

Change from slowly rotating 8-hour shifts to rapidly rotating 8-hour and 12-hour shifts using participative shift roster design

by Peter A Smith, PhD,¹ Brett M Wright, PhD,² Ron W Mackey,³ Harley W Milsop,³ Susan C Yates, PhD⁴

Smith PA, Wright BM, Mackey RW, Milsop HW, Yates SC. Change from slowly rotating 8-hour shifts to rapidly rotating 8-hour and 12-hour shifts using participative shift roster design. *Scand J Work Environ Health* 1998;24 suppl 3:55–61.

Objectives The study examined the impact of change, from slowly rotating continuous 8-hour shifts to more rapidly rotating continuous 8-hour and 12-hour shifts, on the health and quality of life of shift workers.

Methods Self-report survey data were collected from 72 shift workers at 3 sewage treatment plants before and several months after roster change. After the change 1 plant first worked a rapidly rotating, 8-hour shift roster and then worked a 12-hour shift roster, and the other 2 plants worked continuous 12-hour shift rosters.

Results After the change the shift workers at each plant reported increased satisfaction with roster design, a decrease in physical and psychological circadian malaise associated with shift work, improved day sleep quality, less tiredness, and improvements in the quality of home, social and work life. A between-plant comparison of the rapidly rotating 8-hour and 12-hour shift rosters showed greater improvements had been obtained with the 12-hour shift roster, and no significant differences in tiredness or sleep quality between the redesigned 8- and 12-hour shift rosters. However, a within-plant matched-pairs comparison at the 1st plant of the rapidly rotating 8-hour shift roster and the 12-hour shift roster showed no significant differences.

Conclusions The results show that the prior level of support for change may best explain the impact of roster redesign on individual well-being. They lend further support to shift worker participation in roster design.

Key terms circadian malaise, health, quality of life, tiredness.

Shiftwork research has, for many years, generally favored continuous three 8-hour shift rosters with faster rather than slower speeds of rotation, on the grounds that faster rotation is somewhat less socially disruptive (1) and results in less cumulative sleep loss and circadian disturbance (2). Continuous 12-hour shift rosters with short spells of day and night shifts fit the criteria for inclusion as rapidly rotating rosters. They have the additional advantage of reducing the number of work shifts and increasing the number of days off, but at the cost that employees must work a longer shift (3) and thus change the pattern of exposure to the occupational stress of shift work. Twelve-hour shifts also typically restrict the opportunity for overtime, and their introduction may therefore both reduce the length of the average workweek and the frequency of double shifts (ie, 16-hour shifts) worked.

The evaluation of shift rosters is usually only possible when there is a change from the existing roster to a “new” roster. Under such conditions the effects of roster difference are influenced by the effects of the change process and the contrast between the “old” and the “new” roster. In many studies of roster redesign the involvement of the shift workers in the design of their “new” roster is unclear, and change to 12-hour shifts also introduces a faster speed of rotation (eg, 4, 5, 6, and 7).

This paper reports the results of a roster change at 3 sewage treatment plants, all with a slowly rotating, continuous, three 8-hour shift roster prior to the change. After the change 2 of the plants moved immediately to continuous 12-hour shift rosters and the 3rd went first to a 6-month trial of a continuous rapidly rotating 8-hour shift roster and then to a trial of a 12-hour shift roster. It was

¹ Centre for the Study of Organisational Process, Performance and Finance, Faculty of Commerce and Management, Griffith University, Nathan, Queensland, Australia.

² Sydney Water Corporation, Sydney, New South Wales, Australia.

³ Sydney Water Corporation, Australia & Australian Services Union, Sydney, New South Wales, Australia.

⁴ Faculty of Arts, University of Wollongong, Northfields Avenue, Wollongong, New South Wales, Australia.

Reprint requests to: Dr Peter A Smith, Centre for the Study of Organisational Process, Performance and Finance, Faculty of Commerce and Management, Griffith University, Nathan, Queensland, Australia 4111 [E-mail: PeterSM@ORGO.gu.edu.au]

therefore possible to compare rapidly rotating 8-hour shifts with 12-hour shifts with both roster conditions operating as "new" shift rosters and to compare the same shift workers on both "new" rosters.

Table 1. Biographical details of the shift workers participating in the roster redesign.

