

Participatory Development of Age-Adjusted, Optional Shift Time Schedules in Industrial Workers in a Chemical Plant

R. Karazman¹, I. Kloimüller¹, H. Geißler¹, I. K.-Morawetz¹, J. Gärtner², K. Hörwein²
(1) Institute of Occupational Health Promotion - I.B.G. Austria, A-1070 Vienna, Seidengasse 33-35/9;
(2) Arbeitszeitlabor/Technical University of Vienna

1. Introduction

Work time schedules, especially shift schedules, are keys to a balanced working and private life. Keeping the right balance, is the key to a meaningful life, psychobiological health and a long working life. Inadequate shift schedules cause high stress, psychobiological exhaustion and loss of meaning of working and private life. With inadequate shift schedules the risk of accidents, sickness, early retirement and death rise.

This balance changes during working life, particularly with age and changing family status (e.g., with or without children). With increasing age, risks for shift workers rise and shift schedules tend to become ever more inadequate, as work ability and night shift tolerance generally decrease and meaning of life changes. The sleep quality of the middle-aged and elderly deteriorates, i.e., their sleep is shorter, more easily disrupted and lighter and they wake up more often than the young (Monk and Folkard, 1996). Furthermore, indirect cross-study comparisons suggest that the circadian rhythms of middle-aged people adapt much slower to acute changes in routine than those of young people (Moline et al., 1991). In an unpublished US study Czeisler proved that both age and years of experience with shift work affect sleep and can lead to sleep disorders and eventually to early retirement.

In general, we have a different psychobiological identity at the age of 25, 40 or 55. But the main discrepancy is the fact that shift schedules and weekly working hours are mostly the same for young and older workers, although the workers' psychobiological work ability, their interests and social skills are very different. According to an Austrian study, less than 20 percent of workers think they will be able to continue shift working till retirement (Koller et al., 1978). That means that work time schedules that do not consider age differences encourage early retirement, as they lead to psychobiological exhaustion and loss of meaning of life.

Therefore, when defining an age-adjusted working environment, one of the principal goals is the design of optional working time schedules and optional shift work schedules that allow the worker to select the schedule that fits best to his personal work ability and interests. The best way to develop such a shift work system is by a participatory approach supported by expert knowledge and technological tools.

2. The Programme "Productive Ageing" in a Chemical Plant in Austria

Such a participatory development of new shift schedules has been part of an age-adjusted re-engineering programme in Austria's biggest chemical plant with a total staff of 1,150 workers. This programme has been called "Productive Ageing". Traditionally, the shift work in the plant was characterised by a very high early retirement rate and shift workers were not older than 52 years. Over the last five years a comprehensive industrial re-engineering programme has raised productivity and reduced staffing by technological change. This "technological revolution" has changed work content from physical to cognitive demands and has raised the feeling of stress in the ageing work force.

So as to offset this modernisation programme and avoid the loss of a huge part of the highly experienced and skilled workforce because of exhaustion, sickness and early retirement, the company has now started the programme "Productive Ageing". The aim of this programme is to reorganise workplaces, adjusting them to the workers' age, and to re-design shift schedules. This programme is one of the many occupational health promotion projects within the framework of the Austrian national programme "Age-Conform Work Environment", aiming at work re-engineering, adapting work processes to the workers' age in pilot companies and maintaining health, work ability and work interest in elderly workers. This programme concentrates, above all, on shift schedules.

The Institute of Occupational Health Promotion, IBG-Österreich, has been advising management and employees on how to reorganise the company so as to adjust work processes to the workers' age and safeguard their health.

3. Methods

3.1. The Shift Work Schedule before the Programme

Before the programme started, the shift schedule was a 4-crew shift schedule with 38.0 hours per week and a rotation of MMAANN-- with several standby shifts per year. In order to reach the agreed weekly working hours (i.e., 38.0 hours), one person out of seven had to be on standby. Every worker was scheduled for such shifts.

