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PERFORMANCE, SATISFACTION AND WORK LOAD IN SHORT-CYCLED REPETITIVE WORK

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Dissertation submitted in fulfillment
of the requirements for the degree of
Doctor in Psychology

by

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Summary

The aim of this study was to explore relationships between performance levels, work satisfaction and work load in short-cycled repetitive work. In chapter 1 and 2 concepts of work load, stress and strain are discussed in general and in relation to short-cycled repetitive work.

Chapters 3, 4 and 5 are devoted to a description of the repetitive task studied, namely the operation of cigar making machines and to a discussion of planning of research and sampling of subjects.

By cigar making machines tobacco leaves are rolled as an outer covering around cigar punches. The machines run continuously with a cycle time of 3 s. At each cycle the worker has to place a tobacco leaf on the machine die. When she does not succeed in doing this within a short time span, she may stop the machine.

To understand different aspects of work load, performance and satisfaction, comparisons were made between 20 high performance and 20 low performance female workers.

Job satisfaction (chapter 6) was measured by the Brayfield-Rothe scale and Patricia Smith's Job Description Index (J.D.I.). It was found, not very surprisingly, that more high than low performance workers were satisfied with their work (see Khaleque, A., Performance and job satisfaction in short-cycled repetitive work, in Sell, R.G. and Patricia Shipley (Eds.), Satisfaction in Work Design, Ergonomics and Other Approaches, London, 1979, Taylor & Francis, 95-100).

To study in detail the activity of both high and low performance subjects, a punch tape recorder was used to register with a precision of 0.1 s the times of the day at which machine stoppages occurred and the duration of each stoppage. This was done for every worker during an entire morning and an entire afternoon shift. The tapes were fed into a computer for analysis. It was found (chapter 7) that low performance workers stop their machines nearly three times more and two times longer than high performance ones. The number and duration of stoppages display a quite nice circadian variation in the high performance but not in the low performance group. This difference may be explained by assuming that high performance subjects are almost continuously functioning at their maximum capacities.

Strain (chapter 8) was studied by Borg's Scale for Ratings of Perceived Efforts (RPE-scale), a feeling of fatigue scale, the Questionnaire for Subjective Symptoms of Fatigue (Industrial Fatigue Research Committee of the Japanese Association of Industrial Health) and the Inventory for Subjective Health (Dirken). On each of them the high performance subjects obtained, quite unexpectedly, higher scores, i.e. they sustain a higher degree of strain than the low performance subjects. They seem to do this in order to earn (rather small) bonuses. Some evidence for this could be found in their J.D.I.-pay-scale scores.

Chapter 9 is devoted to a comparison of strain in satisfied and dissatisfied workers. A negative correlation was found between satisfaction and heart rate, but this finding deserves further research.

In chapter 10 some conclusions are discussed.

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INTRODUCTION

Applied psychology has made rapid strides in successfully dealing with many human problems involved in different fields of industrial work. Technological advancement has brought about important changes in the physical and mental composition of work. The development of mechanical systems has caused virtual disappearance of heavy physical work in most manufacturing industries. The technological progress, on the other hand, has multiplied the number of short cycled repetitive work in different types of manufacturing industries. Though the problems of repetitive work are very important from the viewpoints of production, efficiency, well being of workers etc., yet a lot of problems concerning this type of industrial works remain to be explored.

The present study was an attempt to find answers to some questions concerning performance, satisfaction and work load in a short-cycled repetitive work. This study was conducted on the workers of a cigar factory in Leuven, Belgium.

At the beginning of this research project during the last quarter of 1976, we explained the objectives of this study to a joint meeting of the management and workers' representatives of the factory and they approved our plan.

We explained every test to the subjects before administering it and assured them that anonymity would be maintained about the results.

Data collection began in early 1977 and was completed in February 1978. First we administered job satisfaction tests, then we had to wait for about six months to collect information concerning number and duration of machine stoppages and finally we administered some test on strain. Data collection required unexpectedly longer period because it took nearly one year to build an apparatus (i.e. punch tape data collector) for registering the number and duration of machine stoppages.

We conclude this brief introduction with an outline of the thesis:

Chapter I deals with the concept of work load, confusion concerning the use of this concept and explanation of the concept in relation to the present study. It also includes discussions on various categories of work load factors and techniques for measuring work load.

Chapter II attempts to define short-cycled repetitive work, give a brief historical review of the development of such work, discuss problems of work load in repetitive work and means to solve such problems.

Chapter III is intended to give a brief introduction of the cigar factory, describe the selection of the workers, the wage system and the production process. It contains somewhat more elaborate description of the cigar making department, the cigar machines and the cigar making task.

Chapter IV deals with the origin and the aims of this study, and further with difficulties of this research in particular and of field research in general and also with the limitation of laboratory research.

Chapter V contains descriptions concerning sampling procedures, ages, experience, educational qualifications of the subjects and so on.

Chapter VI through IX present the results of this study: job satisfaction measures; number and duration of machine stoppages; strain in high and low performers; and strain in satisfied and dissatisfied workers.

Finally, Chapter X discusses the contribution of the findings of the present study to understand some problems of this repetitive work and possible steps for solving some of these problems in the light of the obtained results and indicates the perspectives for further research in this field for clearer understanding of some of these problems.

CHAPTER I

WORK LOAD

Introduction

Studying work load and trying to find means to reduce it without losing working efficiency seems to be a timely subject.

In recent years trade unions have been demanding improvement in working conditions by reducing work load. Presently there is an increasing resentment against working conditions specially in short-cycled repetitive work. For many years this resentment concerned work organisation only in manufacturing industries. Nowadays short-cycled repetitive work can be found also in clerical jobs e.g. in banking offices. Technological changes, such as the introduction of computers and visual displays are responsible for this situation. As a consequence white collar people have also become personally interested in the problem of better working conditions in short-cycled repetitive work.

The fact that trade unions representatives are asking for better working conditions, i.e. a decrease in work load, should not lead us to think that work load is well defined and easily measurable. In many cases, excepting heavy muscular activities, work load is something that has to be evaluated by experts, which means that there is much uncertainty and that methods are not objective enough. In other cases there are discussions between workers and management about differences in work load of different work places. This again shows that the methods used are not entirely objective. These few remarks make it clear that better measurement techniques for work load are yet to be developed.

Let us now consider the use and definition of the concept of work load. Although work load as an area of investigation has become prominent over the last two decades, still there is much confusion in the use of this concept. Some authors are very critical of the concept of

work load , e.g. Sperandio (1972) states that work load is a ghost concept, having to do with heterogeneous aspects of the relation between man and his work and that it is an ill-defined concept, only used because of its familiarity. Jahns (1973) says that he finds himself overwhelmed by the diversity and vagueness in the way in which the term is defined and used. Similar opinion has been expressed by Teiger (1978).

There is much truth in the above remarks, because work load means different things in different situations and it also means different things according to the measurement techniques used. As a consequence we can find expressions as visual load, mental load, work load of a given job or work load of a given subject.

We have to agree that work load is a very broad concept: everything that is resisting us during work and everything we have to overcome and endure during work constitutes our work load. We can consider work load as the sum of all factors exterior to the individual, which he has to overcome and to endure to reach his work goal. But we can consider work load also as the physiological and psychological effects of this external work load, within the worker. It is clear that work load is frequently largely determined by the work organisation (e.g. by the speed of machines), but on the other hand it should be noticed that in other cases the worker is controlling in some (large) measure his own load.* He can put his goals very high in terms of quantity, quality and speed of work. So he partly creates his own external load. His internal work load will depend on his physiological and psychological qualities. Here, as nearly everywhere, interindividual differences are important and the proverb "One person's meat is another's poison" is applicable.

* This is, e.g. very clear in the case of the motorcar driver as pointed out by Näätänen and Summala (1976). The driver can decide for himself on the speed at which he will drive and on his distance to the car he is following. Concerning the latter if he chooses 0.5 or 1.0 s instead of the safe 2 s distance, he creates a high work load. If he wants to overtake other cars at every opportunity then again his external work load will be very high and perhaps his internal one too ...

It is not always possible to separate neatly external and internal work load. By expending high efforts, subjects may as well create for themselves a high external load as an exaggerated physiological or psychological tension within themselves.

Categories of work load factors

After these general introductory considerations about work load it is interesting to give a survey of the different factors that contribute to work load in industrialized countries. We are referring here to the really comprehensive survey by Monod and Lille (1976). These authors give the following definition of work load: "the effects on the organism of the burden the worker bears on his shoulders - in the real and in the figurative sense - performing the work that allows him to live and to keep his status in society, carrying on all his responsibilities, taking into account what he is and also the environment that surrounds him". It should be noticed that work load is defined here as effects in the organism. What we have called external work load is called by Monod and Lille "work load factors".

They further make a distinction between primary work load factors and secondary ones. The primary factors are related to the individual's work place, the secondary ones to the social situation of the worker.

Monod and Lille have been criticized at the meeting of the French Society of Occupational Medicine, where they presented their invited survey on work load, for including these large perspectives concerning load from factors outside the work situation. Of course it was perhaps unusual for occupational medical doctors to care for what happened to the workers outside the factory but on the other hand it is clearly incomprehensive to try to study the total load of workers without taking into account the secondary work load factors too.

Concerning the primary work load factors a distinction can be made between the task, the physical and the chemical environment and the social environment. The task and its load can be described in a qualitative way:

the type of body movements (physical tasks), the type of information transmission (mental tasks); and in a quantitative way: frequency of operations, their duration, their rhythm (paced, unpaced), rest pauses, shifts and other variations.

Concerning the physical and chemical work environment many factors can be listed, such as climate (temperature, humidity, air velocity, barometric pressure), noise, vibrations, lighting, dust and toxic substances, work space, individual protection as glasses, special clothing, etc.

The social environment may include relations with peers and with supervisors etc.

Concerning the secondary work load factors Monod and Lille mention: transport to and from work, possibilities of rest after work, work to do at home (preparing meals, cleaning, caring for children), extra work at home (moonlighting), some play activities (creating either some energy expenditure as football or some mental tension as chess: if these are complementary occupational activities, they augment the work load), need for information (newspaper reading and T.V. watching), problems of family life as crowded dwellings (effects on sleep and rest), as working hours differing from those of wife or children, as disturbed family relations, etc.

Primary and secondary load factors are related. Both may contribute to decrease the degrees of freedom of the worker and the time during which he can live as he likes. The nature of work determines the type of housing, of recreational and playing activities. Every occupational overload influences family life, and familial difficulties contribute to a deterioration of occupational life. This list of work load factors suggests that it is very difficult to comprehensively evaluate work load in an absolute way. It is easier to make comparisons of work load factors. But even then we don't know in a sure way which weight to give to each factor and really not much is known on interactions between work load factors.

The list of work load factors given by Monod and Lille is quite exhaustive. Other authors have tried to make classifications by using more general categories of work load. An example of such a classification is given by Koten (1978). This author considers four classes of work load factors. First, work load can be related to energy expenditure. There are limits to the quantity of muscle work people are able to carry out in a given time. Secondly, work load can be related to problem of biomechanics. All movements necessary to perform work tasks are not always matched to the possibilities of joints and skeletal parts.* This is specially the case if the same movements have to be repeated hundred of times a day. It is of course one of the tasks of ergonomists to design work in such a way that this biomechanical work load (and other types of work load) decrease to acceptable levels. It should be noticed that this work load factor is also mentioned by Monod and Lille as the type of body movements, but it is not stressed in the same way as by Koten, who is writing for medical doctors interested in problems of invalidity and rehabilitation. Thirdly, work load factors have to do with social relations as well in the work milieu as in the larger society. Fourthly, mental load factors should be mentioned. Koten makes a distinction between mental load by information transmission and by inter- or intrapersonal conflicts.