	Mean	Range	%
Age (years)	39.1	20–55	.
Time with corporation (years)	12.2	0.8–34.2	.
Time on "old" roster (years)	5.2	0.3–32.0	.
Years of shiftwork experience	7.8	0.3–32.0	.
Marital status			
Married	.	.	73.3
Separated/divorced/widowed	.	.	10.0
Single	.	.	16.7
Partner's employment status			
Waged employment — full-time	.	.	34.5
Waged employment — part-time	.	.	16.1
Not in waged employment	.	.	29.3
Families with children at home			
Under 5 years of age	.	.	27.4
6 to 12 years of age	.	.	24.2
13 to 18 years of age	.	.	12.9
No children	.	.	35.5

Table 2. Self-report survey scales.

Questionnaire topic	Number of items	Type of scale	Positive indicator
Attitude towards shift work (13, 14)	1	5-point	Low score
Attitude towards shift roster (15)	1	5-point	Low score
Job satisfaction (15) ^a	5	7-point	High score
Energy and vigor (15)	10	5-point	High score
General Health Questionnaire 12 (16)	12	4-point	Low score
General Health Questionnaire 6 ^b	6	4-point	Low score
Digestion (15)	8	4-point	Low score
Cardiovascular symptoms (15)	8	4-point	Low score
Minor complaints (13, 14)	9	4-point	Low score
Circadian malaise (13, 14)	10	4-point	High score
Muscular complaints (13, 14)	4	4-point	Low score
Minor infections (13, 14)	4	4-point	Low score
Dayshift tiredness ^{b, c}	1	5-point	Low score
Nightshift tiredness ^{b, c}	1	5-point	Low score
Day-off tiredness ^{b, c}	1	5-point	Low score
Tiredness (13, 14)	1	3-point	High score
Fatigue (13, 14)	1	3-point	High score
Day sleep quality (13, 14)	14	3-point	Low score
Night sleep quality (13, 14)	14	3-point	Low score
Impact on home life (13, 14)	6	3-point	High score
Impact on social life (13, 14)	7	3-point	High score
Impact on work life (13, 14)	6	3-point	High score
"New" roster improvement ^{b, c}			
Family life	1	5-point	Low score
Social life	1	5-point	Low score
Mental health	1	5-point	Low score
Work performance	1	5-point	Low score

^a Not included in the before-change survey.

^b The first 6 items of the General Health Questionnaire (16).

^c Single item question designed for this study.

Subjects and methods

Subjects

Twelve shiftwork crews from 3 sewage treatment plants in Sydney, Australia, were studied. Each crew comprised 6 male shift workers. The shift workers' age, time of employment with the corporation, length of service with the "old" roster, total number of years' experience with shift work, marital status, partner's employment status, and percentage with under 18-year-olds living at home at the 1st data collection point are shown in table 1. They were similar for all 3 plants.

Shift rosters

Before the change each plant worked a slowly forward rotating continuous three 8-hour shift roster with 7 consecutive shifts preceding days off. After the change plant 2 and plant 3 worked continuous two 12-hour shift rosters (each following an 8-day cycle with 2 night shifts, 1 or 2 days off, 2 day shifts, and 2 or 3 days off). Plant 1 first tried a forward rotating continuous three 8-hour shift roster with shifts following a 2x2x3 cycle and then introduced 12 hour shifts. The shift change times for the 8-hour shift rosters were 0600, 1400, and 2200, and for the 12-hour shift rosters the shift change occurred at 0700 and 1900. The rosters were as follows (D=day shift, N=night shift, A=afternoon shift, O= off shift):

DDDDDDDOOAAAAA OONNNNNNNNOO

(the before-change continuous three 8-hour shift roster)

DDAANNNOODDAANNNOODDDAANNNOO

(the after-change 2x2x3 8-hour continuous shift roster used in plant 1)

NNODDOOO

(the after-change continuous 12-hour shift roster used in plants 1 and 3)

OODNNNOO ODDN

(the after-change continuous 12-hour shift roster used in plant 2)

