RESEARCH MOTIVES AND METHODS IN FIELD APPROACHES TO SHIFT WORK

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There is an increasing dependence of industrial activities upon night and shift work. Shift work is obviously one of the most demanding work schedules and the focus of field investigations has been on the potential deterioration of work capacity and health of the workers (Colquhoun, Folkard, Knauth, & Rutenfranz, 1975; Rutenfranz, Knauth, & Colquhoun, 1976; Rutenfranz, Colquhoun, Knauth, & Ghata, 1977; Kogi, 1962, 1971; Winget, Hughes, & LaDou, 1978). Most of these field studies have been undertaken with a view to minimizing the deteriorating effects of phase shifting in the work-sleep cycles, usually making use of a set of practicable methods (van Loon, 1963; Wedderburn, 1967; Mori, Kato, & Sudo, 1974; Colquhoun et al., 1975; Kogi, Takahashi, & Onishi, 1975; Koller, Kundi, & Cervinka, 1978; Åkerstedt & Torsvall, 1978; Reinberg, Vieux, Ghata, Chaumont, & Laporte, 1978; Matsumoto, Sasagawa, & Kawamori, 1978). The diversity of field research strategies, however, has really been remarkable, particularly in terms of the parameters selected for study and the methods for measuring such parameters.

It may be argued that the diversity of methods and parameters reflects the complexity of the changes in the biological circadian rhythm, the implications of these changes for safety and health, and divergent opinions about the relative importance of the various components of circadian periodicity. On the other hand, shift work is also a social form of human activity. Many field studies of it are, as a matter of fact, based on more or less common expectations, which in turn are closely associated with current social concerns about shift work. At least, it seems that the understanding of research results is dependent on a combination of interests in both biological and social variables (Wedderburn, 1967; Taylor, Popock, & Sergean, 1972; Kogi, 1971,1977; Rutenfranz et al., 1977; Carpentier & Wisner, 1976). The trends, if any, in current field research methodology regarding shift work reflect the fact that shift work potentially affects the social as well as biological functioning of the worker, and that to a large extent, the nature of the problem dictates the types of research strategies available to the investigator.

Diversity of Shift Systems

A recent report by the Shift Work Committee of the Japan Association of Industrial Health (1979) revealed that distribution of shift workers varied greatly between different industries and between different enterprises, though some changes in practice had been noted since similar previous studies (Kogi, 1962, 1971). Of a total of 743,000 workers working in 1426 undertakings surveyed 23.3% were engaged in shift work. A breakdown of the ratio of shift workers to the total workforce by industry showed that the ratio was 70% in mining, 23% in manufacturing, 36% in electricity and gas supplies, and 36% in hospitals, while it was only less than 4% in finance. Of the shift workers surveyed, those in the non-night systems (mainly in the form of day and afternoon systems) accounted for 2.0%, those in the night-including two-shift systems (day or afternoon and night) which are known as day-night systems 6.8%

(including both full and part-time types),three-shift systems 13.6% (non-weekend-work type 4.0% and continuous type 9.6%),and other systems 0.9% (mostly in alternate-day systems). As shown in Table 1,the distribution of shift workers differed much between industries.

Table 1

Percentage of Workers Employed in Various Shift Systems by Industry, by Age and by Night Shift Frequency

Subgroups	Double day systems	Day-night systems	Three-shift systems			Other shift systems
			3-team	4-team	Others	
(Night work)	-	+	+	+	+	-,+
(Weekend work)	-	-	-,+	+	-,+	-,+
By industry						
Mining	0.4	4.7	51.6	3.7	0.1	0.1
Manufacturing	2.2	7.2	3.1	8.7	0.5	1.0
Power supply	0.1	2.5	---	30.5	3.3	---
Finance	0.3	2.4	0.6	---	---	0.3
Hospital	0.5	0.9	---	---	33.0	1.7
By size of enterprise						
Manufacturing 1000~	2.2	8.4	3.4	10.7	0.5	0.9
~999	2.3	3.7	2.2	3.0	0.2	1.3
By age						
Male, 34 or less	47.9	60.2	38.8	47.5	58.4	53.9
Female, 34 or less	93.2	---	---	---	65.4	---
By night shift frequency						
6 or less/months	---	24.7	21.9	28.2	64.3	29.4
7-10 months	---	13.7	57.5	60.7	12.9	43.6
11 or more	---	29.3	6.3	2.2	1.3	17.0

(Results of a survey by the Shift Work Committee of the Japan Association of Industrial Health, 1978).

The non-night-work systems, usually in the form of non-weekend-work double dayshift systems, were found in manufacturing, particularly in textile, food products, and transport machinery and equipment industries, but also included other manufacturing industries such as chemical, electrical machinery and equipment, iron and steel, and others. The night-including two-shift systems were seen in various industries, indicating that these systems are widely em-

ployed, second in frequency only to the three-shift systems. But in finance the two-shift systems were the most frequently reported type of shift work. Also noteworthy was the variability of three-shift systems by industry, which are most common in mining, manufacturing and power supply plants. Most of the 3-team 3-shfit systems were of the non-weekend-work type, and only in a small portion in manufacturing, of the continuous type. The continuous 4-team 3-shift systems, on the other hand, were more popular in manufacturing and power supply plants. It should be noted that the 4-team 3-shift systems have become widely used in Japan only since the late 1960's (Kogi, 1971). The other more irregular types of 3-shift systems were found in a small percentage in manufacturing and public service sections, such as hospitals. Alternate-day systems and 'other' shift systems were found in all trades, but were most common among gate-keepers, guards, and power source maintenance workers.

Table 1 also shows that the variability of shift systems is related to workforce variables, such as enterprise size, age and sex of workers. Current practice seems basically unchanged from previous reports, though relatively more elderly people are now engaged in shift systems (Kogi, 1971). In the manufacturing industries, all types of shift systems were found in both large-sized, medium, and small-sized enterprises, but the day-night systems and the 4-team 3-shift systems were more prevalent in larger enterprises. Notable was the similar rates of non-night-working shift workers for both large, medium, and small undertakings. The relative frequency of non-night systems was largest in small-sized enterprises with less than 300 workers. Further, a clear tendency was found for the double-day systems to be used in industries employing young female workers. In the case of males, the day-night systems were most frequently worked by those under age 35.