We have discussed two classifications of work load factors. A further question remains as to how one can evaluate work load. Here we want to refer to the measurement scheme put forward by Rolfe (1976). The author has proposed that work-load can be evaluated by direct performance measures, but they need to be supplemented by the following additional measures:

1. observational analysis of the subject's performance (using check-lists,

* In a study on automobile assembly lines (Marcelin 1975) it was discovered that, seemingly through a process of self selection, older workers left some work places for which the biomechanical work load was too high. For these work places (placing of seats and internal coverings) the mean age of the workers was 33 years; in work places where large carbody parts were assembled the mean age was 39 years.

- films, tape recordings, trained observer's records, etc.);
2. subjective assessments obtained from the operators themselves (using prepared questionnaires, rating scales, check-lists, etc.);
 3. additional performance measures using loading tasks (i.e. an additional standardised task, e.g. mental arithmetic, is performed simultaneously with the primary task under study and from the second task measures are derived to indicate the extent of load imposed upon the operator by the primary task.);
 4. physiological measures (i.e. the effort expended by the operator in meeting the demands of the task is assessed in terms of the physiological activity, e.g. heart rate, exhibited during the performance of the task).

But Leplat (1978) has expressed the idea that before deciding on techniques to measure work load we have to analyse the work i.e. to discover what is really going on when someone is performing a given task. Only in this way it is possible to discover indices of work load that are pertinent ones. For instance the oxygen consumption is probably no pertinent work load index for an office worker.

Leplat is classifying possible work load indices in the following way:

1. Indices related to the functioning of the organism:
 - a. energy expenditure,
 - b. heart rate and respiratory rate,
 - c. sinus arrhythmia,
 - d. blood pressure,
 - e. electroencephalogram,
 - f. electromyogram.
2. Indices related to the interaction between organism and environment:
 - a. posture e.g. distance between eye and task,
 - b. speed, accuracy, errors.
3. indices related to the degree of adaptation to the task:
 - a. degree of automatisisation of movements,
 - b. types of cognitive processes.

4. Indices related to the feeling of effort.
5. Indices obtained by indirect methods (e.g. subsidiary tasks).

Leplat is also giving a classification of work load factors:

1. Factors related to the requirements of the task:
 - a. e.g. short cycle times,
 - b. uniform content.
2. Anatomical and physiological factors:
 - a. biometrical and biomechanical factors,
 - b. fatigue,
 - c. age, handicaps, use of alcohol.
3. Physical and chemical environmental factors.
4. Psychological factors:
 - a. skill,
 - b. personality:
 - anxiety,
 - introversion-extraversion,
 - motives and attitudes.
5. Social factors:
 - a. organisation,
 - b. activities outside work.

Thus, according to Leplat work load factors are extremely diverse, and this fact indicates the complexity involved in measuring work load.

Our terminology

Discussion on work load, as mentioned earlier, can raise problems of terminology. So let us give some clarification of the terminology we are going to use in this work.

Instead of external work load we are going to use the term stress and for internal work load the term strain. We shall interchangeably use

the terms external work load and stress and similarly the terms internal work load and strain. In the title of the thesis we have used the general term "work load" (meaning as well external as internal work load or in other words, as well stress as strain).

The term stress has first been used in biological science by Selye (1936) in a very specific way to indicate a stereotyped endocrine response of the organism to anything that represents an exacting task or a dangerous situation. The latter were called stressors.

The term stress has been taken up by psychologists and sociologists as a generic term for all sorts of threatening factors (e.g. Dirken, 1967). Actually most of these factors cause in some people at some time a stress syndrome (see studies by Levi, 1972). Quite recently different authors have started changing the terminology. They use the term strain for the stress syndrome and the term stress instead of stressor. Let us quote Selye (1964) to explain the reason for it: "... stress is the condition existing in elastic material when the strain of an external force acts upon it. Had my English been better ... , I should have called my phenomenon the 'strain syndrome' and that which causes it 'stress'."

Singleton (1974) points out that psychologists have recently tried to distinguish between stress and strain in a way analogous to that in which engineers use these terms, that is stress is the imposed situation and strain is the individual's reaction to the situation.

Wilkins (1974) viewed that ergonomists like to limit the use of stress to the demands or threats, which impinge upon the organism and to prefer the term strain for the resulting efforts of the organism to adapt to the stress.

Strictly speaking we should use the term stress only for those factors that impinge on the worker and that may cause strain. By strain we understand all the physiological and psychological effects caused by stress in the organism.

It should be noted emphatically that stress and strain are not necessarily to be considered as unacceptable. It may further be argued that even for high levels of stress and strain the eventual acceptability should be a matter of a cost-benefit accounting decision process.

CHAPTER II

WORK LOAD IN SHORT-CYCLED REPETITIVE WORK

Introduction

In this chapter we try to define short-cycled repetitive work, give a brief historical review of the development of such work, discuss problems of work load in repetitive work and means of solving such problems.

By short-cycled repetitive work we refer to the type of work in which a given sequence of movements is repeated over and over again with quick succession. In general, the main characteristics of this type of work are: repetition of the same sequence of movements and short cycle time, i.e. short duration of sequences (e.g. in most cases it varies from 0.5 s to 2 min).

The development and application of the principles of efficient work flow, division of labour etc., led to the widespread establishment of mass and flow production systems, which are mainly characterised by repetitive work (Wild 1972). Although short-cycled work may be considered as the ultimate result of the process of division of labour, yet such process has not led to the growth of an extreme type of repetitive work, except in industrial cultures. It may be argued that up to some point all work is repetitive. For instance, the primitive blacksmith making lances or other weapons is also doing repetitive work. But in this case the cycle time is long, some hours may go by before he restarts the same operation or he may work only after receiving an order from a known person, say a neighbour.

With the development of industry at the end of the 18th century, organized systems of production, working for an anonymous market came into being. In these organizations some splitting up of work into very small

parts was advantageous from a production point of view. For instance a jacket may be made by one person and in that case he needs much skill and hence long training. But in mass production systems, layers of cloth are cut (by machine) following a given pattern. The pieces are assembled by many people. Each person has always to perform the same small task which he can learn in a short time (i.e. in a few days). In this example people are not necessarily pressed by the pace of a machine although they may have to reach some production standards.

A further development is marked by the use of conveyor belts to form an assembly line in which every activity is very precisely timed. The period from the end of the nineteenth century to the middle of this century saw the firm establishment of the assembly line as a production system and the beginnings of partially automated assembly systems (Bright 1958).

The concept of the moving assembly line was first introduced by Henry Ford in his automobile industry in 1914 (Chinoy 1964). By the year 1915, moving assembly at Ford spread from the magneto line to chassis assembly and to the assembly of body. Labor time in assembly dropped from 12 hours 28 minutes to 84 minutes per chassis in seven months. So the assembly line may be considered as one of the landmarks in manufacturing history (Bright 1958).

This development passed through a series of rapid refinements (e.g. integrating the body and chassis assembly through the body drop operation) but still was far from perfect. Now over 60 years later, the assembly line embraces essentially the same concept but is not yet fully automatic. Many functions on automobile assembly lines have been mechanized to the extent of using power screw drivers, power wrenches, conveyORIZED delivery of parts, multiple power spindle nut runners to tighten several nuts at once, automatic tire mounting, etc. But till now, in most cases the best example of short cycled repetitive work can be found in automobile industry.

It may be remarked that short cycled repetitive work can also be found outside manufacturing industry but in such cases succeeding cycle times

are not identical as in industry. For instance, the work of a cashier in a supermarket or that of a clerk on a visual display keyboard in a bank office may also be considered as short cycled. But in these examples the time pressure may be different from that imposed by a paced machine. On the other hand work load in unpaced tasks may be higher if the worker wants to go very fast e.g. to earn a bonus.

The problems of short cycled repetitive work have mainly been studied from two viewpoints. The first group of researchers were mainly interested in studying the perceptual motor skills involved in such work. Their approach is sometimes simply mechanistic, in other cases rather psychobiological in the sense that they are only interested in those aspects of workers' behaviour that seems largely determined by biological or nervous system's factors, without taking into account workers' feelings about their work and the possible long range consequences of these feelings.

The second group of researchers, mostly social psychologists and sociologists, are interested exclusively in the latter aspects: the psychological meaning of such work to the worker.

People who were concerned about the question of skill in short-cycled repetitive work, considered this system as a fundamentally good one and were interested in its amelioration. They attached much importance to the problems of right pacing of assembly line, administration of rest pauses etc. Some of these work study people, as we may call them, considered the worker as a sort of robot.

On the other hand, people who were interested in the psychological meaning of short-cycled repetitive work were concerned about the detrimental effect of such work on the worker. They attached much importance to the problems of stress, job satisfaction, monotony, mental health, etc.

Let us discuss these two viewpoints in somewhat more detail.

Short-cycled repetitive work studied as a perceptual motor skill

We have already discussed in brief the contribution of the American industrialist Henry Ford in introducing conveyor belts in automobile assembly.

Taylor's historic contribution in organizing work tasks into the smallest detail is also widely acknowledged. Taylor was concerned primarily with workers who performed routine manual tasks. He seems to have considered such workers' movements similar to those of a machine. These movements could therefore be planned so as to involve the most efficient use of energy. Taylor's work has been the basis of what may be considered as a sort of movement, that has got the name of "scientific management". This term was first used in 1910 by one of Taylor's followers. Taylor, working as an engineer in a steel plant at the end of the 19th century was stuck by the inefficient way much work was being done there. So his aim was to increase efficiency. He tried to do it in two ways, first by stimulating workers to using their physical energy in a more rational way and secondly by motivating them. He proceeded by finding the proper method of doing a given piece of work, training the worker how to do it in the right way, setting a definite time standard for accomplishing the work, and then paying the worker a premium in the form of extra wages for doing the task as specified. This line of work has come to be known as time study.

During his many years in industry Taylor carried out extended investigations in order to determine the best method of doing work and to obtain specific data for standardizing a task. In order to illustrate his approach we will briefly describe one of his well known studies: investigation of shoveling. In 1898, when Taylor went to the Bethlehem Steel Works, he undertook to improve work methods in various parts of the plant. One task that attracted his attention was shoveling. About 600 men were employed in this work. Taylor found that shovelers were lifting loads of 3.5 pounds when handling rice coal and up to 38 pounds when moving iron ore. He tried to determine what shovel load permitted a first-class shoveler to move the largest quantity of material in a day. He took two good shovelers and detailed two time study men with stop watches to study the

work of these men. At first large shovels were used so that heavy loads were taken. Then the end of the shovel was cut off to permit a smaller shovel load, and again the tonnage handled was noted. This procedure was continued from very heavy shovel loads to very light ones. The results of this study showed that with a load of 21 1/2 pounds on the shovel, a man could handle a maximum tonnage of material in a day. Thus, a small spade that would just hold 21 1/2 pounds was provided for the worker when he handled ore and a large scoop was provided when handling light material such as ashes. After 3 1/2 years Taylor was doing the same amount of work with 140 men as was formerly done by 400 to 600 men. He reduced the cost of handling material by 50 %.