3.2. The Participatory Shift Modelling Process

The participatory development of the new shift schedule was done in the following steps:

- 1. Strategic decision** by management
- 2. Qualitative analysis** by occupational health experts
- 3. Questionnaire** filled in by shift workers and other staff members
- 4. Shift-planning group** with several meetings
- 5. Software "Shift Plan Assistant"**
- 6. First approval of the new shift model** in a work unit
- 5. Final approval** by management and works council

Management decision.- The management made the strategic decision to introduce an age-adjusted re-organisation of the shift work as part of the programme "Productive Ageing". The

financial constraint was that the new shift schedule system should not raise the company's personnel costs. The company, however, did not want to profit from the reform and was ready to pass all grants-in-aid or internal savings (e.g., from night allowances) on to the workers. So as to increase its leeway, the management switched from the criteria of "head counting" to a system of "work time equivalence", which disregards the number of people working in that time - as basic personnel cost criteria. This paved the way for a reduction of the individual working time, which again led to a rise in staff numbers. Simultaneously optional shift work schedules could be introduced - a prerequisite for adjusting shift work to age.

Qualitative analysis.- It investigated demographic structure, absenteeism, working culture, private relations, history and made a comparison to models of "good" shift work developed by occupational health experts based on documents and interviews with shift workers. The project design was built on the results of this analysis.

Questionnaire.- Every employee - including all shift workers – received and filled in a tailored questionnaire. The aim of this survey was to obtain a representative result and information about which burdens shift workers experienced and what they wanted to change at work, on which the work of the shift planning group could be based. This questionnaire included standardised item modules as actual and prospective indicators for the development of health and work ability. The questionnaire was developed by IBG after 48 expert interviews and focus groups with management and trade union representatives.

Actual indicators	ergonomics, work load, subjective health and symptoms Occupational Stress Questionnaire (Tuomi et al./FIOH)
Prospective indicators	life quality, meaning of life, recognition, trust, commitment Work Ability Index (A. Elo/FIOH)
Shift work indicators	ergonomic aspects, suggestions and wishes for a shift work reform

"Shift planning group" and software.- This group was established at the beginning of the programme. Its task was to develop a shift work system built on the results of the questionnaire and the findings of ergonomic science to support the health development of shift workers. This shift time model was then presented to the management, employees and works council for approval.

The shift planning group consisted of shift workers, leading staff members, workers' representatives, work time experts of the "Arbeitszeitlabor" (work time laboratory at the Technical University Vienna) and was led by experts of IBG. The tools applied by the group were shift-modelling software and wage calculations. The wage calculation for the different new shift models was done by the personnel department of the company.

Computer animation by the software "Shift Plan Assistant".- The new shift schedule was generated by using a special computer software based on Windows and is called "Arbeitszeitassistent/Shift Plan Assistant". It was developed by the Arbeitszeitlabor. This software allows rapid calculation of new shift schedules by input of different variables and visualisation of results. This visualisation was further developed into a meta-plan technique with video projection, thanks to which all members of the shift planning group could immediately find out what effects and consequences certain measures or ideas with regard to time schedule would have. This means: this software projection makes information

immediately available to all members of the group and enables an interactive modelling group process.

First Approval.- The new shift plan model and all its financial consequences were extensively explained and presented for approval to the shift workers of that department where the pilot project was to be implemented first.

4. Results of the Evaluation of Workplaces

4.1. Characteristics of Shift Workers

360 of 1,150 employees are shift workers in the production area monitoring the production process of various chemical products. The work consists of monitoring the production via VDU and is done in continuous shift groups. A group of day workers is multi-professional and consists of production workers, office clerks and managers. The group characteristics are:

	Day worker	Shift worker	Response shift work
Number			347
Age (average)			47 a
Age (median)			43 a
Female %			2%
Male %			98%
Seniority (median)			20 a

4.2. Results of the Qualitative Analysis

The main problem of the old shift schedule **MMAANN--** was the rather short rest period of two days off. The first day off was after a night shift, which most shift workers partly used for catching up on sleep, and the second day before a morning shift so that it was partly used again for sleeping. Private life was, thus, often limited to psychobiological regeneration. Particularly older workers reported a progressive degree of fatigue and need of regeneration, etc.. In 1997 the average age of shift workers was 47 years and their traditional early retirement age 52. This meant that in five years time half of the shift workers would be expected to retire.

Standby shifts posed another major problem as they often led to cancelling vacations, thus burdening the private and family life. Furthermore, workers of the production area did not receive a "training" proper, training here just meant working immediately with the new technologies. So shift workers felt a lack of qualified training as well as supervision, which resulted in a high stress levels.

4.3. Results of the Questionnaire

Ergonomic evolution of the workplace.- In an evaluation of macro- and micro-ergonomic changes in the company the workers were asked which aspects of relations, organisation, work and occupational health had improved or worsened compared to five years ago before the re-engineering programme started.