Votes for roster trials prior to change

It was agreed that participation in roster design should include a secret ballot at each plant, with a minimum of 65% voting in favor before any change could be introduced (8). In the 1st vote 2 plants voted with a sufficient majority for an immediate trial of 12-hour shifts. At one plant the vote was 75% in favor of a 12-hour shift trial (with no voter indicating that he would not be willing to try a 12-hour shift roster if a 65% majority voted in favor). In the other plant the vote was 100% in favor of the 12-hour shifts. The 3rd plant voted only 53% in favor of 12-hour shifts. This value fell below the agreed

65% majority. At a 2nd vote, for a trial of rapidly rotating 8-hour shifts, 75% voted in favor. Following the 6-month trial of the rapidly rotating 8-hour shift roster another vote was held. On this occasion 67% voted for a trial with 12-hour shifts prior to reaching a final decision about which roster to adopt (8).

Study design, survey scales and other measures

Self-report questionnaire surveys (table 2) were administered to small groups during visits with each crew at work in the 2 months prior to the change from the slowly rotating, 8-hour shift roster. This survey procedure was repeated in the 5th or 6th month after the change and, for the plant which underwent a 2nd change, from the rapid 8-hour shift roster to a 12-hour shift roster, again in the 5th or 6th month of work with the 12-hour shift roster. The surveys of the "old" roster were completed prior to a vote on whether or not to try the "new" rosters. Data collection was undertaken as part of a participative design process which provided an opportunity to collect additional information through individual and group discussion.

The shift workers were also asked to keep sleep diaries in the weeks before roster change and again for some weeks 3 months after the change. Personnel data on overtime hours, near-miss occupational health and safety accident reports, workers' compensation claims, sickness absence, time spent in meetings, and attendance at training claims were also collected. The response rate for returned surveys was 72.2% before the change and 63.8% after the 1st roster change. Before the change 38.5% of the forms had missing data and after the change the corresponding value was 36.0%. The response rate after the 2nd roster change at plant 1 was 66.7%, 18.8% of which was incomplete. Failure to complete a questionnaire resulted from absence from work or being engaged in work which would not allow completion of a survey on the survey day. Individual and group discussion at each plant did not indicate any clear differences between the survey respondents and nonrespondents. Missing data within the returned surveys was primarily a result of there being insufficient time for the workers to check whether all the questions had been answered. Only 3 shift workers refused to complete a survey — all on the grounds that they disliked questionnaires — and only 4 shift workers clearly indicated on their surveys that they refused to answer a particular question or section of the survey. To ensure anonymity, no record of who did or did not complete a survey was kept. However, with the agreement of the shift workers at plant 1, it was possible to match the surveys completed after the change to the rapidly rotating, 8-hour and the 12-hour shift rosters. Less than 25% of shift workers at each plant returned a sleep diary, and few of these diaries included more than 7 days of recording.

Independent sample t-tests were used to compare data collected before and after the 1st roster change and to make between-plant comparisons. Matched pair t-tests were used to compare the "new" 8-hour and 12-hour shifts within plant 1.

Results

Effects of first roster changes

The only significant difference in the attitude towards shift work was with roster satisfaction. After the change there was greater satisfaction with the roster (table 3).

For the 5 health variables included in each testing, only circadian malaise (ie, disturbed appetite and sleep, indigestion, constipation, flatulence, irritability, moodiness, depression, tiredness, and fatigue) showed a significant change. Less malaise was reported after the roster change (table 3).

Day sleep quality was significantly improved after the change. Night sleep quality was not. Self-reported tiredness and fatigue were both lower following the change (table 3).

There was significant improvement in home and social life after the change to the "new" roster (table 3).

Between-plant comparison of rapid 8-hour and 12-hour shifts. Before the roster change a comparison of the 2 plants that moved to 12-hour shifts and the plant that started rapidly rotating 8-hour shifts showed no significant differences in attitudes towards shiftwork, self-report health complaints, day and night sleep quality, and impact of shift work on home, social and work life (table 4). After the roster change there were several significant differences between the plants that moved to either 12-hour shifts or to the rapidly rotating 8-hour shifts.

The only significant difference in attitudes towards shift work and work occurred for roster satisfaction. Those working the 12-hour shifts were more satisfied with their roster than those working the rapid 8-hour shifts (table 5).

For the 8 health variables only the General Health Questionnaire 12 scores differed significantly between the 2 "new" rosters. Those working 12-hour shifts reported fewer psychological health complaints (table 5).