Barnes (1964) has commented that one cannot read Taylor's investigations in shoveling without realizing that he was a scientist of high order. He has further pointed out that for Taylor, time study was a tool to be used in increasing the over-all efficiency of the plant, making possible higher wages for labour and lower prices of finished products to the consumer.

But there is a great deal of criticism against Taylor (see e.g. Hoxie 1915 and Farmer 1921). Trade unions have criticised him for merely trying to squeeze more work from the employees and destroying their solidarity by introducing bonus system.

From a scientific point of view, his method has often been criticised for not being quite scientific. Taylor seems to have an atomistic view on human behavior. Human activity, in his view, is built up by independent units with additive properties. Smader and Smith (1953) have proved that this view is not true. They have shown that the time taken by an element in a sequence of movements is determined by preceding and following elements. Discarding an element because it is seemingly unnecessary may shorten or sometimes lengthen the complete sequence.

Another criticism is that in studying movement, he has ignored inter-individual differences. Interindividual differences in speed are very important in organizing assembly lines. For some workers the set times may be comfortably long, for others they may be too short. Thus the former gets a short rest pause at each cycle but the latter does not get such pause.

Taylor is also criticised for using only one criterion of work evaluation, i.e. production, and ignoring other criteria such as fatigue, work satisfaction, physiological effects etc., which are presently used.

Besides Taylor, two other persons who made historic contributions in this field are Frank Gilbreth and his wife Lillian Gilbreth. They became mostly interested in the nature of the movements of different parts of the body during work. They tried to modify movements and to replace some movements by more efficient ones. They wanted to analyse movements into their elementary constituent parts called therbligs (anagram of Gilbreth). Their aim was to find "the one best way" for each task. This line of work is known as motion study. The method used in these studies was careful observation of work with the help of chronometers, photo- and cine-cameras, and trying out alternative modes of operation.

Commenting on time study and motion study Barnes (1964) states: "Today the controversy over the value of using either the one or the other of the two techniques has largely passed, and industry has found that time study and motion study are inseparable, as their combined use in many factories and offices demonstrates."

A number of general principles, evolved from time and motion study has been summarized by Barnes (1949) as follows:

1. Smooth and continuous motions of the hands are preferable to zig-zag motions or straight-line motions involving sudden and sharp changes in direction.
2. Arm motions should be made in opposite and symmetrical directions and simultaneously.
3. The two hands should begin as well as complete their motion at the same time.

Time and motion study has made universal impact and has been widely accepted. Concerning the wide acceptance of time and motion study and especially its acceptance in Russia by Lenine, Kakar (1970) states, "The fact that both a conservative bourgeois regime in France and a revolutionary regime in Russia propagated Taylor's system should not be a surprising one. To them, Taylor's work was a part of technology with its implications of universality and neutrality".

In different countries different time and motion study systems have been developed (e.g. the REFA system in Germany, the M.T.M. system, etc.). Attempts have been made to identify work load factors in short-cycled repetitive work within the frame of reference of this work-study philosophy (i.e. without taking explicitly into account the problems created by the meaning or the absence of meaning of this type of work to the worker). A frequently identified work load factor in repetitive work is, of course, too short cycle time. In a field experiment by Wagret (1964) in a small engineering plant in Switzerland, a shortening of cycle times led after a few weeks to nervousness, sleep difficulties etc. Veil (1964) drew attention to the fact that people doing short cycled repetitive work break down easily when other difficulties (e.g. familial ones) are upsetting them.

Some difficult movements required by such work may lead after a few years to joint lesions.

Short-cycled repetitive work and its psychological consequences

Since the late 1960's, an intense debate has been developed concerning the question of industrial work and stress associated with it. Work stress, it is thought, can give rise to low job satisfaction, and to poor physical and mental health (Cox et al. 1979). Not surprisingly, simple repetitive work has given rise to much concern. It is often described as boring or monotonous and has been cited as the major source of workers dissatisfaction, alienation and poor mental health (e.g. Walker 1950, Walker and Guest 1952, Guest 1955, Blauner 1964, Kornhauser 1965, Gardell 1971 and 1973, and Jessup 1974). Quite recently, Cox and Mackay (1979) have studied the impact of repetitive work from the point of view of stress. They point out that the worker who carries out repetitive work, in most cases, has no control over the pace of that work and little opportunity to decide how (s)he actually does it as this power is often vested with the machine.

Attempts have been made to solve the problems of short-cycled repetitive work mainly through automation and work restructuring, where automation is not possible or not (yet) wanted for other reasons.

Automation

One of the best possible solutions to the problems of short-cycled repetitive work seems to be automation, which may be considered as a logical development of the principles of mass production systems. Faced with steadily rising labour costs in industry, the Western world has increasingly turned to automation, while additional potential benefits include improved product quality, the removal of operators from hazardous operations and a reduction in floor space required for assembly lines (Prenting 1966). Besides economic considerations, the levels, expectations, values and motivational factors of the working population in industrialized countries have changed in a manner likely to affect the willingness of workers to accept the requirements of short-cycled repetitive work. These factors have made the arguments for automation stronger, where technology is suitable (Buxey et al. 1974).

Work restructuring

Although criticism of short-cycled repetitive work has been going on for many years, it is only recently that companies have begun to experiment with work restructuring as one of the solutions to the problems of repetitive work. The restructuring and replacement of assembly line work has been pioneered largely by industries engaged in the manufacture of comparatively small products, and only recently automobile industry, for instance Volvo (Windholm et al. 1975), begun to experiment in this area.

The proliferation of literature relating to the restructuring of work has led to some confusion in this area (Buxey et al. 1974). However, the following terms are generally used:

Job enlargement — The addition of one or more related tasks to a job (e.g. instead of staying at one station and completing one-third of a set of operations on every car, doing the complete set of operations on every third car). This process is sometimes also called horizontal job expansion. The intention is to break monotony and reduce time pressure by lengthening cycle times. There can be some widening of interest.

Job rotation — The movement of operators between different jobs. This is usually done at regular intervals ranging from a few hours to several weeks and is sometimes arranged on a less formal basis. In this way the operators learn to perform various jobs. Apart from increasing variety, job rotation provides to some extent opportunity for learning, greater use of skill, etc.

Job enrichment — The addition of tasks and/or responsibilities which increase job variety and challenge and improve worker's motivation. This process is also called vertical job expansion. A job may be enriched by an individual undertaking a greater responsibility, for instance by organising and checking his own work, or by being involved in decisions about planning, scheduling, setting own work pace and organizing the work of his own unit.

The arguments supporting job restructuring by these means have been put forward by several researchers (e.g. Ford 1969, Lawler 1969, Sheppard and Herrick 1972). Job restructuring in general has led to the reorganization of assembly line work, through for example reduction in line length and increase in cycle time (e.g. Van Beek 1964) and the introduction of job rotation (Philips 1969).

However, in some cases the solution to the problems of short-cycled repetitive work by means of automation is not possible because it requires big investments.

On the other hand, work restructuring may also prove difficult in cases where the short-cycled repetitive work is a highly skilled one. This was the case of the short-cycled repetitive work we have studied. In our case job rotation seems not possible, firstly because this job requires quite a long time to learn and secondly, no similar job is available for rotation.

CHAPTER III

DESCRIPTION OF THE CIGAR MAKING TASK

In this chapter we shall give a brief introduction to the cigar factory where this study was conducted, and describe the selection of the workers, the wage system, the work schedule and the production process. These will be followed by a somewhat more elaborate description of the cigar making department, the cigar machines and the cigar making task.

The present study was conducted on the workers of the cigar making department.

The factory consists of the following production departments:
1. filler department, 2. bunch department, 3. wrapper leaf treatment department, 4. cigar making department, 5. wet powdering and packing department and 6. finishing department.

The number of persons working at the beginning of 1977 in the different production departments of the factory is shown in Table III-1.

Table III-1. Number of male and female workers in the different production departments of the cigar factory.

Departments	Number of male workers	Number of female workers
Filler department	17	2
Bunch department	4	25
Wrapper leaf treatment department	5	43
Cigar making department	15	235
Wet powdering & packing and Finishing department	8	69

Selection of the workers

The workers of the cigar factory are selected by the management on the basis of a performance test (the lathe-test). The applicants are classified into three grades (i.e. "not good", "good" and "very good") on the basis of their scores on this test. Those applicants who get less than 45 in the selection test are classified into "not good" grade and they are not selected. The applicants who get 45 or above are selected and among them who get between 45-55 are classified into "good" grade and who get above 55 are classified into "very good" grades.

It may be mentioned here that though the problems of reliability and validity of the selection test used by the management for selection of the workers do not come within the scope of the present study, still Spearman's rank order correlation was computed between selection test scores and performance scores of the subjects of the present study, just to see whether performance is correlated to selection test scores. But the correlation was not significant ($N = 35$ *, $\rho = -.10$).

Wage system

There is a minimum production standard, set by the management, for each type of tobacco leaf on which the workers get a minimum hourly wage. However, this minimum production standard differs with different types of tobacco leaves depending on their quality. From this minimum value on, the workers can earn a linearly increasing bonus amounting to a maximum of 12 % of the basic hourly wage. For example, to earn this 12 % more they have to produce nearly 60 % more cigars per hour.

Work schedule

Most of the workers of the cigar making and the bunch making departments and the workers of the machine stripping section of the wrapper leaf department work according to a two-shift system. The workers of all other departments are working according to fixed hours (without shift).

* Five of the 40 workers (who took part as subjects in the present study) were enrolled without selection test.

The non-shift workers are called "day-workers". The work period for the day workers starts at 07:45 hours and continues up to 16:25 hours with 40 minutes rest pause from 12:00 to 12:40 hours. For the shift workers, the first shift starts at 06:00 hours and continues up to 14:00 hours with a break of 30 minutes from 09:30 to 10:00 hours and the second starts at 14:00 hours and continues up to 22:00 hours with a rest pause of 30 minutes from 17:00 to 17:30 hours. The shift workers are rotated from one to the other shift every week and this changeover takes place at the beginning of each week. For the shift workers, the work schedule consists of 7 1/2-hour days excluding 30 minutes rest pause and 5-day weeks. For the non-shift workers the work schedule consists of 8-hour days excluding 40 minutes rest pause and 5-day weeks.

The production process

The production of cigars is carried out through the above mentioned production departments. The processing of cigars through the different departments is shown in Figure III-1.

