic and acute fatigue.

2.1 Examples of 8 and 12-hour shift rosters

Figure 1 shows some examples of both continuous 8 and 12-hour shift rosters. It is worth noting that slowly rotating rosters are not generally very popular with the majority of shift workers whereas rapidly rotating rosters, either 3-shift 8-hour (Wedderburn, 1967) or 2-shift 12-hour rosters, are more popular. 12-hour shifts, because they condense the workweek into fewer shifts and give more full days without night work, are generally found to be even more popular (Smith et al, 1998).

2.2 Rosters and sleep and fatigue

We can look at each roster in terms of a number of characteristics which impact on sleep and fatigue: shift start and end times; direction of rotation; shift length; number of consecutive night shifts; number of consecutive day shifts; the time off between consecutive night shifts and days off between spells of shifts; the number of work hours per week; the regularity of the roster; and the number of shift crews.

Shift start and end times. Very early starting morning or day shifts tend to result in sleep loss because bed times are not generally much earlier and, for some, fear of oversleeping results in disturbed sleep. Shift start and end times may also effect journey times to and from work depending on the variability in traffic density.

Direction of rotation. It was once argued that forward rotation (i.e. DAN) favoured adaptation of body rhythms to night work. However, there is a large body of evidence (e.g. Knauth et al, 1981 and Smith, 1972) to show that body rhythms show, at best, marginal adaptation to night work. However, forward rotation may support a better sleep-wake pattern across a roster because it does not readily enable quick returns between shifts (Barton and Folkard, 1993). Forward rotation therefore is generally preferred.

Shift length. There is a large body of evidence to show that fatigue is influenced by shift length and time of day (e.g. Hildebrandt et al 1974).

Number of consecutive night shifts. Because morning and afternoon sleep length is related to the circadian rhythm daytime sleep length is shorter than night sleep length. Therefore, the greater the number of consecutive night shifts the greater the cumulative sleep loss. Nonetheless, the greatest sleep loss is associated with the first night shift, which requires a transition from night sleeping hours to day sleeping hours. It follows that fewer consecutive night shifts means more first night shifts and therefore more first night shift night to day sleep transitions. Furthermore, because sleep is not entirely a “hard wired” behaviour and because shift workers are seeking to balance demands of both work and home life, with fewer night shifts there is a tendency to trade sleep hours for other activities (e.g. Smith, 1979).

Number of consecutive day shifts. The number is not infinite. Long spells of work do not support a healthy lifestyle, which is important in coping with stress (e.g. Kessler et al, 1985).

The time off between consecutive shifts and days off between spells of shifts. This time is necessary for sleep, rest and recreation and other activities. Balancing work and other demands as well as sleep, requires a minimum break between shifts. Rest, recreation and leisure, are all necessary to support a lifestyle able to cope with stress (e.g. Cooper and Payne, 1980).

The number of work hours per week. The evidence from field research (e.g. Haslam, 1981) and laboratory research (Alluisi, 1970) shows clear effects on the military performance of soldiers in the field and on the test performance of research subjects in laboratory of extended periods of duty.

The regularity of the roster. Regularity supports predicatabilty that enables sleep and other activities to be planned ahead. Irregular rosters, typically caused by call-out and overtime working, do not assist shift workers to live healthy lifestyles (Knauth, 1996).

The number of shift crews. Four crews are generally used to provide continuous 24-hour operation. However, a five crew system can provide greater flexibility, for example, to enable training and other non-direct production requirements, without incurring a need for overtime hours work (e.g. Smith et al, 1998; Di Milia, 1998).

2.3 Rosters and family and social life

The impact of shift rosters on family and social life is even more complex than its impact on sleep and fatigue (Smith et al, 1998; Knauth and Costa, 1996; Smith, 1994). Indeed, this is a strong argument for the involvement of shift workers in shift roster design. Furthermore, family and social life interact with sleep and fatigue (Smith, 1979) and are important in coping with stress (Cooper and Payne, 1980).

3.0 Case Study Example: Sydney Water Bondi STP

3.1 Education about shiftwork

The initial educational input was directed at two levels of the organisation: headquarters based managers and union officials with a remit covering human resource management and some degree of responsibility for the STP; STP based shift workers and managers. It was undertaken at the STP and was conducted at a series of shift crew meetings attended by headquarters and plant personnel. The meetings were facilitated by an external facilitator with an extensive background experience of research into shift work. The meetings focussed on roster design with an extensive interactive discussion of the potential strengths and weaknesses of a range of design alternatives. Each shift crew took part in at least two of these discussion meetings and each meeting ran for at least one hour. The participants at these meetings were provided with a copy of the BEST 3 (Wedderburn, 1991). The discussions were wide ranging and included explanation of the basis for ergonomic design criteria as well as local issues such as pay, overtime, job content, travel to work arrangements and social and family impacts.

The second series of these discussion meetings followed the same format as the initial meetings. One meeting was held with each shift crew. Each meeting focussed on shaping and clarifying the processes to be followed for selecting rosters for trial and the evaluation of these trials.

The ongoing occasional series of follow-on educational input focussed on particular shift rosters and feedback of trial data including results from self-report surveys, sleep diaries, and workplace records of attendance, overtime hours worked, accidents and plant operational incidents. Because of the impact of attendance at plant committees (e.g. production and OHS committees) and attendance at training sessions (e.g. to renew certification to allow work in confined spaces or to develop new operator skills) on the pattern and total number of hours worked records of these were specifically added to the monitoring process. The occasional meetings were also plant-based meetings with each crew and, where practicable, also included plant and headquarters personnel. They also served as an opportunity to exchange informal feedback about roster operation and as a source of ideas for improvement. For example, the provision of motel sleep accommodation very close to the STP for use by shift workers who, for whatever reason, felt too tired to drive home at the end of a shift, arose from a suggestion at one of these occasional meetings.