There was no significant difference between those working 12-hour shifts and those working 8-hour shifts on self-reports of tiredness or sleep quality (table 5).

For the 3 life-style impact variables (ie, on home, social, and family life) those working 12-hour shifts reported a less negative impact of shift work on both their home and social lives (table 5).

Those who changed to 12-hour shifts reported greater improvements in their family and social lives and life overall. There was no significant difference in the

Table 3. Effects of roster change. (df = degrees of freedom)

	Before change		After change		Statistical difference		
	Mean	N	Mean	N	t-Value	df	P-value ^a
Attitude towards shift work	2.4	39	2.1	47	1.29	84	0.202
Attitude towards shift roster	2.9	40	1.8	47	3.91	85	0.000
General Health Questionnaire 12	21.8	39	20.7	47	1.55	84	0.125
Minor complaints	30.0	32	31.6	45	-1.94	75	0.056
Circadian malaise	27.3	36	31.8	46	-4.04	80	0.000
Muscular complaints	13.8	37	14.5	46	-2.10	81	0.039
Minor infections	12.9	39	12.9	44	-0.04	81	0.965
Day sleep quality	30.8	52	25.4	30	2.93	80	0.004
Night sleep quality	22.0	52	20.0	30	-1.47	80	0.145
Tiredness	2.2	40	2.8	47	-3.07	85	0.003
Fatigue	2.5	40	3.1	46	-3.06	74.6	0.003
Home life	9.7	38	13.8	44	-6.25	78.1	0.000
Social life	11.1	39	15.8	44	-4.77	81	0.000
Work life	11.0	35	12.3	45	-2.80	78	0.007

^a Bonferroni correction P<0.05 requires a t-score significance of P<0.004.

Table 4. Before-change between-plant comparison of rapid 8-hour shifts and 12-hour shifts. (df=degrees of freedom)

	Before 12-hour shifts		Before rapid 8-hour shifts		Statistical difference		
	Mean	N	Mean	N	t-Value	df	P-value ^a
Attitude towards shift work	2.6	23	2.1	16	1.34	37	0.187
Attitude towards shift roster	3.1	24	2.6	16	1.26	38	0.215
General Health Questionnaire 12	22.5	23	20.8	16	1.92	37	0.062
Minor complaints	30.6	18	29.3	14	-1.07	30	0.294
Circadian malaise	27.5	21	27.1	15	0.22	34	0.824
Muscular complaints	13.7	21	13.8	16	-0.16	35	0.872
Minor infections	11.5	22	11.9	16	-0.64	36	0.528
Day sleep quality	31.5	23	29.5	15	0.62	36	0.540
Night sleep quality	24.2	22	21.1	14	1.35	34	0.185
Tiredness	2.3	24	2.1	16	0.75	38	0.457
Fatigue	2.5	24	2.5	16	-0.13	38	0.900
Home life	9.8	23	9.5	15	0.37	36	0.711
Social life	10.2	23	12.3	16	-1.35	37	0.186
Work life	11.0	20	11.0	15	0.00	33	1.000

^a Bonferroni correction P<0.05 requires a t-score significance of P<0.004.

reported improvements in physical and mental health or in work performance between the 2 groups (table 5).

Within-plant comparison of rapid 8-hour and 12-hour shifts. The results of the matched pairs t-test comparison are presented in table 6 for the survey data collected in the 5th and 6th months of operation of the 2x2x3 8-hour shift roster and the 12-hour shift roster at plant 1. None of the comparisons showed a significant improvement with 12-hour shifts.

Diary sleep records, overtime work, near-miss occupational health and safety accident reports, and workers' compensation claims. The mean sleep lengths calculated from sleep diaries indicated no major change in the duration of night or day sleep after the roster changes.