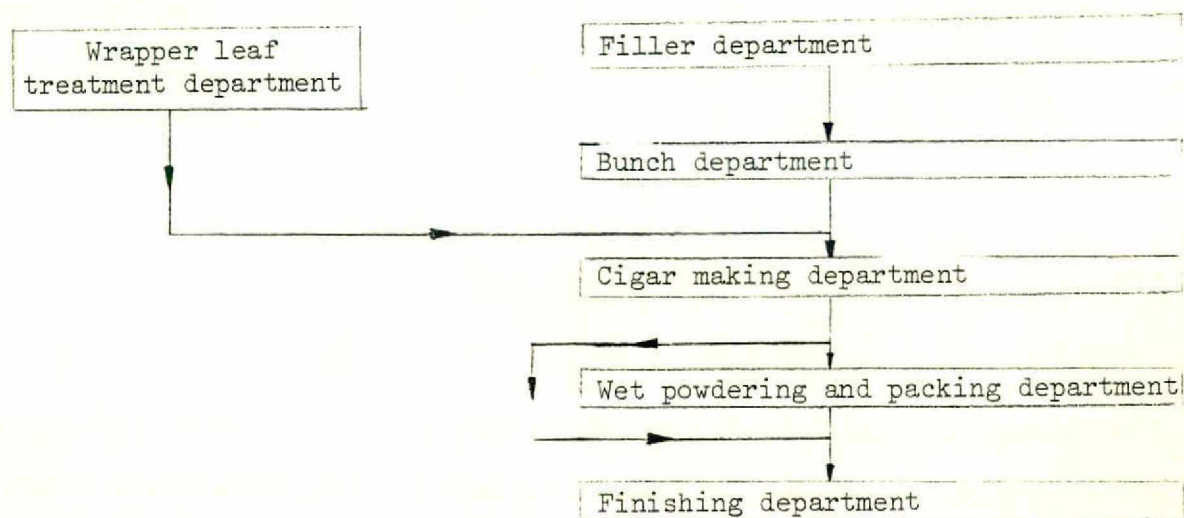


Figure III-1. Flow diagram showing the different production departments of the factory.

The first stage involved in manufacturing cigars is filler making, which is done by the filler department. The filler is the inner core which forms the body of the cigar. It is made of cut pieces of tobacco leaves of various types. The filler department is responsible for the blending of the filler to right proportion in order to assure uniformity and secure flavours and qualities.

The second stage is binding the filler which is done by the bunch department. The binder is the sheet consisting of 50 % tobacco powder and 50 % glue in which the filler is rolled and wrapped to form the cigar bunch.

The next stage is the preparation of the wrapper, which is done by the wrapper leaf treatment department. The wrapper is the outer covering of the cigar consisting of a ribbon of leaf rolled spirally around the cigar bunch. To prepare the wrappers the leaves are softened by a moisture for stemming them, i.e. removing the stalks or midribs.

The next stage is rolling the wrapper leaf spirally around the cigar bunch which is done by the cigar making department. Thus a cigar is made by wrapping a binder sheet around a bunch of cut filler leaf and overwrapping with a fine wrapper leaf. Since the workers of the cigar making department form the subjects of the present study, a detailed description of the workers of this department and of the cigar making task will be given in the following section.

Wrapped cigars then go to the wet powdering and packing department, where cigars are polished with wet powder made of tobacco dust and alcohol. Polishing with wet powder covers leakages on the wrapper leaf and make the cigar shiny. After wet powdering, cigars are dried and packed in boxes made in the same department.

At the final stage the cigars go to the finishing department, where labels indicating number of cigars in the packet, price rate, etc., are pasted on the packets. Boxes are wrapped and sealed with cellophanes. It may however, be mentioned here that a certain kind of products, for example small size cigars, are not wet powdered. Firstly, because they

are wrapped with very fine tobacco leaves and secondly, to meet the demands of the consumers with different tastes. So, this kind of products are not processed through the wet powdering department, instead, they are sent to the finishing department directly from the cigar making department.

The cigar making department.

The cigar making department consists of 250 workers, 15 of them are male and 235 are female (see Table III-1). The male workers are employed for repairing and maintaining the machines and the females for making cigars. The female workers are between 17 and 56 years old and have from 1 to 30 years of experience.

The cigar making department is considered by the management as very important for the production of the entire factory. The greatest number of workers belong to this department (see Table III-1). Moreover, the problems of absenteeism and labour turnover are the greatest in this department. For example, the rates of absenteeism of the workers of this department in the years 1975 and 1976 are 6.09 % and 8.61 % respectively, whereas, the rates of absenteeism of the workers of the entire factory for the years 1975 and 1976 are 5.67 % and 7.88 % respectively. Similarly, the rates of labour turnover of this department in the years 1975 and 1976 are 16.4 % and 11.9 % respectively, whereas the rates of labour turnover for the entire factory for the years 1975 and 1976 are 13.3 % and 10.62 % respectively. The management has, reportedly, received a greater number of complaints of heavy work load from the workers of this department.

Cigar machines

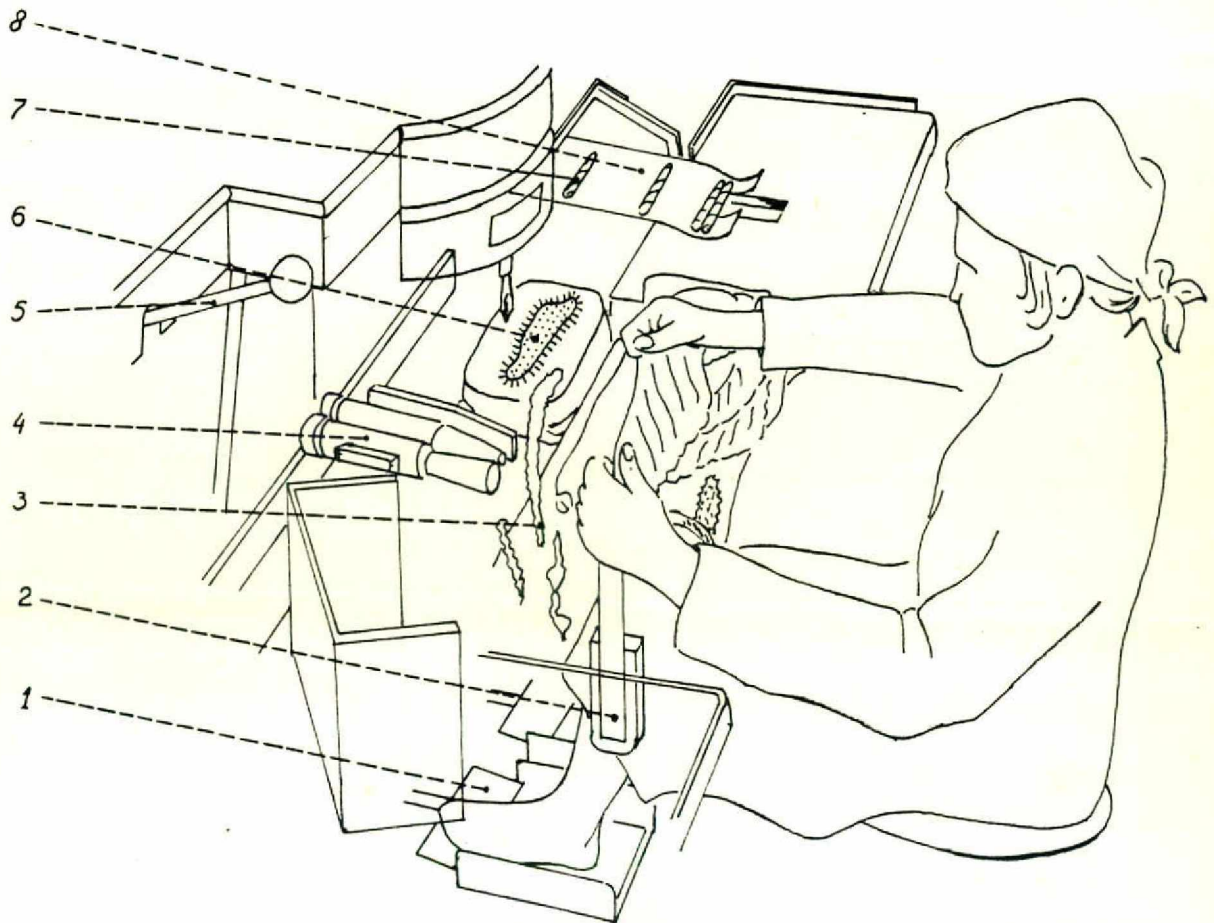
The cigar making machines of the factory are mainly of two types, i.e. machines producing a single cigar in every cycle and machines producing a double cigar in every cycle. There are some other variations in both the single cigar making machines (S.C.M.) and the double cigar making machines (D.C.M.), such as machines with tray filler and without tray filler, and machines with air stream and without air stream. The machines with tray

filler have an automatic device through which finished cigars automatically roll down and fall in a tray. The machines without tray filler have no such device and the workers working with these machines have to pick up finished cigars with their hands and to put them into a nearby box. The machines with air stream have an automatic device for blowing away the tobacco waste by pressing a knee lever (see Figure III-2). The machines without air stream have no such device and the workers operating those machines remove the fragments of the used tobacco leaves with their hands and put them into a box placed nearby.

Different types of machines, mentioned above, have different cycle times. A detailed list of different types of machines and their cycle times is given in Table III-2.

Table III-2. List of different types and numbers of cigar making machines and their cycle times.

Main types of cigar making machines	Subtypes of cigar making machines	No. of cigar making machines	Cycle time of cigar making machines
Single cigar making machines (S.C.M.)	S.C.M. with tray filler and with air stream	16	20 cycles per minute
	S.C.M. with tray filler and without air stream	1	20 cycles per minute
	S.C.M. without tray filler and with air stream	9	18.7 cycles per minute
	S.C.M. without tray filler and without air stream	17	18.7 cycles per minute
Double cigar making machines (D.C.M.)	D.C.M. with tray filler and with air stream	5	17.6 cycles per minute
	D.C.M. with tray filler and without air stream	0	---
	D.C.M. without tray filler and with air stream	31	16 cycles per minute
	D.C.M. without tray filler and without air stream	23	16 cycles per minute



1. Pedal; 2. Knee lever for waste blowing device; 3. Fragments of used tobacco leaves; 4. Cutting roller; 5. Handle for stopping the machine; 6. Die; 7. Wrapped cigars; 8. Conveyor belt.

Figure III-2. Cigar making machine used in the factory.

Cigar making task

The task of the workers consists in feeding machines with tobacco leaves for wrapping and finishing cigars. The task is machine paced but the machine can be stopped at any point in its 3 seconds cycle by pressing a pedal. This short cycled repetitive work seems quite different from common assembly tasks in which the parts to be assembled are always identical. Tobacco leaves, being biological products, are quite variable. So at every cycle of the machine the workers have to make a decision about the exact positioning of the tobacco leaf on the wrapper die in order to make as many wrapping pieces as possible from the leaf. Immediately after placing a leaf on the die, the workers have to take away their hands and let the cutting rollers pass over the die, and then they have to replace and readjust the leaf on the die for the next cutting and so on (see illustrations in figures III-3, III-4, III-5 and III-6).



Figure III-3.

The worker is placing a tobacco leaf on the die in such a position that as many cuttings as possible can be made from the leaf.



Figure III-4.

The cutting rollers have cut the tobacco leaf placed on the die and left the die. The worker is about to remove the waste of tobacco leaves from the die to make it ready for placing another leaf on it before the cutting rollers come back again.



Figure III-5.

The worker is taking another tobacco leaf from the bundle and checking it before placing it again on the die.