The frequency of night shifts per month varied with shift system type, as shown at the bottom of Table 1. The day-night systems had a higher percentage of workers working 11 or more night shifts per month, whereas 7-10 or less night shifts per month were more usual among three-shift workers and a substantial portion of workers working 6 or less night shifts per month are found in all of these types.

A more explicit picture pointing to the diversity of shift systems is shown in Table 2, which gives the numbers of different shift systems by industry. Of the 1426 enterprises studied, 716 of them adopted 1235 shift systems. As the table shows, in the mining and manufacturing industries all of the major forms of shift systems were found. There were sharp differences in the distribution of the kinds of shift systems between different industries. The non-night-including shift systems, indicated as double dayshift systems in the table, were found in the textile and food products industries and in many branches of manufacturing and in finance. The night-including shift systems, mostly in the form of day-night 2-shift systems without weekend work, were found in mining, finance and all manufacturing branches. Of the 185 cases of semi-continuous systems without weekend work in full-day operation, normal practice was weekly rotated 3-team 3-shift systems, though 2-shift systems accounted for 32 cases.

Table 2

Number of Shift Systems Adopted by Different Industries in 1426 Undertakings Surveyed by the Shift Work Committee of the Japan Association of Industrial Health (1978)

Shift System	Mining	Manu-facturing	Power supply	Finance	Hospital	Total
(No. of undertakings studied)	43	1275	24	62	22	1426
(No. of undertakings having shift systems)	31	620	24	20	21	716
Double dayshift system	3	106	1	9	1	120
Day-night shift system	17	241	-	21	-	279
Semi-continuous system						
2-shift system	1	30	-	1	-	32
3-shift system	16	131	-	1	-	148
Others	-	5	-	-	-	5
Continuous system						
2-shift system	3	63	13	1	4	84
3-team 3-shift system	4	35	-	-	-	39
4-team 3-shift system	7	147	23	-	-	177
Other 3-shift system	7	33	2	-	20	62
Alternate-day systems	1	177	-	-	2	180
Other shift systems	1	100	-	4	4	109
Total	60	1068	39	37	31	1235

The continuous full-day systems amounted to 362 cases, which were composed of 84 2-shift systems, 39 3-team 3-shift systems, 177 4-team 3-shift systems, and 62 other 3-shift systems. Characteristic were 3- or 4-team 2-shift systems seen in petroleum products and chemical industries as well as in electric and gas supplies. The 4-team 3-shift systems were prominent in continuous operation industries including chemical, paper-pulp, iron and steel, and others. Alternate-day systems and 'other' systems were observed widely in all trades. Only 8 cases of the permanent night shift type were included in the latter.

The distributions by shift system type of the number of consecutive night shifts and the length of portal-to-portal hours for a normal night shift are given in Table 3. In the case of day-night systems and semi-continuous systems, those with consecutive 5 night duties and those with consecutive 6 night duties were approximately equal, indicating a tendency towards the 5-day week system. A few, mostly with weekend work, were of 4 or shorter sequence of night duties. In contrast, the continuous systems were characterized by a

large difference in the number of consecutive days of night work between different types. Typical were 1 or 2 days for 3-team 2-shift systems, 1 day for 4-team 2-shift systems, 3-7 days for 3-team 3-shift systems, and 2-6 days for 4-team 3-shift systems. In the case of 4-team 3-shift systems, four main divisions were 2, 3, 4, and 5 consecutive days, having sharp differences in their distribution between trades.

Table 3

Number of Different Shift Systems by Number of Maximum Consecutive Night Shifts in a Rotation Cycle and by Length of a Night Shift

Shift System	No. of consecutive night shifts							Length of a night shift (portal-to-portal hours)				
	1	2	3	4	5	6	7	8.9	9 10.9	11 12.9	13 23.9	24
Day-night shift system	6	13	8	7	116	111	3	195	57	10	4	-
Semi-continuous system												
2-shift system	6	1	-	-	12	12	-	6	1	11	8	-
3-shift system	1	1	5	-	49	89	1	94	45	3	1	-
Others	-	-	-	1	2	-	-	-	1	1	1	-
Continuous system												
2-shift system	27	14	10	2	1	5	7	4	2	34	31	-
3-team 3-shift	1	1	7	3	11	6	7	23	12	1	-	-
4-team 3-shift	4	36	56	33	41	5	1	91	77	5	-	-
Other 3-shift	8	15	7	3	8	5	3	29	23	5	2	-
Alternate-day systems	168	-	-	-	-	-	-	-	1	-	4	122
Other shift systems	32	6	5	2	-	2	1	1	3	2	23	20

(Results by the Shift Work Committee of the Japan Association of Industrial Health, 1978).

The portal-to-portal hours of night work were also very variable and a night shift of more than 9 hours in a 3-shift system or a night shift of more than 13 hours in a 3-shift system were uncommon.

The observed diversity of shift systems may in part be determined by technical reasons (such as necessity of continuous production or social service) but it also seems to be determined more essentially by socioeconomic conditions including labour customs, social habits, and traditions. The lack of labour standards for shift work schedules, except for labour standards law regulating night working hours for minors and females, as well as specifying extra payment for midnight hours, accounts for this variability. Nevertheless, the variabilities of shift systems doubtlessly represents the influence of common social concerns about the physiological, psychological and social life implications of working in such systems. The presence of so many kinds of shift rotation with respect to night work, weekend work, number of teams, night shift frequency, night shift length, number of straight night shifts,

conditions of rest and freetime activities, is by itself evidence of the significance of these factors in selecting a shift system.