(Strong) improvement	% of N	(Strong) impairment
<p>air quality within company area - 76 economic situation of company - 67 plant equipment - 61</p> <p>workplace safety - 55 future of company 54 public image of company 44</p>		<p>psychomental demands 74 stress level 70 staff numbers 70 time pressure 67 income 62 employment security 52 sanitary facilities, restrooms 48 respect towards colleagues 47 justice among colleagues 46</p>

In the 5 years of re-engineering and lean production in the company the workers experienced an improvement of the "hardware" of the company (technical, safety, economic conditions) and an impairment of the "software" (psychomental stress, quality of relations, security) as compared to the past when the company was still nationalised and boasted favourable social conditions but struggled with economic problems.

Quality of life.- The quality of life was evaluated for three different periods: retrospectively for the year 1992, for the year 1997 (today), and looking forward to the year 2000. From these three points in time you get an image of how every worker experiences the development of his own life-quality. This development is an indicator of the balance between work, private and personal life, or of an imbalance, which – if chronically - causes mental and physical illness.

Compared to the results of day workers, shift workers experienced a stronger decrease in life quality from 5 years ago. Breaking down the shift group at the age of 45, we could see that this decrease was brought about by workers over 45 which experienced and expected a dramatic loss of life quality in the next three years.

Quality of life at different times (n=654)	Day worker (highly) satisfied (n=306)	Shift worker (highly) satisfied (n=348)	Shift < 45a (highly) satisfied (n=)	Shift ≥ 45a (highly) satisfied (n=)
5 years ago (1992)	70.9 %	67.1 %		
today* (1997)	62.7 %	42.0 %		
in 2-3 years* (2000)	58.3 %	36.8 %		

One main reason for this pessimistic view of the personal future is the workers' lack of private life caused by psychobiological exhaustion caused by work (the assessments of younger workers were more balanced).

Effect of job on private life (n=654)	Shift worker (n=348)	Day worker (n=306)
sufficient leeway	26.4%	63.1%
job hampers private life	64.1%	36.6%
job prevents private life	9.5%	0.3%

This result shows that there is a high risk of imbalance between private and working life in an ageing workforce that can be mainly explained by psychobiological overdemand by the old shift schedule.

Work Ability Index.- The evaluation by the WAI led to similar results: a significant lower WAI in shift workers in comparison to day workers and a progressive decrease in work ability in shift workers over an age of 40 years (with 65 percent of the shift workers being over 40). It must be noted, however, that the average age of day workers is 2 years higher than that of shift workers.

WAI/age classes(n=512)	Day workers (n=293)	Shift workers (n= 219)
< 25a		
26-30a		
31-35a		
36-40a		
41-45a		
46-50a		
> 50a		
ANOVA: p=0.0000		

Breaking down workers into the various WAI classes, it can become obvious that significantly more shift workers show poor work ability than day workers. This means: shift work bears higher work demands.

WAI/work ability classes	Day workers (n=293)	Shift workers (n= 219)
high	21.8%	37.4%
above average	43.0%	41.6%
below average	30.7%	17.4%
poor	4.4%	3.7%
ANOVA: p=0.0000		

As far as the maintenance of the work ability is concerned, around 30 % of shift workers are not sure of being able to their present job in 2 to 3 years time! This is the second reason for this very pessimistic view on future life quality in shift workers presented above.

Work ability in 2-3 years (n=645)	Shift worker (n=348)	Day worker (n=306)
unlikely	2.9 %	0.7 %
not certain	24.6 %	12.1 %
relatively certain	72.5 %	87.2 %
ANOVA between : p=0.0000		

Occupational Stress Questionnaire.-In the OSQ (Elo A., 1978) the stress level proved to be double as high as at reference workplaces of other industrial sectors. Main stressors were subjective high cognitive and psychomental work demands and subjective lack of qualified support by supervisors. The technological re-engineering of the last five years proceeded so rapidly that workers perceived a lack of training, because this training was only done during work.

Stressor profile in shift work.- For all groups of workers the main stressors were: the short two-day shift break, the lack of staff, night work – this holds especially true for older colleagues - and ageing in general. When broken down into the different age classes, the older shift workers seemed to adapt better to social or psychobiological stressors than younger workers (except night work and "ageing").