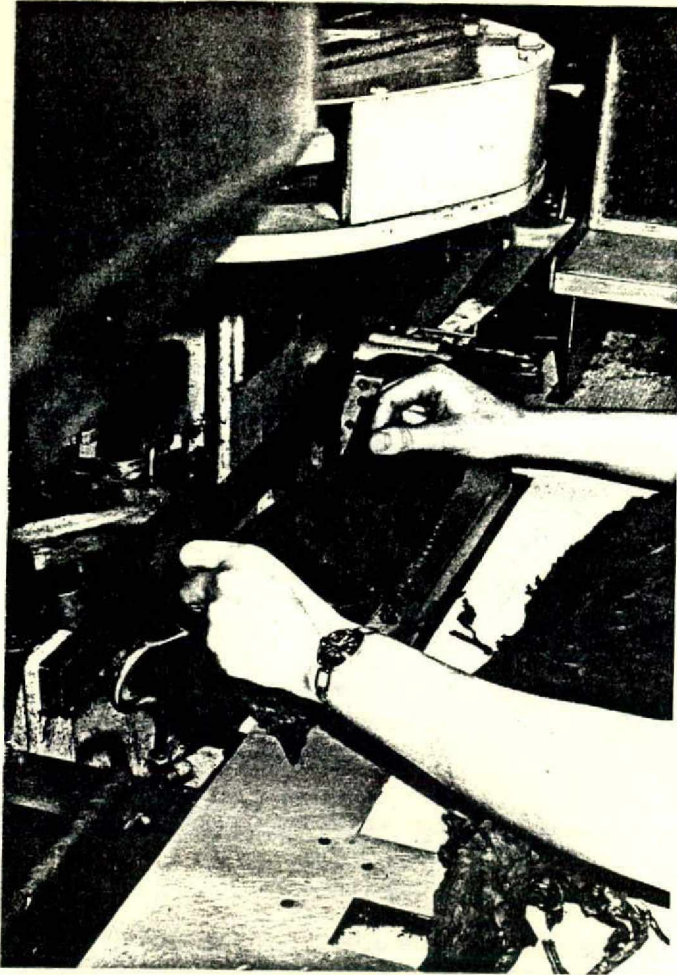


Figure III-6.

The worker is placing the tobacco leaf again on the die.

Thus within a brief cycle of 3 seconds, the workers have to check a tobacco leaf, to place it on the die in proper position, to remove the hands from the die, to check cutting and gluing of wrapper leaf, to inspect wrapped cigars, to remove waste of tobacco leaves from the die either manually or by pressing aside the knee lever of the waste blowing device, to transfer wrapped cigars from the bowl at the conveyor belt to the tray manually or to monitor the automatic transfer device, etc. The task seems to require a high degree of sensori-motor skill and appears to put heavy load on the workers.

CHAPTER IV

PLANNING OF RESEARCH AND
DIFFICULTIES OF FIELD RESEARCHOrigin of the present study

This research project, on the problems of short-cycled repetitive work, originated from a selection problem in the cigar factory, described in Chapter III.

The factory, as already mentioned in Chapter III, was facing some problems of labour turnover, absenteeism etc. The management considered these as selection problems and wanted to make a reappraisal of the selection procedure. We visited the factory and got the impression that the work was quite difficult for any average individual. Besides the selection problem, which we studied later on (we found that the test used was not a valid one), it appeared to us that there were some problems of work load and work design. Thus we decided to study these problems and started analysing different aspects of this work task.

Aims of the present study

To understand some aspects of this work, we wanted to study and compare two groups of workers (i.e. high and low performance workers) doing this seemingly difficult task.

It may be mentioned here that this was an exploratory study and we did not have any clear cut hypothesis. Nevertheless our aims were to find answers to the following questions:

1. Is there any difference between the high and low performance workers in job satisfaction?
2. How are these two groups of workers doing their work?

- a. Is the work cycle time of the high performance workers different from that of the low performance workers?
- b. Are there differences between these two groups in their numbers and durations of machine stoppages?
- c. Are there differences in numbers and durations of stoppages between morning and afternoon shifts within each of the high and the low performance groups?
- d. Do the rest pauses have any influence on the number and duration of machine stoppages of these two groups?

3. How far do the high and low performance workers differ in strain resulting from this work?

4. Are satisfied workers reacting differently from dissatisfied workers (i.e. strain in the satisfied and dissatisfied workers)?

To find an answer to the first question, we have studied and compared job satisfaction of these two groups of workers. Results will be given in Chapter VI.

With regard to the second question, we wanted to measure the work cycle time of the high and low performance subjects but following the advice of Singleton (1976) we did not measure it (somewhat more elaborate explanation will be given in Chapter VII). Instead of it, we have registered the numbers and durations of machine stoppages for 7 1/2 hours excluding 30 minutes rest pause, once during the morning shift and once during the afternoon shift, for each of the high and low performance subjects. Results will be given in Chapter VII.

Relating to the third question, we have assessed and compared the strain in the high and low performance workers. Results will be given in Chapter VIII.

Concerning the fourth question, we have compared strain in the satisfied and dissatisfied subjects. Results will be given in Chapter IX.

Difficulties of field research

We have studied the problems of this short cycled repetitive work in a field condition.

Several researchers (e.g. Harlow 1953, Hartnett and Murrell 1973) have emphasized the need for field research in solving real life problems. But the problems one faces in conducting field research are in fact enormous. In describing the difficulties of field research, Radloff (1973) states:

"A few years ago, a bright but discouraged young researcher delivered an interesting paper at a human factors conference. He presented an impeccably neat factorial design with which he proposed to measure the performance of a new sensing device in guiding high speed aircraft to their targets. Before giving the results he presented a fairly long and pathetic apologia detailing a variety of predictable real-life interferences that had hopelessly confused the neat cells of his experimental design. The error term in his analysis of variance was enormous. He concluded with an observation somewhat as follows: 'An investigator going into the field can rely on only one thing, the utter and complete dissolution of his experimental design.' " Commenting on this problem, Radloff (op cit) points out that the proper response to this state of affairs is not to abandon field research but to recognize the fact that the appropriate experimental design in field studies exists in naturally occurring variables that are imposed with greater force and fidelity than a researcher can possibly produce in a laboratory condition. He observes that in order to be successful, the investigator must design studies so that the naturally existing requirements of the situation work for rather than against him. Radloff further remarks that with the development of new methods and tools for data collection and analysis (e.g. camera, tape recorder, television, sophisticated electronic equipments), it is more feasible now than before, although still difficult, to conduct sophisticated field studies.

Chapanis (1967) has pointed out that it is quite difficult to get significant results in field studies because of large error variances due to the influences of extraneous factors which are not possible to control. On the other hand, it is easier to get significant results in laboratory experiments due to better control of variables. However, he has put forward

a number of criticisms against laboratory experiments which we will briefly discuss at the end of this chapter.

Hartnett and Murrell (op cit), summing up the experience of field research well over 20 years, have identified some characteristic problems of field studies, which often create difficulties in meeting the requirements of a good experiment:

Management

It is frequently difficult to find managers willing to expose their organisation to experimentation. In some cases, a condition is made that there should be no interference with production. Sometimes explicitly or implicitly the management intends to have some particular point proved, for example, the capacity of employees to cope with increased machine speeds. Any attempt on the part of the management to manipulate things in order to prove their points may make the results of the experiments meaningless.

Trade unions

In some cases the unions are suspicious about the objectives of the researchers and do not want to cooperate unless they feel certain that the results will not create any difficulty for their members and anonymity will be maintained.

Shop floor

Without the cooperation of the shop floor, the support of the unions and management can be of little or no use in creating favourable conditions for a good field study.

Lack of uniformity and poor records

Production figures constitute another problem which is beyond the control of the researcher. These include lack of standards or variable standards of quality control. Comparability can be very difficult, if not impossible, where there is batch production because of dependence on work study values which vary from batch to batch. Yet another problem is poor personnel records which is especially disruptive when biographical details

are required for matching of subjects.

Hartnett and Murrell (op cit) observe that in spite of these difficulties one should try to control and reduce unwanted error in the results of field studies by using the following techniques as much as possible:

1. stratified or random sampling in order to avoid bias;
2. matching by using the subject as his own control or by randomising to avoid biased assignment;
3. careful experimental design to avoid confounding the independent variables when the effects of a number of experimental conditions are examined in one experiment;
4. sufficiently precise measurement and quantification of both the dependent and independent variables in order to make a meaningful analysis and therefore a relevant conclusion possible.

Finally, they have stressed the need for follow up of field research.

Difficulties encountered during the present study

We did not face, from the management of the cigar factory, the sort of difficulties described by Hartnett and Murrell (op cit). We received every possible cooperation from the management during this study.

However, the management introduced some changes in cigar making machines (which will be discussed in somewhat detail in Chapter V) during data collection and transferred five of our subjects from shift to day work. These decisions of the management created difficulties for us and we had to drop these subjects from this study. But these changes, as we understood, were not intentional, but parts of the long term planning of the factory.

The management imposed no precondition to us concerning non interference with production during this study. But we refrained from employing any measuring technique which might have interfered with the workers' production. For instance, we did not use sophisticated heart rate measures during work and dropped the plan of using secondary task techniques for measuring strain as these might interfere with the workers' production.

We encountered no difficulties with the workers' representatives or with the workers during this study.

However, we experienced some difficulties in comparing the workers on the basis of their production because of various types of tobacco leaves would be used for making cigars and in some cases different workers would use different kinds of tobacco leaves (a detail description will be given in Chapter V).

We have experienced some problems which may be considered as specific to this study and different from those mentioned by Hartnett and Murrell (op cit). During data collection we lost 45 days due to problems in an apparatus (i.e. the punch tape data collector). This is an electronic apparatus which was very sensitive even to the minor fluctuation or disruption in the power supply of the factory. If there would be any discontinuation of electricity supply of the factory even for a very short period, at the time of registering the number and duration of machine stoppages, the timing unit of the apparatus would go back to zero (a detail description of the apparatus will be given in Chapter VII). Thus the whole day would be lost. For instance, we lost 3 days for disruption in the electric current caused by lightning in the sky.

We lost about two weeks due to the absence of some of our subjects. For registering the number and duration of machine stoppages of any subject, we would have to fix the apparatus with the cigar making machine of that subject before the start of work. If the worker would remain absent on that day without previous information then the whole day would be lost, because we would have to wait till the last moment and then there would be no time to fix the apparatus with the machine of some other subject. In some cases we had to wait for one week for only one subject. For example if any particular subject would be absent on Friday, then we had to wait for at least one week to get her in the same shift.

Limitations of laboratory research

Considering the difficulties involved in field studies, quite a number of experiments have been conducted on the problems of repetitive

work under highly controlled laboratory situations (e.g. Murrell 1963). It is true that highly controlled laboratory studies are necessary for establishing fundamental laws but they have got limited relevance to practical situations due to a number of reasons (Chapanis 1967), such as:

1. by their very nature laboratory experiments are at least only rough and approximate models of any real life situations;
2. laboratory experiments select only a few of all the possible independent variables that influence behaviour in any practical situation; as a result hidden interactions in real life may easily nullify or even reverse conclusions arrived at in laboratory;
3. methods used to present variables in laboratory are sometimes artificial and unrealistic;
4. the effect of controlling extraneous or irrelevant variables in laboratory for increasing precision of an experiment may make the effect so small that they are of no practical importance.

After surveying a number of laboratory experiments, Murrell (1968) has shown that however highly reliable the laboratory experiments may be, their validity in practical situations quite often is very low. One of the important reasons put forward by Murrell for this low validity is that performance of subjects in the laboratory may differ from that under similar circumstances in real life. It has been reported by Buckner (1963) that decrements of performance predicted from vigilance experiments has not always been confirmed in, for instance, the radar display rooms of ships. Ring (1957) has criticized the excessive reliance on laboratory studies. The internal validity of laboratory research has been questioned by Rosenthal et al. (1969), who have examined critically the problem of experimenter bias. Limited relevance of laboratory studies to the real world problems has also been pointed out by Zubek (1969).