An attempt was also made to include the partners of shift workers directly in the educational process. Three meetings at different times of day and on different days of the week were held for partners at a local hotel. Attendance was not high and, unlike the shift crew meetings, there was little interaction from their partners. The attempt was not pursued further.

3.2 A structure for participation in decision-making.

The agreed structure for participation followed the tradition of the industry: it included management, trade union and the shift workers themselves. Non-traditional was the inclusion of the external shift work research expert to represent OHS in terms of ergonomic shift roster design criteria. Formal decision-making took place at three levels:

A steering committee of delegates representing management (headquarters and plant), employees (a shift worker from each crew and their union official), and OHS (the external shift work expert). This committee reached decisions by consensus, however, each group on the committee, including OHS, had the right of veto to any decision. An unresolved veto would have resulted in return to the traditional pattern of decision-making through industrial negotiation. The steering committee approved rosters for trial and accepted, rejected or modified them following trial.

The shift workers. In addition to informal influence through the shift crew discussion meetings each shift crew elected a representative onto the steering committee. The shift workers formally voted in a secret ballot for and against rosters to be given a six-month operational trial and for and against rosters for adoption following trial. Acceptance of rosters for trial required a simple majority vote in favour. Acceptance of rosters for adoption post trial required a two-thirds majority vote in favour.

Rosters for trial or adoption had to meet ergonomic design standards set by the external expert. Additionally they had to be linked to individual work hours limits (i.e. individual overtime limits) covering the number of hours worked and the pattern of hours worked per day and per month. The ergonomic design criteria and individual work hours limits were set to reflect a reasonable duty of care, in particular in terms of fatigue. They were regularly discussed with the steering committee, shift crews, plant management and individual shift workers. Adherence to individual work hours limits was monitored and the data was reviewed monthly.

It was agreed by the steering committee that any trial would be terminated if in practice the trial was seen to seriously threaten OHS, plant safety or the viability of the business. Following each trial the steering committee determined whether the roster was acceptable for inclusion for an adoption vote by the shift workers or whether it should be modified and re-trialed in a modified form prior to a final adoption vote.

3.3 Data based roster evaluation and total quality management.

Self-report questionnaire surveys with a number of scales (see Smith et al, 1998) were administered in small groups at visits to each crew at work in the two months prior to change and in the fifth or sixth month after change to a “new” roster. The shift workers were also asked to keep sleep diaries in the weeks before and following roster change. Personnel data on overtime hours worked, near miss OHS reports, workers’ compensation claims, sickness absence and time spent in meetings and training were also collected. Personnel data formed the database for monthly total quality management of the operational shift roster.

3.4 Outcomes

Over the past five years the STP has moved from a slowly rotating continuous 8-hour shift roster to a rapidly rotating 8-hour shift roster. This was followed by the trial of a continuous rotating 12-hour roster which, because of difficulties in maintaining its operation within strict individual overtime hours limits (largely due to the need for meetings and training), has finally been replaced with a five crew 12-hour roster which requires each crew to work 8 months of continuous rotating shifts followed by 2 months of weekday day work. The roster redesigns have resulted in improvements in shift worker satisfaction and a significant cost saving (due to the reduction in overtime hours worked) by management. Average maximum weekly work hours, including overtime, with 12-hour shifts have been reduced to 39 hours per week. Nonetheless, fatigue continues as an OHS issue that requires ongoing monitoring of work hours.

4.0 References

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Table 1 Best Practice Roster Design Criteria (see Knauth, 1996)

1. No more than three consecutive night shifts.
2. At least 10 hours between consecutive shifts and at least a 48-hour break between the end of the last night shift and the start of the first day shift.
3. At least one full weekend and some part weekends off each month.
4. Individual work hours limits to avoid excess hours work and fatigue.
5. No second jobs.
6. Travel to or from work (or post-shift sleep facility) no greater than 1 hour.
7. Shift swaps allowed as long as within work hours limits and involving no quick night-day changeovers.
8. At least two and preferably three short breaks during the shift for meals and recreation.
9. Medical screening of shiftworkers.

Table 2 An example of individual overtime limits operating with a 12-hour shift roster (NNODDOOONN etc)

<u>Maximum work hours per 24 hours</u>	14
<u>After 2 night shifts minimum required break</u>	24
<u>Maximum overtime hours in 4 weeks</u>	12
<u>Maximum total work hours in 4 weeks</u>	156

Figure 1 Some example shift rosters

Slowly rotating 8-hour shift roster

D = 0600-1400 A = 1400-2200 N = 2200-0600 O = off

DDDDDDDOOAAAAAONNNNNNNOO

Rapidly rotating 8-hour shift roster

D = 0600-1400 A = 1400-2200 N = 2200-0600 O = off

DDAANNNOODDAANNNOODDDAANNOO

Two rapidly rotating 12-hour shift rosters

D = 0700-1900 N = 1900-0700 O = off

NNODDOOO

OODNNOOOODDN

N.B. 5 crew rather than 4 crew operation can add a double day shift with each of the five crews working 8 months of rotating shifts and 2 months of day shifts only.