Areas of Shift Work Research

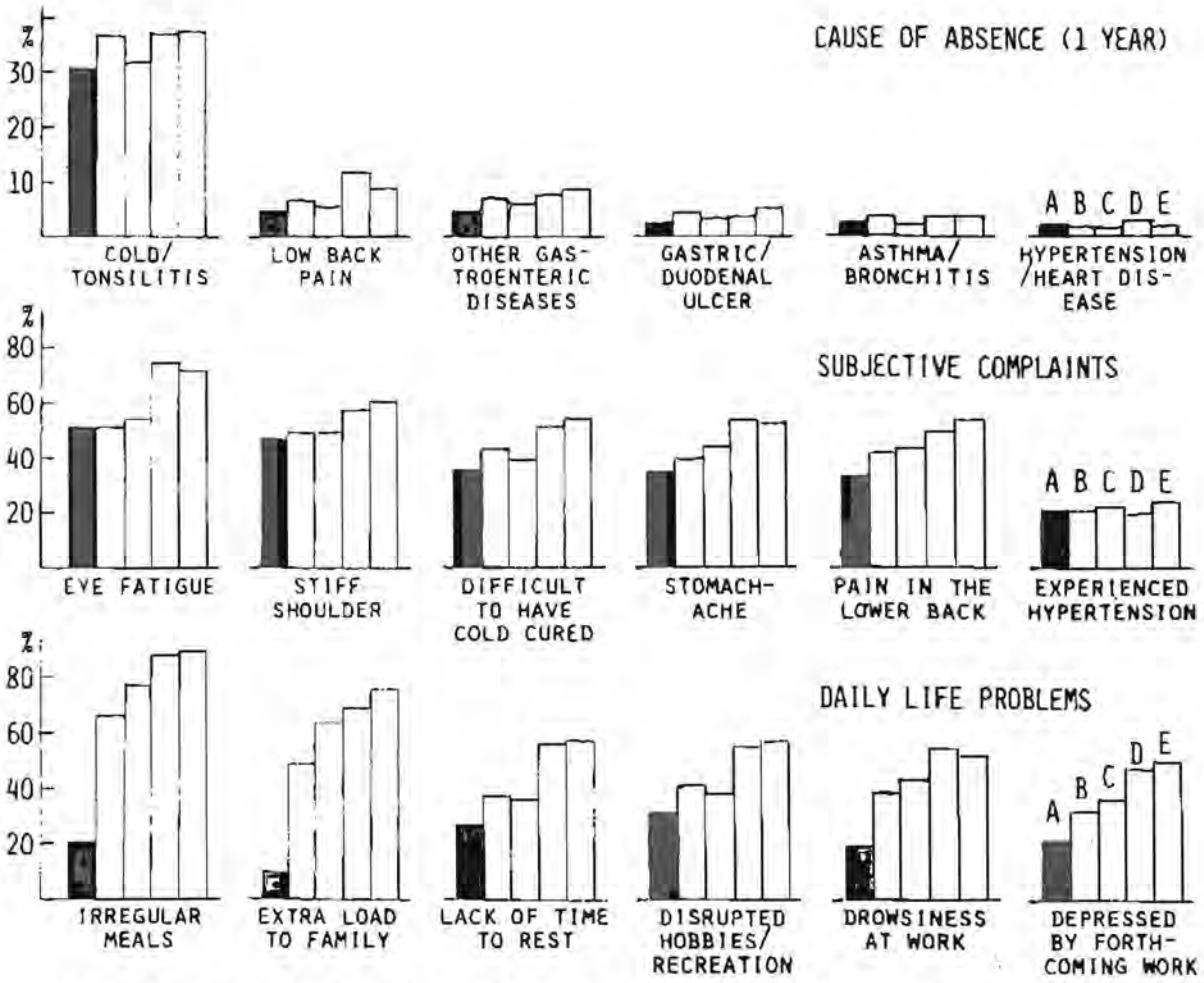
As indicated by the extent of the variability in shift work schedules, subsequent research strategies and methodologies are really diversified. It is guided by various implications the shift systems have for work performance, health, and daily life. It seems suitable that most field studies on shift work pay attention to the multiple consequences of shift working. Attention should also be paid to the structure of all of these research variables.

Consequences of Shift Working as Problems

The major problem areas of shift work have been reviewed in many previous papers. There seems to be a general concensus as to what areas should be taken into consideration. These areas range from effects on work performance, safety, health risks, physiological re-entrainment, insufficient sleep, family and social life, and professional relationships (Akerstedt & Torsvall, 1978; Colligan, Smith, Hurrell, & Tasto, 1979; Kogi, 1971, 1977; Koller et al., 1978; Matsumoto et al., 1978; Reinberg et al., 1978; Rutenfranz et al., 1976, 1977; Taylor et al., 1972; Wedderburn, 1967; Winget et al., 1978). The methods applied and questions posed by field researchers, however, may vary greatly according to the research design as well as between countries. At the same time, it is reasonably assumed that selection of methods is being guided by actual consequences of shift work. The meaning of those specifically selected methods or specifically posed questions becomes understandable when their relation to the whole 'shiftworker problem' is made clear, the structure of the problem areas being similar to any shift working situations. Thus, what matters is not the similarity or uniqueness of methods, but rather the place of questions in and the relation of methods to the whole structure of problem areas.

In this respect, the general aspects of the problems confronting shiftworkers seem universal for worker groups engaged in different kinds of shift systems, the relative importance of each problem being naturally different when the situations differ. This may be confirmed by many previous reports mentioned above as well as by the results of another survey on day and shift workers conducted by the Shift Work Committee (1979) of my country. Some examples for male workers are given in Figure 1.

This survey was carried out using a health questionnaire form with the purpose of studying the effects of different types of shift work on the health and life of workers. Valid responses were received from 2152 regular daytime workers and 7964 shift workers of which 1837 and 7565 were male, respectively. The respondents were workers of coal mines, food processing, pulp and paper products, publishing and printing, chemical and machinery manufacturing industries, transport and communication, post offices and others. Of the male workers, 1563 were on non-night 2-shift systems, 4749 on 3-shift systems, 219 on night-including 2-shift systems, and 1034 on other shift systems. Figure 1 shows for male day and shift workers the percentages and causes of absence from work due to sickness during the past one year period, the rates of those complaining of subjective symptoms, and rates of those mentioning problems of working life. Only typical results are indicated here.