Stressor profile in shift work Age classes	TOTAL	<35a	36-45a	45a>
short shift break of 2 days	58.1	63.8	59.6	51.2
lack of staff	54.7	63.8	51.5	52.4
night work	40.1	33.3	34.6	54.8
loss of friendships	35.6	53.6	30.1	29.8
ageing	30.8	21.7	25.7	46.4
loss of private life	26.0	34.8	21.3	26.2

Symptom checklist.- The evaluation of mental and somatic health in the employees showed a high amount of psychobiological symptoms like sleep disorder, fatigue and strong perspiration in shift workers and a high amount of musculoskeletal symptoms in both shift and day workers alike. The comparison between shift and day workers in the category "frequent symptoms" – i.e., with more than 20% of the sample, led to the following result:

SHIFT WORK (n= 302; 18% without frequent symptoms)	DAY WORK (n= 263; 30% without frequent symptoms)
<ul style="list-style-type: none"> • sleeping disorders 40 • back pain 38 • fatigue, exhaustion 28 • strong perspiration 28 • neck pain 24 • joint pain 21 	<ul style="list-style-type: none"> • back pain 35 • neck pain 25 • joint pain 21

The subjective health was rated by shift workers significantly worse than by day workers.

5. The New Shift Schedule System

5.1. Suggestions for a Health Promoting Reform of Shift Work by Shift Workers

The workplace evaluation and suggestions made by shift workers and occupational health experts helped to establish the preconditions for a health promoting reform of the shift work.

General suggestions to support health in shift work.- In the questionnaire shift workers were asked which shift reform measures they thought would support their health best. They ranked employment safety first.

Health promoting measures in shift work	N=347
safeguarding of jobs	63.8 %
more personnel	62.1 %
health promotion and training	38.8 %
higher income	37.6 %
reduction of working hours	31.3 %

Shift schedule reform suggestions by shift workers.- Shift workers wanted to make their shift schedule healthier mainly by way of:

Shift schedule reform suggestions by shift workers	N= 347
working time reduction to 36h/week	65 %
no standby shifts	58 %
three or more days off	57 %
night work reduction for workers > 45a	23 % (>
crediting home-to-office time	23 %
for older workers << 36 h/week	21 %

73 percent of workers agreed to tolerate a partly salary reduction in case of working time reduction. The basic suggestions made by external experts were identical to those of shift workers and mainly focussed on measures to adapt work to age and stress reduction.

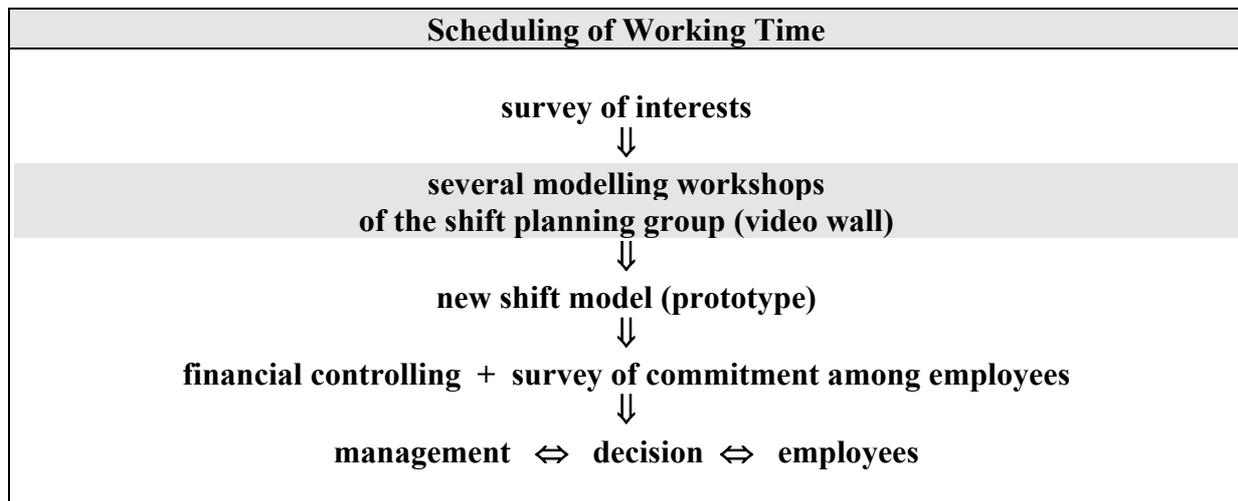
5.2. Defined Goals and Preconditions for the Shift Schedule Re-Design Process