Data on the overtime worked at each plant was collected for the 12 weeks prior to the change and for 32 weeks after the change. Before and after the roster change overtime hours were highest at plant 2 and lowest at plant 3. Plant 1 reduced overall overtime by 36% after the rapid 8-hour shifts were introduced; plant 2 reduced overtime by 47% after the introduction of 12-hour shifts, and plant 3 showed a 60% reduction with 12-hour shifts. These reductions were accompanied by less time being spent in training and in meetings between shift crews and with day workers. For the 12-hour shifts the reduction in overtime coupled with less overlapping hours spent at work alongside day-time management and day workers was reported as giving rise to communication difficulties. The shift workers' comments, such as "We seem to be at work much less often with the new roster", need to be

Table 5. After-change between-plant comparison of rapid 8-hour shifts and 12-hour shifts. (df = degrees of freedom)

	12-hour shifts		Rapid 8-hour shifts		Statistical difference		
	N	Mean	N	Mean	t-Value	df	P-value ^a
Attitude towards shift work	32	1.9	15	2.5	-1.93	45	0.060
Attitude towards shift roster	32	1.3	15	2.9	-3.95	16.62	0.001
Job satisfaction	31	21.6	15	21.1	-3.95	16.62	0.001
Energy and vigor	31	38.1	14	36.9	0.93	43	0.358
General Health Questionnaire 12	37	19.3	15	23.5	-4.26	45	0.000
Digestion	32	11.4	14	13.5	-1.91	44	0.063
Cardiovascular symptoms	31	9.3	15	10.7	-1.73	42	0.055
Minor complaints	31	32.6	14	29.6	2.56	43	0.014
Circadian malaise	32	33.0	14	29.2	2.60	44	0.013
Muscular complaints	32	14.9	14	13.7	1.92	16.18	0.073
Minor infections	31	13.0	13	12.6	0.80	42	0.429
Dayshift tiredness	30	2.3	15	2.9	-2.01	43	0.051
Nightshift tiredness	30	3.1	14	3.4	-0.98	42	0.332
Day-off tiredness	30	2.0	15	2.5	-1.98	43	0.055
Day sleep quality	28	25.3	13	28.5	-1.46	39	0.153
Night sleep quality	29	19.9	13	21.8	-1.06	40	0.294
Home life	30	15.4	14	10.4	6.17	42	0.000
Social life	31	17.7	13	11.2	6.64	42	0.000
Work life	31	12.7	14	11.4	1.97	43	0.055
Family life	32	1.5	15	2.9	-3.90	19.34	0.001
Social life	32	1.7	15	3.2	-4.64	45	0.000
Life overall	32	1.7	15	3.1	-3.89	19.05	0.001
Physical health	32	2.2	15	2.8	-2.02	45	0.049
Mental health	32	2.3	15	2.7	-1.62	45	0.112
Work performance	32	2.1	15	2.7	-2.32	45	0.025

^a Bonferroni correction $P < 0.05$ requires a t-score significance of $P < 0.002$.

considered against day management comments such as "They don't seem to ever be here with the new roster". The near-miss accident reports and workers' compensation claims were similar prior to and after the roster change. The near-miss occupational health and safety accident reports during the 6 months of "new" roster operation were 1 each for the rapid 8-hour shifts and 12-hour shifts. The 12-hour shift near-miss did not involve a shift worker. Two workers' compensation claims were lodged during the 6 months of "new" roster operation. Both involved claims for long-term hearing loss related to the work environment several years prior to the roster changes. No accidents were recorded in the 6 months preceding or following the change. Sickness absences were similar prior to and after the roster change; however, 2 shift workers went on long-term sick leave after the roster change as a result of nonwork injuries.

Discussion

Reduced disturbance in circadian rhythms and greater social satisfaction resulting from the faster rotation achieved by 12-hour shift rosters may explain the popularity of 12-hour shift rosters. However, a greater contribution to their popularity may be that they provide a

Table 6. Matched-pair comparison of the rapidly rotating 8-hour shifts and the 12-hour shifts. (df = degree of freedom)

	8-hour shifts (2x2x3) (mean)	12-hour shifts (mean)	Statistical difference		
			t-Value	df	P-value ^a
Attitude towards shift roster	2.8	2.5	-0.34	11	0.74
Energy and vigor	32.5	33.1	0.27	10	0.79
General Health Questionnaire 6	11.2	11.6	0.49	11	0.64
Digestion	11.3	15.1	1.30	11	0.22
Cardiovascular symptoms	10.2	11.2	0.74	11	0.48
Dayshift tiredness	2.8	2.9	0.22	11	0.83
Nightsift tiredness	3.4	3.3	-0.19	11	0.85
Day-off tiredness	3.2	2.6	-1.03	10	0.33
Improved family life	2.6	2.3	-0.63	11	0.54
Improved social life	2.9	2.3	-1.70	11	0.26
Improved life overall	2.8	2.3	-0.73	11	0.48
Improved physical health	2.8	2.2	-0.96	11	0.36
Improved mental health	3.1	2.8	-0.56	11	0.59
Improved work performance	3.0	2.8	-0.44	11	0.67
Roster advantages outweigh disadvantages	1.6	1.4	-0.25	11	0.81