A: DAY WORK, B: DOUBLE DAYSHIFT, C: 3-SHIFT, D: DAY-NIGHT, E: OTHER SHIFT SYSTEMS.

Figure 1. Percentages of causes of absence from work due to sickness during the past one year period, rates of those complaining of subjective symptoms, and rates of those mentioning problems of working life among industrial male day workers and shift workers on different types of shift schedules (results of a health questionnaire survey by the Shift Work Committee of the Japan Association of Industrial Health). [Not significant for 'Hypertension/ Heart Disease' and 'Experienced Hypertension'; significant at the .01 level for 'Asthma/Bronchitis'; the others significant at the .001 level by the Chi Square test.]

Those who were absent from work due to sickness during the one year period constituted 43.2% of male daytime workers, as against 51.9% of double day-shift workers, 45.6% of 3-shift workers, 53.0% of day-night 2-shift workers and 52.8% of other shift workers, indicating higher rates of sickness absenteeism among shift workers. The mean frequency of sickness absence was 0.81, 1.20, 0.88, 1.09, and 1.22, respectively. As causes of absence due to sickness, the descending order of frequency was: colds, gastro-enteric disorders, disorders excepting ulcers, dental problems, low back pain, gastric-duodenal ulcers, and asthma and bronchitis for both men and women. Colds, gastro-intestinal diseases, low back pain and gastric-duodenal ulcers were especially more frequent among shift workers than among day workers, as opposed to heart diseases or hypertension and some other illnesses which showed no distinct differences between the day and shift worker groups. The rates of subjective complaints related to such illnesses were apparently higher among shift workers than among regular daytime workers, which was also the case for common gastro-enteric complaints such as frequent diarrhea and constipation or common respiratory complaints such as coughs or phlegms as well as for eye fatigue, stiff shoulders and sleeplessness.

As for the effects of shift working on the workers' family and social life, complaints concentrated on the irregularity of life and disturbances of rest and freetime, the rates of such complaints being very high among shift workers, as shown at the bottom of Figure 1. Particularly high rates among shiftworkers were: 'meals become irregular', 'irregular shifts bring extra burden to family members', and such items as 'lack of time to rest', 'disturbed to engage in hobbies or recreational activities', 'embarassed by becoming very drowsy while working' and 'sometimes feel depressed to think of the forthcoming work'. The questionnaire also revealed that the shift workers were concerned about the harmful effects of shift work and that points raised as components of the effects of shift work on daily life were closely correlated with the state of health of the worker.

Major Problem Areas and Current Questions

In view of the fact that shift working gives rise not only to disturbances in daily activity cycles but also produces harmful effects on the health of the workers, the Japanese Shift Work Committee has identified seven major problem areas of shift work. These are shown in the left column of Figure 2 along with suggested ameliorative strategies as proposed by the committee which are presented at the corresponding righthand end.

In the context of the Committee report, which referred to both literature at home and abroad and the results of its own two surveys, the following seven questions may be extracted as those pertaining to the seven problem areas. These questions are added to Figure 2 in connection with the corresponding problem areas.

1) In the area of physiological disorders: To what extent is the phase shifting of circadian physiological rhythm controllable? (What are the limitations and what are the important consequences thereof despite the efforts of improving work schedules to reduce physical and mental disturbances resulting from the phase shifting?)