CHAPTER V

SAMPLING OF SUBJECTS

Forty subjects, consisting of 20 high and 20 low performance workers were taken in this study. As already mentioned in Chapter III, the subjects were chosen from among the workers of the cigar making department of the factory. Information concerning working shift, experience in cigar making work, age and educational qualification of the workers was collected from the personnel records of the factory.

The subjects were divided into high and low performance groups on the basis of the production of one randomly chosen month (i.e. November) out of the entire production of the year 1975 (available latest production records for one full year at the time of the sampling of subjects at the end of 1976). For dividing the workers into the high and low performance groups, the production sheet of every worker, excluding those who were below two years of experience in 1975, was prepared. The workers who had less than two years of experience in the present work were excluded from the population in order to avoid progressive influence of experience on the work cycle time of the subjects for the present study. It may be mentioned here that a study by Crossman (1959) on the speed of operating cigar making machines revealed that improvement in cigar making performance takes place up to the period of two years of practice, i.e. the work cycle time of operators gradually decreases up to two years of practice and after two years the cycle time of the operators becomes steady and the operators come to attain a more or less stationary level of skill for their work. The fact that the work cycle time decreases progressively due to practice had already been established by De Jong (1957) in a more general way, which we shall discuss somewhat more elaborately in Chapter VII. So, out of 235 workers (see Table III-1) of the cigar making department, a total of 100 workers who were below two years of experience was excluded and the individual production record sheets were prepared for the remaining

135 workers. The individual production record sheet contains information, such as the name and token number of the worker, working shifts, types of tobacco leaves used during the said month, total number of defectless cigars produced with every type of tobacco leaves, weight of every type of tobacco leaves used for making cigars, weight of tobacco leaves used for producing every 1000 defectless cigars, total number of defective cigars produced with every type of tobacco leaves, defective cigars produced per 1000 defectless cigars with every type of tobacco leaves and working hours with every type of tobacco leaves.

The workers have to make cigars with various types of tobacco leaves, for example, as many as 27 types of tobacco leaves were used during the month of November, 1975. Tobacco leaves, being biological products, differ in size and quality and consequently the performance of the workers would differ with different types of tobacco leaves. For accurate comparison of the workers, separate record sheets of production were prepared for every type of tobacco leaf. On these sheets, the average hourly production of defectless cigars of every worker with every type of tobacco leaf was calculated to compare their rate of production of defectless cigars. Weight of tobacco leaves used by every worker for producing every 1000 cigars with every type of tobacco leaf were calculated to compare their rate of economy in using tobacco leaves for cigar making. The medians of the quantity of defectless cigars and the quantity of tobacco leaves used by the workers within every type of tobacco leaf were computed. Thus the workers were compared within each type of tobacco leaf on the basis of the two given criteria: the rate of production, i.e., the quantity of defectless cigars, and the amount of tobacco leaves used, i.e., the economy in using tobacco leaves for making cigar covers.

It may be mentioned here that the analysis of the production records of the month of November, 1975 revealed that as many as 17 workers, who were comparatively high in their production (above the median of the defectless cigars produced per hour) and also high in economy (below the median of the weight of tobacco leaves used per 1000 cigars) with some types of tobacco leaves were not consistently high both in their production and economy with other types of tobacco leaves (see Appendix A). Similarly, as many as 16 workers, who were comparatively low in their

production (below the median of the defectless cigars produced per hour) and also low in economy (above the median of the weight of tobacco leaves used per 1000 cigars) with some types of tobacco leaves were not consistently low both in their production and economy with other types of tobacco leaves (see Appendix A). Moreover, the analysis of the production records further revealed that as many as 17 workers, who were high in terms of the number of defectless cigars produced with certain types of tobacco leaves were not consistently high in economy in using tobacco leaves for making cigars with the same types of tobacco leaves and vice versa (see Appendix A).

As many as 34 workers, who were consistently high in their rate of production (above the median of defectless cigars produced with every type of tobacco leaves) and also consistently high in economy in using tobacco leaves (below the median of weight of tobacco leaves used for making cigars with every type of tobacco leaves) were included in the high performance group of population (see Appendix B). On the other hand as many as 51 workers, who were consistently low in their rate of production (below the median of the defectless cigars produced with every type of tobacco leaves) and also consistently low in economy in using tobacco leaves (above the median of the weight of tobacco leaves used for making cigars with every type of tobacco leaves) were included in the low performance group of population (see Appendix B).

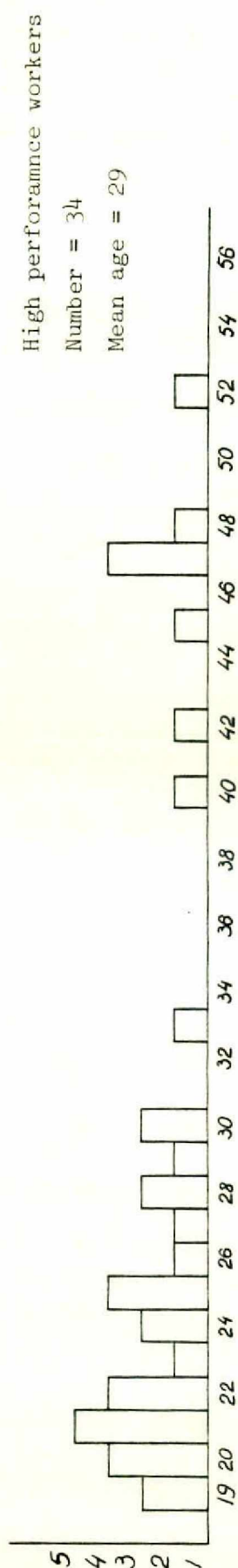
Then an amalgamated list consisting of 85 workers of both the groups, i.e., 34 high and 51 low performance workers, was given to the management of the factory to rate these workers into the high and low performance groups on the basis of the impression of supervisors about the performance of these workers. Out of 34 high performance workers, 32 workers were rated as high performers and two were rated as low performers. The two high performers, whom their supervisors rated as low performers were excluded from the high performance population. So, the high performance group of population was finally consisted of those 32 workers, who are high performers both according to the objective criterion, i.e., the performance, and the subjective criterion, i.e., the supervisors' rating. On the other hand out of the 51 low performance workers, 45 workers were rated by their supervisors as low performers and 6 were rated as high performers. The six

low performance workers, whom their supervisors rated as high performers, were excluded from the low performance population. So, the low performance group of population was finally consisted of those 45 workers, who are low performers both according to the objective criterion, i.e., the performance, and the subjective criterion, i.e., the supervisors' rating. Finally, 20 subjects were selected randomly from among the high performance group of population and another 20 from among the low performance group of population.

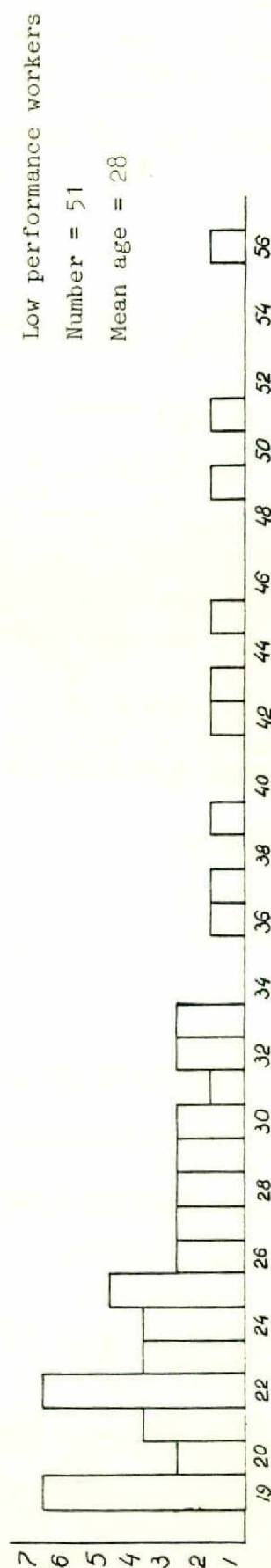
It may be mentioned here that an age-distribution table of the population consisting of 34 high and 51 low performance workers was prepared to see if the ages were distributed in a comparable way in the two groups. The age-distribution table (see Table V-1) shows that the workers of both the high and low performance groups are almost evenly distributed at different age levels. So, the subjects of both the high and low performance groups were selected disregarding their age levels.

The mean age of the high performance subjects was 29 years and their mean experience was 9 years. On the other hand, the mean age of the low performance subjects was 27 years and their mean experience was 7 years. The educational qualification of the subjects of both the high and low performance groups ranged from primary school to lower secondary school level.

It has already been described in Chapter III that the workers would operate different types of cigar making machines. Considering these variations in the types of machines, perhaps an ideal condition would be to study comparable numbers of the high and low performance subjects from among the workers of each type of machines. But this was not possible because at the time of data collection the management was transforming machines (e.g. installing air stream and automatic trayfiller devices to those machines which were without such systems). So, we had to choose 20 high and 20 low performance subjects irrespective of the types of machines they were operating. However, a subsequent distribution of the subjects according to their types of machines reveals that nearly equal numbers of the high and low performance subjects were working with each type of machines at the time of data collection (see Tables V-2 and V-3).



Distribution of age (in years) of the high performance workers



Distribution of age (in years) of the low performance workers

Table V-1. Age distribution of the population.

Table V-2. Number of subjects of high and low performance groups working with single and double cigar making machines.

	Number of high performance subjects	Number of low performance subjects
Single cigar making machines	8	9
Double cigar making machines	12	11

Table V-3. Number of subjects of high and low performance groups working with the various sub-types of both single and double cigar making machines .

	Number of high performance subjects	Number of low performance subjects
Machines with tray filler and with air stream	5	5
Machines with tray filler and without air stream	0	0
Machines without tray filler and with air stream	8	9
Machines without tray filler and without air stream	7	6

It may be mentioned here that in analysing the results of this study, a comparison has been made between the high and low performance subjects disregarding these minor variations in the types of machines they used. This was done for two reasons. Firstly, the numbers of subjects of the high and low performance groups working with each type of machines were too small to allow any statistically meaningful comparison within each type. Secondly, these variations seem to have been counter balanced by the fact that nearly equal numbers of the high and low performance subjects were working with each type of machines at the time of data collection.

CHAPTER VI

JOB SATISFACTION IN HIGH AND LOW PERFORMERS

Introduction

Job satisfaction is a very widely studied subject. According to an estimate of Locke (1976) more than 3350 articles have been published on this subject up to 1976. Despite this enormous number of studies there is still a lot of confusion about the concept of job satisfaction. Concerning this conceptual controversy, Katz and Maanen (1976) state: "There is perhaps no area in the social sciences fraught with more ambiguity, conflicting opinion or methodological nuance than that of work satisfaction. Yet, paradoxically, there are few areas more researched." Similar views have been expressed by Locke (1969) and Cope (1979). "Job satisfaction may be defined as a pleasurable or positive emotional state resulting from the appraisal of one's job or job experience." (Locke 1970). This seems to be a nearly acceptable definition. Commenting on Locke's (op cit) definition, Verhaegen (1979) states: "It seems to be impossible to arrive at any better definition because of the very nature of the subject.". But this definition is somewhat vague and non-operational. So, we shall define job satisfaction operationally in terms of a measuring instrument (i.e. the Brayfield-Rothe scale) used in this study: job satisfaction is the sum of scores obtained by the Brayfield-Rothe scale.