^a Bonferroni correction $P < 0.05$ requires a t-score significance of $P < 0.003$.

reduction in the number of days involving night work and an increase in the number of days off. Both of these factors may further reduce the stress and social disruption of shift work.

Discussion with the individual shift workers and shift crews involved in these trials of 12-hour shifts indicated that these workers did indeed regard the major advantage of 12-hour shifts to be the reduced number of days spent working shifts and the positive carry-over effects that this had on reducing the impact of shift work on their family and social lives. It also indicated, as earlier research has shown (1), that rapidly rotating continuous 8-hour shifts were more socially acceptable than slowly rotating continuous 8-hour shifts. However, rapid rotation reduced the number of consecutive days off. This was a particular disadvantage for the more frequent 2-day breaks when the 1st day off began at 0600 hours after a spell of night shifts. Because of the need to recover from night work and to make the transition to night sleep, these 2-day breaks were reported as providing only 1 real day off. The results support earlier research which shows that the distribution of time for recovery from night work and for social and family life is an important factor in satisfaction with roster design (9).

Nonetheless, the survey results are contradictory in terms of the support they offer to 12-hour shifts.

The change from "old" to "new" rosters with more rapid rotation through either 8- or 12-hour shifts was supported in advance by 83.3% of the shift workers in the 3 plants. The results showed increased satisfaction with the roster design, a decrease in the physical and psychological circadian malaise associated with shift work, improved day sleep quality, less tiredness, and improvements in the quality of home, social and work life.

The between-plant comparison of the results for the 12-hour shifts and rapidly rotating 8-hour shifts concerned a group voting 87.5% in favor of trying 12-hour shifts and a group voting 75% in favor of trying rapidly rotating 8-hour shifts only after 47% had rejected trying 12-hour shifts. The results showed that satisfaction with roster design, psychological health, and improvement in the quality of home, social and work life were all significantly greater for the 12-hour shifts. Furthermore, there was no significant increase in tiredness or any decrease in sleep quality with the 12-hour shift roster. Nonetheless, earlier research has shown that significantly less sleep may be taken for night shifts following a change from slowly rotating 8-hour shifts to more rapidly rotating 12-hour shifts (7, 6) and that 12-hour shifts have a potential for increased fatigue (10) and increased safety risk (4, 11). Negative effects such as these may be less readily shown by self-report data from shift workers who strongly support roster change.

The within-plant matched-pairs comparison of rapidly rotating 8-hour shifts and 12-hour shifts showed,

however, no significant differences between the 2 rosters. It examined the 2 rosters for the group which 1st voted 53% in favor of a 12-hour shift trial, but then, because this was an insufficient majority to proceed with the trial, voted 75% in favor of a trial of rapidly rotating 8-hour shifts as an alternative to the existing slowly rotating 8-hour shift roster; and finally, because of continuing pressure by the majority who had voted for 12-hour shifts, held another vote, which achieved a 67% vote in favor of a 12-hour shift trial prior to a final decision about which roster to adopt.

The voting percentages are reflected in the survey reports of satisfaction with the different rosters. The votes for change showed that the plant which moved 1st to rapidly rotating 8-hour shifts and then to a trial of 12-hour shifts was less clear about the need for roster change and about what change to adopt. These workers were less satisfied with either of the alternative rosters than the workers at the 2 other plants.

The difference between the results obtained with each roster may be associated with the differences in satisfaction expressed by the shift crews at each plant. Furthermore, the overall improvement reported when the rosters were first changed at each plant could be associated with the reduction in overtime which accompanied the change from the original rosters.