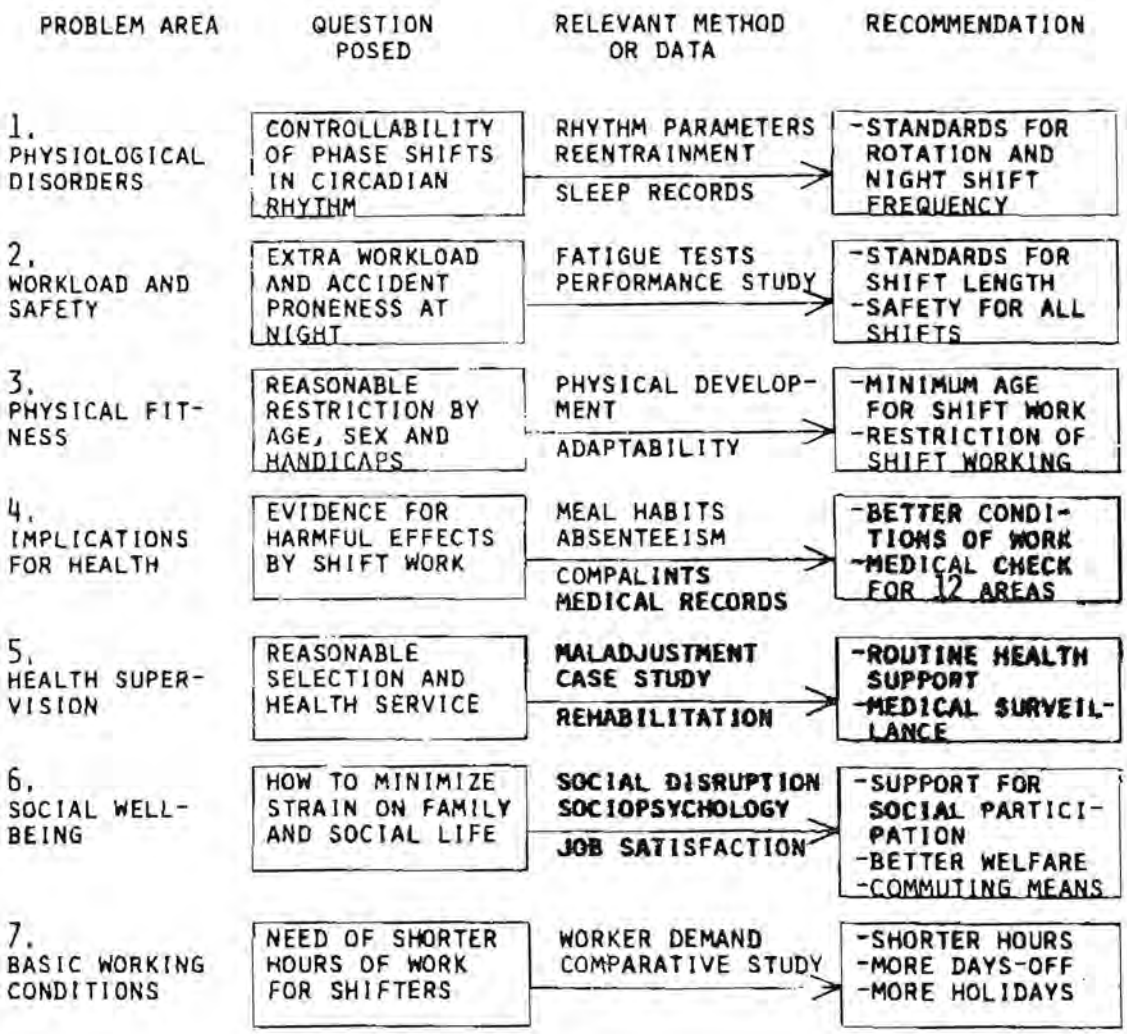


Figure 2. Major problem areas and recommendations by the Shift Work Committee report of the J.A.I.H. and related questions and methods in the author's view. [Differences significant at the .001 level.]

2) In the area of workload and safety: Is the notion significant that the night or early morning shift work imposes on workers an extra workload leading to actual deteriorations of working performance and an enhancing of their accident proneness?

3) In the area of physical fitness to shift work: What kinds of reasonable restrictive measures for shift work are required for very young or aged workers, for maternity protection, or with respect to the handicapped in view of the present level of knowledge on such people and individual differences?

4) In the area of implications for health: What evidence is available concerning harmful effects by shift work on health and what are the implications thereof? (What aspects of health are endangered by shift working and what are the differences in harmful effects, if any, between different shift work schedules?)

5) In the area of health supervision: How must the occupational health services for shift workers be organized to prevent harmful effects and to promote good health, especially with respect to selection, routine health measures, medical checkups, rehabilitation and others?

6) In the area of social wellbeing: How can the strain on family and social life be minimized by organizational efforts? (How serious are the social disruptions of shift workers and what supportive measures for individual workers are useful?)

7) In the area of basic working conditions: What standards of shorter hours of work, days off and holidays for both day and shift work will be helpful in promoting the health and wellbeing of shift workers?

These questions must be answered using factual data collected from shift workers on various shift schedules. The available information is by no means satisfactory. However, some concrete recommendations can be suggested based on the present state of knowledge. And according to reviews by Carpentier and Wisner (1976) and Rutenfranz et al. (1976, 1977) and the Japanese Committee report, recommendations do seem possible for at least two aspects of working conditions, i.e., criteria for schedule construction and provision of health services. Examples of methods usable to attain data for considering such recommendations are illustrated in Figure 2.

As for the establishment of criteria for optimizing the scheduling of shifts, the questions one, three, and six are specifically relevant, though other questions will also have to be taken into account. Accordingly, methods dealing with rhythm parameters and their changes in re-entrainment, fatigue and performance study methods, methods for basic work capacity measurements as well as field methods including questionnaire, records study and interviewing, are all important, application of multiple methods having obviously particular importance. Sleep records, for instance, in accordance with measurements of functional changes during and between night and daytime sleeps and registrations of subjective evaluation of quality sleeps and of various complaints about sleep, are one of the primary materials for considering any of these questions (Morioka, 1969; Matsumoto et al., 1978). Relations of

sleeps in different stages of shift rotation with work performance, physiological and psychological changes and accidents are only a small part of the whole picture. Thus, development of improved methods for sleep records, including daily life time budget analysis, subjective rating, autorhythmometry and continuous measurement techniques, are very much required. It is noted there are many reports already available on sleep records.

With respect to health services, where questions four and five are specifically relevant and other questions listed above are also closely related, methods for looking into behavioural and symptomatological changes at the daily life level are of critical importance. Analysis of daily life habits and their variations, absenteeism, complaints, cumulative symptoms, maladjustment, disturbances in rehabilitation, etc. seems essential in addition to medical records analysis and case studies. The effects of repeated exposures to night-work-daytime-sleep schedules and their cumulative effects in terms of chronic fatigue, decrease of resistance to gastro-enteric, respiratory, motor-organ, circulatory or neurogenic diseases, and daily habits changes should be made focuses of future methodological study.

Because the purpose of this paper is to discuss the general features of research methods, details will not be elaborated here. But it may be said that we need methods pointing directly to functional changes in terms of rhythm parameter variations and test results, as well as a series of methods for the study of various complaints, symptoms, malajustment and disruptions of the basic human needs of shift workers are essential. The relation between methods and research objectives will be discussed later.

Again, in the author's view, the seven questions listed above may denote the directions of field research on shift work at present and in the near future. Suggested recommendations and possible standards (Shift Work Committee, 1979; Rutenfranz et al., 1976, 1977; Carpentier and Wisner, 1976) will be effective in reducing the adverse effects of shift work, but more research efforts seem necessary to elucidate the long-term effects of shift work schedules, research motives being oriented towards real-life situations and to the needs of the workers. It is naturally impossible to find a single appropriate set of methods, but a need of applying multiple methods of different categories is felt even when replying to only one of those questions.

National and Regional Features

One important facet of shift work research is that the shift work schedules are more or less subject to national or regional trends, so that social concerns and research motives may be dependent upon such trends. This problem, however, must be placed in the perspective of the 'shiftworker problem' as a whole, as discussed above.

A review of the shift work schedules in developing countries of Asia (Kogi, 1977) has revealed not only a diversity of shift practices, which are quite different between countries as well as between enterprises, but has also revealed a wide range of impacts resulting from these practices. Typical examples of shift work schedules in manufacturing industries of some Asian countries are shown in Table 4.