In this study we have used two satisfaction measures: the Brayfield-Rothe scale (Brayfield & Rothe 1951), an overall measure of satisfaction, and the Job Descriptive Index (Smith, Kendall and Hulin 1969), a measure of job facets satisfaction. But in defining job satisfaction we have referred to only one scale (i.e. the Brayfield-Rothe scale) because Ewen (1967) has shown that the sum of satisfaction scores from the five components of the Job Descriptive Index is significantly correlated with the scores of the Brayfield-Rothe scales. This fact is also supported by

the results of the present study (see Table VI-4).

The relationship between performance and job satisfaction has been a matter of continued concern to the individuals connected with the world of work. Since an initial study by Kornhauser and Sharp (1932), investigators have been searching for relationships between these two parameters. Reviews of the literature in this field indicate that the relationship between performance and job satisfaction is still far from clear (Brayfield & Crockett 1955, Herzberg, Mausner, Peterson and Campbell 1957). However, a more recent review of the literature (Vroom 1964) indicates that a low but more or less consistent relationship exists between performance and job satisfaction. Vroom reviewed 23 studies and these studies show a median correlation of $+0.14$ between performance and satisfaction and out of these 23 studies the correlation between performance and job satisfaction was positive in 20 cases and negative in 3 cases.

It is argued that the differences in the jobs studied and in the measuring instruments employed are two of the numerous causes of inconsistent findings (Locke et al. 1964). To identify precise relationships between performance and job satisfaction in different jobs, there remains the need for more research to sample different types of jobs with multiple measuring instruments. The need for more than one method of measurement of job satisfaction is also advocated by Campbell et al. (1959) and Ewen (1964). But so far, few investigators have used multiple measures of job satisfaction in their studies and compared their subjects by standardized scales of job satisfaction.

To measure job satisfaction of the subjects of the present study, as already mentioned, we have used two tests: the Brayfield-Rothe scale and the Job Descriptive Index (JDI). These two instruments are of particular interest in this regard because of their repeated and extensive use by the investigators in this field.

Method

Subjects

A total of 40 subjects (20 high and 20 low performers) was originally chosen for this study (a detail description of the subjects and the sampling procedure is given in Chapter V) and all of them were present during administration of the job satisfaction tests. The job satisfaction tests, as already mentioned in the introduction, were given in the beginning of this research project. But in case of all the other tests, administered subsequently, some of these subjects had already left the job. So the number of the subjects for those tests was less than forty.

Measures of job satisfaction

In the present study we have used the Dutch versions of the Brayfield-Rothe scale and of the Job Descriptive Index (see Appendices C and D). We have got the Dutch version of the Brayfield-Rothe scale in the thesis of De Brabandere (1971). The Dutch version of the JDI was prepared by Koene and his students (Bollen 1970).

The Brayfield-Rothe scale

This is a questionnaire consisting of 18 items dealing with an individual's feelings towards his job as a whole. Each item could be replied by checking any one of the five possible answers: "strongly agree", "agree", "undecided", "disagree" and "strongly disagree". The items were selected in such a way that the satisfied end of the scale was indicated by "strongly agree" and "agree" for one-half of the items and by "strongly disagree" and "disagree" for the other half. The neutral response was "undecided". The items at the satisfied end receive 5 points for "strongly agree", 4 for "agree", 3 for "undecided", 2 for "disagree" and 1 for "strongly disagree". On the contrary, the items for the dissatisfied end receive 5 points for "strongly disagree", 4 for "disagree", 3 for "undecided", 2 for "agree" and 1 for "strongly agree". The possible range of scores is therefore 18 to 90 points. The neutral

point is at 54. A total score on or above neutral point represents job satisfaction and a score falling below this point represents job dissatisfaction.

Brayfield & Rothe (1951) reported a split half reliability coefficient of .87 for this scale for a sample of 231 female clerical employees. Concerning validity they reported a correlation of .93 between the Brayfield-Rothe scale and the Hoppock blank (1935). Brayfield et al (1957) found for this scale correlation coefficients of .40 with the Science Research Associates Inventory (1952), .32 with the Weitz Test of General Satisfaction (1952) and .49 with the Rundquist-Sletto Morale Scale (1936) for a group of 41 male city government employees. Ewen (1967) reported correlation coefficients ranging from .48 to .75 between the Brayfield-Rothe scale and the JDI on three separate samples.

The Job Descriptive Index (JDI)

The Job Descriptive Index consists of five subscales: work, pay, promotion, supervision and co-workers. Each subscale consists of items describing a particular aspect of a job. There are 72 items for the whole scale. Each of the subscales work, supervision and co-workers consists of 18 items and each of the subscales pay and promotion consists of 9 items.

The respondent is instructed to describe these five aspects of his job by means of a "yes", "?" or "no" response to each item of these subscales. The scoring procedure is "yes" = 3, "?" = 1 and "no" = 0 for positively discriminating items and on the other hand "yes" = 0, "?" = 1 and "no" = 3 for negatively discriminating items.

Vroom (1964) has called the JDI "without doubt the most carefully constructed measure of job satisfaction in existence today". Split half internal consistency coefficients are reported (Smith et al. 1969) to exceed .80 for each of the JDI subscales. Smith et al. (1969) found stability coefficients from .45 to .75 on 45 employees over a period of 3 years. A significant stability coefficient is also reported by Schneider et al. (1978).

Considerable data on the validity of the JDI are now available (see for example, Wanous et al. 1972, and Locke 1976) in addition to the significant convergent and discriminant validity data presented in the original publication of the measure (Smith et al. 1969).

Results

The findings of the present investigation are shown in Tables VI-1 to VI-8. The subjects were divided into satisfied and dissatisfied groups on the basis of their scores on the Brayfield-Rothe scale of Job Satisfaction and according to the Brayfield-Rothe's criterion of division. The results of the Brayfield-Rothe scale showed that a significantly greater number of the subjects of the high performance group are satisfied with this job in comparison to the low performance group (see Table VI-1).

Table VI-1. The table shows how many cases of the subjects of the high and low performance groups fall into the satisfied and dissatisfied categories on the basis of their scores on Brayfield's index of job satisfaction.

	Satisfied	Dissatisfied
High performance	16	4
Low performance	10	10
Total	26	14

Note: Z-test for differences between uncorrelated proportions shows that a significantly greater number of subjects of the high performance group are satisfied with their job than that of the low performance group ($z = 2$; $p < .05$, two tailed test).

The results of the Brayfield-Rothe scale further revealed that the mean score of job satisfaction of the high performance subjects is significantly higher than that of the low performance group (see Table VI-2).

Table VI-2. Mean scores on the Brayfield's job satisfaction scale of the subjects of the high and low performance groups.

	Mean	t	p
High performers (N = 20)	62.35	2.08	<.05 (two tailed)
Low performers (N = 20)	56.50		

In the present study, the Brayfield-Rothe scale of job satisfaction showed a significantly high internal consistency (see Table VI-3).

Table VI-3. Internal consistency of the Brayfield-Rothe scale based on the scores of the present study (N = 40).

Correlation between odd-even split halves	.72
Correlation corrected to full length by Spearman-Brown formula	.84
Level of significance	p <.001

Job satisfaction scores obtained by the Job Descriptive Index correlated significantly with the scores obtained by the Brayfield-Rothe scale (see Table VI-4). But the results showed that two JDI subscales (work and pay) out of five (work, pay, promotion, supervision and co-workers) neither correlated significantly with subscales of the same test

(see Table VI-5) nor with the Brayfield-Rothe test (see Table VI-4). However, three other subscales (promotion, supervision and co-workers) correlated significantly with the Brayfield test and among them the two subscales (supervision and co-workers) correlated quite highly with this measure of overall job satisfaction (see Table VI-4).

Table VI-4. Correlation between the Brayfield-Rothe scale and the JDI scale and also between the Brayfield-Rothe scale and the subscales of the JDI, based on the scores of the present study.

	JDI full scale	Subscales of JDI				
		work	pay	promotion	supervision	co-workers
Brayfield-Rothe scale	.63***	.25	.24	.35*	.64***	.51**

Note: N = 40; * = $p < .05$; ** = $p < .01$; *** = $p < .001$; the correlation coefficients without asterisk are not significant.

Table VI-5. Intercorrelations of JDI subscales based on the scores of the present study.

subscales	work	pay	promotion	supervision	co-workers
work	-				
pay	.21	-			
promotion	.28	.43*	-		
supervision	.02	.56*	.40*	-	
co-workers	.21	.22	.48*	.53*	-

Note. N = 40; * = $p < .01$ (two tailed test); the correlation coefficients without asterisk are not significant.

The findings of the present study about absenteeism showed that the incidence of absenteeism of low performance subjects was significantly greater than that of the high performance workers (see Table VI-6). However the results showed no significant difference between the subjects of the satisfied and the dissatisfied group in the incidence of absenteeism (see Table VI-7).

Table VI-6. Incidence of absenteeism of the high and the low performance subjects during 1975 and 1976.

High performance subjects		Low performance subjects	
Token number	Frequency of absence	Token number	Frequency of absence
2081	1	2272	4
1809	5	2090	6
2245	1	1979	5
1183	4	1759	4
584	0	1714	3
2121	3	2040	6
1651	1	2153	4
1548	3	2237	5
1435	1	1917	0
1900	2	1983	4
2098	1	1404	0
1989	3	1986	1
1555	2	1822	0
1747	4	1966	5
2167	3	1134	2
1276	3	2321	5
1920	3	1772	3
2285	0	2414	2
1027	0	2295	4

Note: The Mann-Whitney U-test shows that the difference between the high and low performance subjects in the incidence of absenteeism is significant ($U = 130$; $p < .05$, one tailed).

Table VI-7. Incidence of absenteeism of the satisfied and dissatisfied subjects during 1975 and 1976.

Satisfied subjects		Dissatisfied subjects	
Token number	Frequency of absence	Token number	Frequency of absence
1555	2	2285	0
2081	1	1651	1
1747	4	1809	5
1876	6	2098	1
2245	1	1772	3
1900	2	1759	4
2121	3	1986	1
1183	4	1966	5
584	0	2153	4
1548	3	1822	0
1435	1	2318	5
1920	3	2272	4
1276	5	1917	0
2321	3	2295	4
1989	3		
2414	2		
2167	3		
1983	4		
1027	0		
1714	3		
2040	6		
2090	6		
2237	5		
1979	5		
1404	0		
1134	2		

Note: The Mann-Whitney U-test shows that the difference between the satisfied and dissatisfied subjects in incidence of absenteeism is not significant ($U = 170$; $p = < .36$ one tailed).

Analysis of the response distributions of some of the interesting items of the subscale "work" of the Job Descriptive Index has led to some striking findings. It has been found that a significantly greater number of the subjects, who consider their job as routine, are satisfied with their work and although they find the work routine still they do not consider it boring or frustrating (see Table VI-8).

Table VI-8. Response distribution of the subjects of the high and low performance groups on some of the interesting items of the subscale "work" of the JDI questionnaire.