These alternative explanations of the results do not deny that, under appropriate work conditions, 12-hour shifts offer real advantages to many shift workers. In particular, for many, they reduce the negative impact of shift work on family and social life by reducing the number of shifts worked. However, there are longer periods of time when 12-hour shift workers are out of direct contact with day working management and employees. This lack of contact was reported as a disadvantage by plant management. Plant managers found that reduced contact with the shift workers exacerbated communication difficulties at work. They also reported that the reduced availability of overtime to provide flexibility in meeting operational demands caused difficulties. In practice greater management discipline was required over the use of overtime, as was greater creativity in tackling the integration of shift crews and day workers.

The trials do, nevertheless, highlight the difficulty that results may be confounded by the prior level of support for existing and new rosters. This prior support may well reflect reasoned individual assessments of the likelihood of a new roster better fitting individual differences in life-style than does the existing roster. The level of prior support is important because the success of a roster in promoting well-being is to a significant extent dependent on the ability of a roster to satisfy the needs of as large a majority of shift workers as possible. It is therefore important to evaluate the results of comparisons between shift rosters, not only in terms of the similarity of

shift workers and the work they perform in each roster condition, but also in terms of the advance support each group of shift workers gives to the adoption of a particular roster design.

Finally, the results from these trials provide a further indication that shift workers are able to make a reasonable assessment of the probable impact that a new roster design will have on their individual life-styles. This ability shown by shift workers provides additional support for the importance of shiftworker participation in roster design (12) and for the longitudinal study of the long-term health effects of 12-hour and other shift rosters (2).

References

1. Wedderburn AAI. Social factors in satisfaction with swiftly rotating shifts. *Occup Psychol* 1967;41:85—107.
2. Colquhoun WP, Costa G, Folkard S, Knauth P, editors. *Shiftwork: problems and solutions*. Bern (Germany): Peter Lang GmbH, 1996.
3. Wallace M, Greenwood KM. Twelve hour shifts. *Work Stress* 1995;9(2/3):105—8.
4. Rosa RR, Colligan MJ, Lewis, P. Extended workdays: effects of 8h and 12h rotating shift schedules on performance, subjective alertness, sleep patterns and psychosocial variables. *Work Stress* 1989;3(1):21—32.
5. Rosa RR, Bonnett, MH. Performance and alertness on 8h and 12h rotating shifts at a natural gas utility. *Ergonomics* 1993;36(10):1177—93.
6. Williamson AM, Gower CGI, Clarke BC. Changing the hours of shiftwork: a comparison of 8 and 12 hour shift rosters in a group of computer operators. *Ergonomics* 1994;37(2):287—98.
7. Di Milia L. A longitudinal study of the compressed workweek: comparing sleep on a weekly rotating 8h system to a faster rotating 12h system. *Int J Ind Erg* 1998;21:199—207.
8. Wright BM, Mackey RW, Milsop HW, Smith PA. Participative shift roster re-design: trials of 8- and 12-hour rapidly rotating continuous shift rosters. *International Committee on Occupational Health, XIIIth International Symposium on Night and Shiftwork*, Finland, 1997 June 23—27.
9. Knauth P. The design of shift systems. *Ergonomics* 1993;36(1/3):1311—21.
10. Tepas DI. Flexitime, compressed workweek and other alternative work schedules. In: Folkard S, Monk TH, editors. *Hours of work: temporal factors in work scheduling*. Chichester: Wiley, 1985;199—210.
11. Kogi K. Job content and working time: the scope for job change. *Ergonomics* 1991;34(6):757—73.
12. Kogi K, DiMartino VG. Trends in the participatory process of changing shiftwork arrangements. *Work Stress* 1995;9(2/3):298—304.
13. Smith PA, Bennett S. Report on the joint University of Bradford and Civil Service Union studies of shiftwork. London: Civil Service Union, 1983.
14. Bennett S, Smith PA, Wedderburn AAI. Towards a synthesis of research findings for application with shiftworkers. *J Hum Ergol* 1982;11:13—9.
15. Barton J, Spelten E, Totterdell P, Smith L, Folkard S, Costa G. The standard shiftwork index: a battery of questionnaires for assessing shiftwork-related problems. *Work Stress* 1995;9(1):4—30.
16. Goldberg DP. *Manual of the general health questionnaire*. Windsor: NFER-Nelson, 1972.