Table 4

Examples of Typical Shift Rotation Types in Manufacturing Plants in Developing Countries of Asia (Kogi, 1977)

Country	Plant	No. of shifts	No. of teams	No. of straight shifts	Shift time I	Shift time II	Shift time III
Semi-continuous shift systems (without weekend work)							
Indonesia	Textile	2	2	6	6-14	14-22	
		3	3	6	6-14	14-22	22- 6
	Wheatflour	3	3	6	7-15	15-23	23- 7
	Paper	3	3	6	7-14	14-22	22- 7
	Paper and	2	2	5.5	8-16	16-24	
	plastics	3	3	5.5	8-16	16-24	24- 8
	Synthetic textile	3	3	6	7-15	15-23	23- 7
	Tobacco	2-3	2-3	5	7-15.30	15.30-24	23- 7
Philippines	Automobile	2	2	1 mo	6-14	14-22	
	Food products	2	2	1 mo	8-17	17-24	
	Rubber	3	3	4 wks	6-14	14-22	22- 6
	Wire and cable	3	3	2-3 mos	6-14	14-22	22- 6
Thailand	Iron	2	2	6	7-15	15-23	
		3	3	6	7-15	15-23	23- 7
Pakistan	Industrial	2	2	6	5-13	13-21	
		3	3	6	7-15	15-23	23- 7
India	Manufacturing	2	2	6	8-17.30	17.30-3	
Bangladesh	Jute	2	2	6	6-11.30 14-16.30	11.30-14 16.30-22	
Continuous shift systems							
Indonesia	Textile	3	4	5	6-14	14-22	22- 6
	Textile	3	4	3	6-14	14-22	22- 6
	Synthetic textile	3	4	2	6-14	14-22	22- 6
	Synthetic textile	3	multiple	5	7-15	15-23	23- 7
Philippines	Textile	3	3	2 wks	6-14	14-22	22- 6
Thailand	Textile	3	3	7	7-15	15-23	23- 7
Pakistan	Industrial	3	3	7	7-15	15-23	23- 7
Sri Lanka	Tyre	3	4	4	6-14	14-22	22- 6
Bangladesh	Cotton	3	3	6	6-10 14-18	10-14 18-22	22- 6

Shift practices and their impacts reflect both past and present practices of shift work in industrialized areas. The basic rotation patterns found are either two-dayshift systems or three-shift systems, the shift length being about 8 hours. The choice of system types depending largely on factors peculiar to each country. The textile industry is an example. Two-shift systems are popular in the textile mills of Japan which exclude midnight hours. Three-team, three-shift systems are commonplace in other countries of Asia such as India, Sri Lanka, Thailand and Philippines, and continuous four-team, three-shift systems are seen in Indonesia which has a 40-hour work week. Another marked difference is found in the length of the period of rotation, or number of consecutive night shifts. Even in the case of semi-continuous two- and three-shift systems where most countries tend to adopt weekly rotation, the shift change in the Philippines takes place at much longer intervals of two weeks, one month, or even longer. In contrast, with continuous systems in Indonesia and some other countries including Japan, there is a tendency to reduce the number of consecutive shifts to less than 5 using four teams for the three-shift systems. Further, modifications of basic patterns are not infrequent in all the countries studied. Weekend work, cycle period, times of shift changes, extension to midnight hours and assignment of days-off and holidays, are some of the modifications observed. A special type of shift system not uncommon in the textile mills of Bangladesh divides the daily working time of a crew into two periods separated by a fairly long break. Especially notable in these countries is the fact that a large number of young female workers are engaged in the continuous three-shift systems.

Many of these 'national' features and modifications are apparently brought about as a result of efforts to alleviate the disruptive effects of shift work (Kogi, 1977). These effects on and the problems of shift workers in developing countries are by and large similar to those experienced by industrialized countries, but considerable differences are observed according to climatic and social conditions in which the new practice is introduced. These conditions appear to be related to the rapid increase of shift schedules in the local economy as a means of utilizing costly equipment and expanding employment (Kabaj, 1968) as well as changing job organization, relative lack of medical and welfare facilities and commuting means, effects of poor allocation of holidays, conflicts arising from religious customs and the attitudes of workers towards shift work. Worker dislike for shift work is clearly relevant to strain of night work, incidence of ailments, inconveniences in social life, as well as to unconcerned supervisors and other socio-psychological factors (Kabaj, 1968; Kogi, 1977). The basic problem areas and types of current questions regarding shift work are compatible with those of Figure 2, though close attention must be paid to social conditions and restrictions by national legislation and custom. Those local circumstances and the specific needs for first-hand information greatly affect the priorities of action-oriented research. This is especially true in countries where the full impact of shift work is not known and the elements of dissatisfaction are often dealt with merely from personnel management viewpoints. It appears important to consider research design with reference to the common structure of the shiftworker problem as well as the specific conditions of industrialization, local legislation and custom.

Field Research Motives and Methods

Selection of a set of methods in field research of shift work is usually based on the question posed by the researcher and its relation to the whole shift work problem structure. The use of methods, on the other hand, is based on the realities of conducting the study (Smith & Colligan, 1979). These realities are in fact very important, since, for example, a study procedure requiring a lengthy period of time would not be acceptable to the enterprise nor to the workers. Likewise, application of research methods must, apart from their validity and reliability, comply with the time, place and opportunity limitations of the working schedules and rest intervals, possibility of repeating measurements or recordings, availability of worker consent and training, cooperation of personnel and others (Gordon, Tepas, Stock, & Walsh, 1979; Walsh, Gordon, Maltese, McGill, & Tepas, 1979). A field research protocol for the study of shiftworkers is thus selected only after painstaking procedures. Also taken into account are the representativeness of the sampled data, the expected variability of critical measures, and the financial considerations (Colligan et al., 1979; Smith & Colligan, 1979). The final set of methods are usually a result of deliberations of the realities and inevitable compromises, but at the same time it reflects the research objectives and background motives in a very realistic way.