Based on results of the evaluation and suggestions, the following preconditions for the participatory re-design process were defined in the shift planning group:

Goals & preconditions	Methods
1. Adjustment to age	<ul style="list-style-type: none"> • Optional shift schedule allow for personal selection of shifts according to one's own preferences and resources • Reduction of working time • Reduction of stress by decreasing working demands and through training • Raising one's ego and finding sense in life by a better fit of work demands and work ability • Improving life quality by compensating for the impairment of private life • Designing the shift schedule in such a way as to further reduce working time and night shifts for the oldest workers to guarantee a soft transfer to pension and build up a good private life
2. Safeguarding of jobs	<ul style="list-style-type: none"> • Switching from head count to a system of time equivalence • The reduction of the weekly working time induces <ul style="list-style-type: none"> • the creation of new workplaces • the safeguarding of jobs • a rise in productivity by maintaining the experienced workforce, fewer sick leaves and flexibility in the administration & handling of equipment
3. Stress reduction	<ul style="list-style-type: none"> • Reduction of stress by decreasing working demands and hours • Longer shift breaks with more days off for regeneration • Permitting workers more control of their own work by giving them the possibility to select their preferred optional schedules • Optional training integrated in shift schedule (stress training, competence, fitness) • Improving employment safety and hiring new workers • Lowering pessimism with regard to future and feelings of insufficiency by a better fit of job demands and work ability
4. Supporting productivity	<ul style="list-style-type: none"> • Shift work reform must not raise personnel costs and head count will abolished • Shift work adjusted to the worker's age reduces sick leave and costs incurred through early retirement, especially by reducing shift "reserves" • Maintaining experienced and educated shift workers by a better fit of work demands and their work ability • Working time reduction and more time for regeneration by supporting human resources • Lower stress levels decrease direct and indirect costs of stress • Flexible shift schedules allow a new administration of equipment
5. Private life quality	<ul style="list-style-type: none"> • Longer shift breaks with more days off • Less exhaustion by reducing work demands • Better compatibility with social life (weekends) • More employment safety

The shift re-designing process and the shift planning group.- The task of the shift planning group was a participatory re-design of the shift system. Participation was guaranteed by the evaluation and questionnaire before the workshops and the representation of all relevant groups in the planning group (workers, management, works council, personnel department, OHS team).

The structure of the shift modelling process was:



It took the shift planning group 4 one-day meetings and approx. 40 hours to calculate the new working time and its effects on salary. In the re-design process two strategic schedule options were flatly refused:

- a system where one shift worker would have to switch between 2 shift groups: this system would allow high flexibility and a couple of new solutions, but the shift workers would then be forced to get accustomed to new colleagues.
- a system which takes into consideration periods with a high number of workers on vacation or with high sick leaves: this system would entail a higher weekly working time for those colleagues working in summer, thus making it easier for other colleagues to go on vacation during this time. But this, of course, means that in the most benign of all seasons the leisure time is reduced.

For these reasons a totally new model was developed.

5.3. The New Shift Schedule

The new shift schedule is characterised by (see fig.):

	1 Mo	1 Di	1 Mi	1 Do	1 Fr	1 Sa	1 So
A	F	F	S	N	N		
B		Z	F	S	S	N	N
C				F	F	S	S
D	N	N				F	F
E	S	S	N				

- a 5-crew schedule,
- basic weekly working hours: 34.4 h/week,
- 5 work days alternate with 3 days off as main shift rhythm,
- two out of five weekends are free (one weekend with 4 days off),
- 15-20 percent new workplaces,
- *Day Z*: one day in 5 weeks reserved is for training, health promotion and the like,
- optional choice to increase weekly working time to 37.6 h/week or decrease it to 29 h/week by opting for or cancelling the *Day Z*.

The Day Z, a day earmarked for training, etc..- This day in the shift schedule is an internal form of cutting production working time where workers can do outside work receive training, health and safety promotion or economic information by the management instead of doing production work.

Working hours will be reduced by 9 percent (i.e., 25 more days off) and the salary by 3 to 4 percent. This relatively low income reduction is made possible by the company passing all premiums and grants-in-aid on to its employees.

5.4. Acceptance of the New Shift Schedule

In all three departments workers have voted on the implementation of this new shift schedule (along with the salary cut intended). Acceptance rate ranges between 87 and 36 percent. The implementation of this measure in the first department is scheduled for October 1998.

References: Monk and Folkard: Making shift work tolerable, 1996