An interesting result has been obtained from a recent survey report by the Industrial Fatigue Research Committee (1977) of the Japan Association of Industrial Health (J.A.I.H.) on fatique studies conducted by its members,mostly in the 1970-1976 period. The replies were collected for the purpose of mutually discussing the field study methodologies of fatigue assessment. Excepting laboratory experiments, reports of 85 such studies from 20 research institutions were analyzed. These institutions included 12 university departments, 4 public and private research institutes and 4 industrial medical departments. Of the 85 field studies, 55 dealt with daytime work only and 35 with shift work in various industrial workplaces. Eight institutions dealt only with day work, 6 only with shift work, while 6 other institutions dealt with both kinds of work.

Table 5 gives the primary research objectives of these field studies as provided by the committee members. In the case of day work studies, the emphasis of conducting a fatigue study was on health hazard study or specific problem solving rather than on job load analysis or work schedule evaluation. Themes for most health hazard studies were mainly cause analysis or ergonomic assessment with respect to health hazards resulting from improper working methods or overwork, such as low back pain, neck-shoulder-arm syndromes (occupational cervicobrachial disorder) and circulatory diseases. The aims of specific problem solving studies were diverse and included studies of training effects or drug effects, assessment of anti-heat-stress measures, ergonomic improvement of consoles or visual displays, and others. This rather heavy weight on specific studies in the case of day work studies contrasted with shiftwork studies, which had in 70% of the total 30 cases a primary objective of job load analysis or work schedule evaluation. The difference in emphasis may have resulted from a specific interest in shift work studies on general workload, cumulative effects and need of assessing shift schedules. Moreover, as the number of institutions dealing with respective categories of research objectives in the parentheses of Table 5 shows, each category involves a

certain number of research groups, implying the results of the table are reflecting a more general trend in research efforts.

Table 5

Primary Research Objectives of Day or Shift Work Studies Undertaken by Members of the Industrial Fatigue Research Committee of the Japan Association of Industrial Health, Mostly in the Period of 1970-1976

Primary Research Objective	Day Work Study	Shift Work Study
Job load analysis	12 (7)	11 (7)
Work schedule evaluation	5 (4)	10 (6)
Health hazard study	20 (8)	6 (4)
Specific problem solving	18 (8)	3 (3)
Total	55 (14)	30 (12)

(In parentheses are numbers of institutions involved.)

Figure 3 gives percentages of research methods applied in those fatigue studies, separately for 55 day work studies and for 30 shift work studies. The percentage A of the figure shows rates of questionnaire, self-reporting and medical examination methods, percentage B those of continuous data-sampling or recording methods, and percentage C those of functional testing and blood or urine studies. In each of the three portions, there are found certain methods characteristically applied to shift work research in contrast with day work research.

In A, self-reporting of subjective fatigue feelings, primarily using the 30-item Fatigue Scale self-report form by the Industrial Fatigue Research Committee of the J.A.I.H. (Kogi & Saito, 1971; Yoshitake, 1971) was the most popular in both day work and shift work studies, being more predominant in the latter. Similarly, general questionnaire surveys were also common to both shiftwork studies and day work studies. But a very remarkable difference was found in time budget analysis, i.e., study of time spent for daily life activities and sleeps by means of self-reporting. Medical checkups and fatigue-site reporting were of almost equal weight in both groups of research.

In B, motion and time study of working behaviour as well as continuous recording of heartrate, electromyogram, eye movement, etc., were frequently used by both day work and shift work studies, though more frequently in the latter. It is shown that analysis of work in situ and that of physiological changes at work are deemed as important in shiftwork research where such techniques are not easy to implement. Then, contrasting rates are seen in subsidiary behaviour study and oxygen consumption measurement, in the case of shiftwork studies the former being dominant and the latter almost out of consideration. This is perhaps because subsidiary behavioural study is increasingly used in overfatigue studies and because the oxygen consumption measurement is

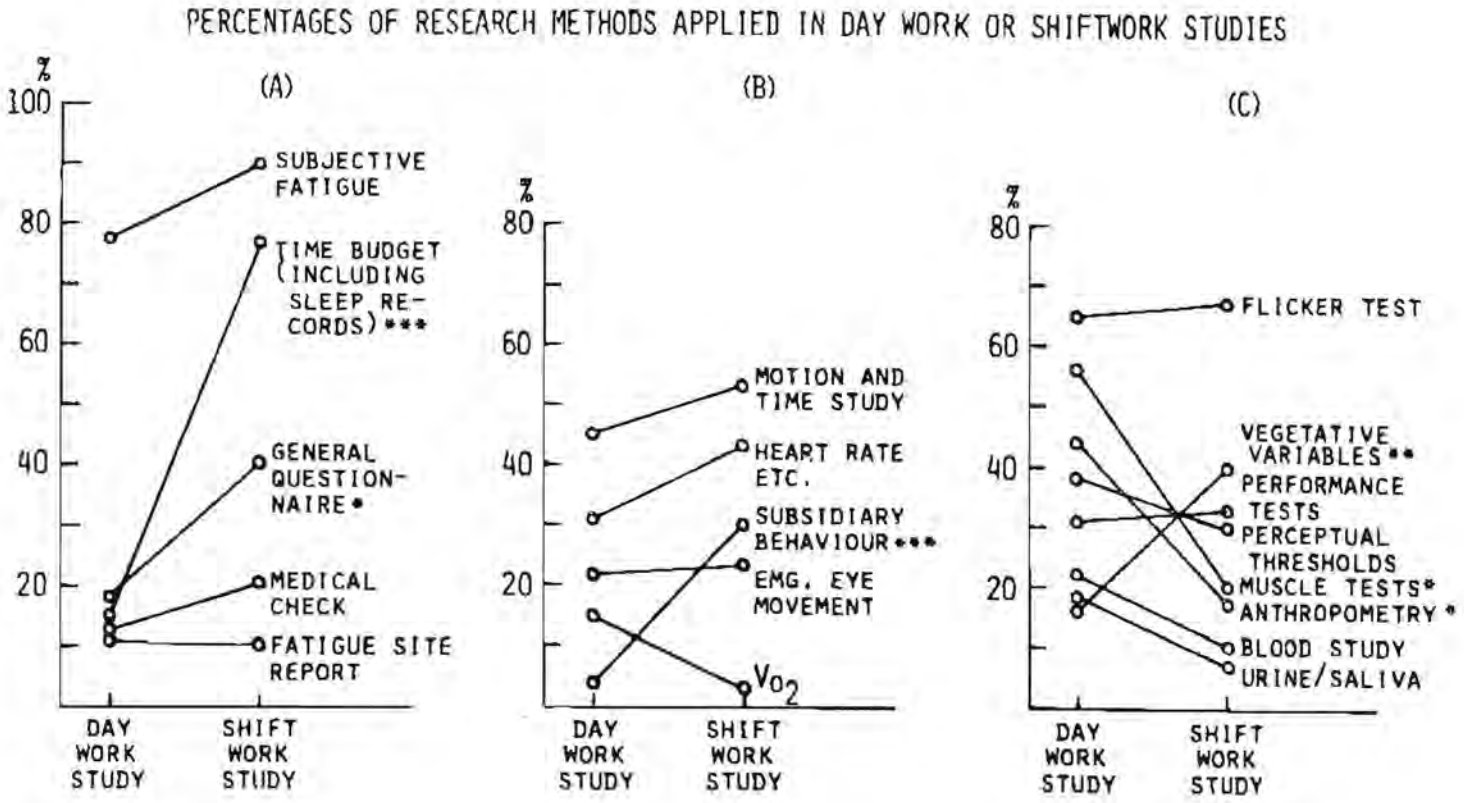


Figure 3. Percentages of research methods applied in field day work and shift work studies conducted by members of the Industrial Fatigue Research Committee of J.A.I.H. mostly during the 1970-1976 period for the purpose of fatigue research. (A) Self-reporting, questionnaire and medical examination methods, (B) Continuous data sampling or recording methods, (C) Functional testing and blood, urine or saliva studies. [* significant at the .05 level; ** significant at the .01 level; *** signigicant at the .001 level.]

usually related to physical load analysis which is seldom a matter of central concern in shiftwork problems.

The results of methods of group C may be interpreted in a similar manner. While muscle tests, which included measurements of muscle forces, tendon reflex thresholds and others, or anthropometric studies were far less popular in shiftwork research than in day work research, the flicker test as a means of activation level study as well as examinations of vegetative variables including blood pressure, body temperature and other autonomic functions were predominant in shiftwork research. Performance tests of various types (such as addition test, aiming tests, tracking performance to choice reaction times or mental capacity measurements) are frequent in both groups. Blood analysis or biochemistry measurements of urine or saliva contents such as electrolytes, mucoprotein, corticosteriods and others were relatively less dominant in shiftwork research. Presumably this is related to the fact that those analyses are more dependent than other tests on laboratory policies. Needless to say, the problem of validity is also important (Colligan et al., 1979; Rutenfranz et al., 1977; Kogi et al., 1971, 1975; Sakamoto & Matsui, 1972).

In summary, the common types of shiftwork research make use of self-reports of subjective fatigue and time budget, motion and time study at work, continuous recording of heartrate and other physiological changes at work, the flicker test and vigilance measures, questionnaire surveys, subsidiary behaviour study and performance tests. Another important method area would be the record study approach (Colligan et al., 1979; Taylor et al., 1972; Walker & de la Mare,1971). Thus, in comparison with day work studies, shift work research may be characterized by more frequent, combined utilization of these methods. The trend in methodologies of field studies of shiftwork is clearly associated with their practicality. Based on the results, the field research methods applicable to a shiftwork study may be classified into the following categories.

a) Self-reporting and questionnaire survey; subjective fatigue, fatigue sites, general questionnaire on working life and health.
b) Time budget analysis and sleep records study.
c) Motion and time study and subsidiary behaviour analysis.
d) Continuous measurement at work of physiological changes; heart rate, autonomic changes, electromyogram, eye movement, electroencephalogram, oxygen consumption, etc.
e) Intermittent application of tests before, during and after work and at rest intervals; anthropometric measurements, muscle tests, perceptual thresholds, activation tests, vegetative variables, blood tests, urine or saliva tests, and others.
f) Specific examination and records analysis; nutritional study, environmental assessment, medical checkups, medical and management records analysis, accident and near-accident records study, etc.

A typical field study of shiftworker problems may use a number of methods from the above categories, though of course, selection of concrete methods and their combinations are determined by research motives and ways of approach, such as comparison of different schedules or study of effects of short sleeps. As discussed earlier, research motives in relation to social concerns on shift work play a vital role in influencing the parameters and measurement strat-

egies selected for study which in turn affect the quality and nature of the subsequent data on which shiftwork decisions are based. Common approaches are to compare the results with certain criteria established earlier or to compare between different schedules. These criteria or comparisons are based on and related to the whole structure of the shiftworker problem. The importance of another approach looking into the human ecology of shiftworkers is thus suggested.

Conclusion

The existing diversity of shift systems and associated means for alleviating worker difficulties were examined to illustrate the extent of physiological, psychological and social life implications of night work and rotational work schedules. The areas of concern regarding shiftwork as indicated by the literature and recent surveys involve the effects of phase shifting, workload and safety, reasonable restriction, harmful effects on health and health service needs as well as strain on family and social life, point to the need of placing the field research methods in the whole structure of the 'shiftworker problem'. This structure, which is suggested to be universal for various shift system types, would constitute baselines for research motives, as guided by current concerns. Shiftworkers are inevitably exposed to these structured disruptions, which offset whatever other merits the shift work organization may have. This leads us to believe that recourse to night work or shift work should be kept to a socially required minimum, and that ways and means of reducing such disruptions must be searched for using field studies in real-life conditions.

Therefore, each field research study should deliberately pay attention to the current questions of shift working which derive from both the problem structure and the local conditions such as legislation, custom and adjustment habits. Since the actual methods employed in field studies of shift work are shown to reflect these structured aspects of the shiftworker problem on the one hand, and the researchers' own concerns over working life qualities on the other, it seems useful to discuss the special features and limitations of each pertinent method. In addition to evaluative and comparative approaches,a human ecological approach based more on information concerning relatively successful and unsuccessful adjustment of shiftworkers should be put forward in planning a field study on shift work.

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