		Yes	No	χ^2	p
ROUTINE (N = 39)*	Satisfying	30	9	11.31	<.001
	Boring	3	36	27.31	<.001
	Frustrating	7	32	16.02	<.001
SIMPLE (N = 20)**	Give sense of accomplishment	16	4	7.20	<.01
	Satisfying	17	3	9.80	<.01
SIMPLE & ROUTINE (N = 20)	Satisfying	17	3	9.80	<.01
	Boring	1	19	16.20	<.001
NOT CHALLENGING (N = 32)***	Boring	2	30	24.50	<.001

- Note: * Among 40 subjects, 39 consider the work as routine and 1 subject considers the work as not routine;
- ** 20 subjects consider the work as simple and 19 consider the work as not simple, one subject is undecided;
- *** 4 subjects consider the work as challenging, 32 consider the work as not challenging and 4 subjects are undecided.

Response patterns of the subjects on another item, whether the work is simple or not, revealed that a significantly greater number of the subjects, who consider their work as simple, are satisfied with this work and although the work is simple to them still they get sense of accomplishment in the work (see Table VI-8).

The response distribution of the subjects further revealed that a significantly greater number of the subjects, who consider their work both simple and routine, find their work satisfying and not boring. Similarly, a significantly greater number of the subjects, who consider their work as not challenging, do not find their work boring (see Table VI-8).

Discussion

The present study provides evidence of a significant positive correlation between performance and job satisfaction in this repetitive job. Although two satisfaction measures, the Brayfield-Rothe scale and the JDI, were used in this study, yet the subjects were divided into the satisfied and the dissatisfied groups only on the basis of their scores on the Brayfield-Rothe scale. This was done considering the significantly high internal consistency of the Brayfield-Rothe scale (see Table VI-3) and its significant correlation with the JDI scale in the present study (see Table VI-4). Moreover the results of the present study indicated that the JDI may not be an appropriate measure of job satisfaction in this case since two of its subscales (work and pay) neither correlated significantly with other subscales of the same test (see Table VI-5) nor with the Brayfield-Rothe test (see Table VI-4). Non significant correlations of the two subscales of the JDI (i.e. work and pay), with its other subscales and with the Brayfield-Rothe scale, seemed due to the fact that some of the items of these two subscales were not quite meaningful in the context of the present job. For example, the item of the subscale "work", as to whether the job is creative, did not seem to be appropriate for there was little creativity in this repetitive job. Similarly, the item of the subscale "pay" concerning profit sharing was not relevant with the system of pay in the present case. Moreover, in this repetitive job, it seemed misleading to consider "yes" response to items such as the job

is routine, and simple, as the expressions of dissatisfaction. Because, to a significantly greater number of the workers the work was satisfying even though they considered it simple and routine. However, two other subscales (i.e. supervision and co-workers) of the JDI correlated quite highly with the Brayfield-Rothe scale of overall job satisfaction. Thus the results indicate the importance of supervision and co-workers to overall satisfaction in this repetitive job.

The positive correlation between the two satisfaction scales, i.e. the JDI and the Brayfield-Rothe scale, should be interpreted with caution. Although, we cannot entirely rule out the probability of partial Hawthorne effect on the positive correlation between the two satisfaction scales yet, it seems difficult to give a simple answer to the question of the Hawthorne effect, if at all there is any, on the positive correlation between the two satisfaction scales. In a field study, like this, the probability that the response of the subjects may be influenced by a number of uncontrolled factors cannot be denied. In the present study, although a significantly greater number of the subjects reported satisfaction with the job, nevertheless, a number of them also reported dissatisfaction with the job. So, it seems untenable to suppose that there is a Hawthorne effect for some workers and not for the other workers. It may be relevant here to mention the observation made by Cook (1967) and Diamond (1974) that despite widespread discussion of the Hawthorne effect, there is not much evidence of the Hawthorne effect in field experiments.

The present study provides evidence of a significantly greater rate of absenteeism of the low performance than of the high performance workers (see Table VI-6). But no significant difference in the incidence of absenteeism has been found between satisfied and dissatisfied subjects (see Table VI-7).

Reviews of the literature in this field indicate that job satisfaction is not always strongly related to absenteeism (Brayfield & Crockett 1955, Herzberg, Mausner, Peterson & Campbell 1957, Schuh 1967 and Vroom 1964). After reviewing 29 studies relating to absenteeism and job satisfaction, Nicholson et al. (1976) show that the relationship is negative or zero in every case.

The result of the present study, as mentioned earlier, provides evidence that a significantly greater number of workers find satisfaction in this repetitive job and even though they consider the job as routine and simple yet they are neither bored nor frustrated with the job; rather they get a sense of accomplishment in performing it (see Table VI-8). The results of this study support the findings of Kilbridge (1960) that some workers like simple tasks.

These findings suggest to be cautious about the generality of some other findings in this field (Viteles 1932, Walker & Guest 1952), which indicated that boredom is more apt to occur in simple tasks than in complex tasks. The results of this study seem to support the findings of some studies (Smith 1955 and Roy 1959) which indicated that boredom depends more on the characteristics of the workers than on the characteristics of the work.

The findings of the present study further suggest not to overgeneralize the importance of job enlargement in removing boredom and in providing job satisfaction in repetitive jobs.

In the light of available evidence, it may be concluded that as boredom appears to depend more on the characteristics of the workers than that of the work, so the solution of the problems of satisfaction and boredom in repetitive jobs seems to lie more in proper selection and placement of workers than in job enlargement.

CHAPTER VII

NUMBER AND DURATION OF MACHINE
STOPPAGES IN HIGH AND LOW PERFORMERSIntroduction

With the pioneering works on time study by Taylor and motion study by the Gilbreths (a brief description of their work was given in Chapter II), a new field of scientific study of human work was opened which has attracted the interest of an increasing number of psychologists, engineers and physiologists. Although Taylor and the Gilbreths did some of their works in close collaboration, it seems that in the early days greater use was made of time study than of motion study for finding out the best working organisation and rate. It was not until the 1930's that a general movement got under way to study work with the objective of finding better and simpler methods of doing it. Then there followed a period during which time study and motion study were used together, the two supplementing each other and the combine term time-and-motion study came to use.

Some of the early studies concerning acquisition of skills in industrial work were conducted by Bryan et al. (1897), Pear (1924) and Book (1925). In the 1930's a number of studies on speed skills were conducted (e.g. Henshaw et al. 1933, Blackburn 1936 and Barnes et al. 1938). A contemporary and more comprehensive study was that of Cox (1934). His work constitutes the most comprehensive examination up to that time of the acquisition of manual skill. Almost simultaneously with Cox's work, de Montpellier (1935) was studying speed skills from a slightly different viewpoint. He studied the changes in motion patterns which accompanied increasing performance. The subjects were required to move the hand in a repetitive geometric pattern from point to point; initially the movements were straight but with practice they became progressively smoothed and curved.

During the last 3 decades quite a large number of studies have been conducted on various aspects and types of human motor activities. The specific aspects of movements which have been elaborately studied fall into the following partly overlapping groups (McCormick 1964):

1. speed of movement,
2. accuracy of movement,
3. force applied during movement,
4. energy cost of movement,
5. biomechanical analysis of movement.

We do not intend to survey these studies here as there are exhaustive reviews elsewhere (Conrad 1951a, Ruch 1951, Darcus 1954, Siddall 1954, Paillard 1960, Morgan et al. 1963, Murrell 1965, Seymour 1966, Welford 1968 and Welford et al. 1976).

A review of the studies concerning different types of movements (e.g. positioning, continuous, serial, repetitive and static movements) is given by McCormick (op cit).

Although each of these studies has its special value, unfortunately most of them have little or no bearing on our problem concerning the speed skill of the operator in short cycled repetitive work. The number of studies on this problem, in real life situation, is relatively few.

One reason for it as observed by Welford (1952) is that the methods of recording movements in continuous sequence were unsatisfactory and the records were excessively laborious to analyse. The problems of recording and analysis have been substantially solved, quite recently, with the development of electronic equipments, which have made it possible to make extensive studies for quite long time both accurately and economically.

Although we do not find any identical study, yet there are some which have similarities with the present study. One such study is by Murrell (1962) who found that when a repetitive task is continued for quite a long period a moderate rise occurs in the mean time required to perform

each cycle of an operation, and this is accompanied by a much greater rise in standard deviation of the successive cycle times. We shall try to describe this study in some more detail.

It is characteristic of most repetitive work, Murrell pointed out, that after a warm-up there is a period of fairly regular and stable performance. This period has been named by Murrell as the "actile" period (Murrell op cit). He proposed techniques to identify the actile period calculating means and standard deviations of work cycles over periods of e.g. 10 minutes. In order to check the viability of this technique and to test the suggestion put forward by Bartlett (1953) that when work was repetitive the onset of psychological fatigue would be shown by the appearance of irregularity in the execution of successive repetitive movements, Murrell set up a laboratory experiment in 1962. The investigation was conducted on a simulated industrial task of testing electrical components, an operation which is found in most electronic manufacturing factories. Twenty-two subjects were employed on fixed weekly wages for a period of 3 to 4 months. They worked 4 hours a day in the laboratory on this repetitive task. The results confirmed the hypothesis of Bartlett (op cit) that irregularities appear in successive cycle times (Murrell and Forsaith 1963, Murrell 1965). There were within-subject and between-subject differences in the time of appearance of irregularities. The aggregated results revealed that irregularity appears after one hour of a continuous working period of 3 1/2 hours as predicted by Bartlett (op cit), but an unexpected fact was that thereafter there was a recovery of regularity followed by a second period of irregularity about one hour later.

These studies of changes of cycle time in repetitive work by Murrell (op cit) were carried out from the viewpoint of fatigue effect, but De Jong (1957) and Crossman (1959) have studied such changes due to learning or practice effect. Murrell's studies are concerned with changes over hours. De Jong and Crossman's studies are concerned with changes over months and years. De Jong (op cit) showed that the time taken to perform a repetitive task falls exponentially so that if the cycle time is plotted against cycle-number on log log paper, time decreases

approximately linearly until it approaches the incompressible minimum. He proposed that the time for completing a cycle was reduced as skill increased according the following equation:

$$T_n = T_\infty + \frac{T_1 - T_\infty}{n^k}$$

Where T_n is the nth cycle time, T_∞ is the incompressible minimum time - that is the time that would be taken if the task was continued for an infinite number of cycles - and T_1 is the time taken by the first cycle. The exponent k expresses the rate at which improvement takes place with practice. De Jong found this formulation to fit reasonably well for a number of industrial operations (Welford 1968, 1976).

The study by Crossman (op cit) on the speeds of operating cigar making machines revealed that the work cycle time of the operators gradually decreases up to two years of practice and after making about three million cycles. After that the cycle time becomes steady and the operators attain a more or less stationary level of skill for their work.

Following the investigation of Murrell (1962) we intended to study the work cycle time of experienced high and low performance workers. Initially our aim was to find whether variability in cycle time observed by Murrell in laboratory condition could also be found in real life situation and perhaps to reach some conclusions about fatigue and needed rest pauses.

However, Singleton (1976) suggested that when the machine cycle time is the same, irrespective of the speed skill of the workers, measuring the work cycle time is not quite meaningful, especially for highly skilled workers because they will accelerate their working speed as much as is necessary to keep pace with the speed of the machine. As there seems to be little or no reason of going faster than the speed of the machine, they would completely fill the cycle time of the machine.

So we changed our original plan and have finally studied some other phenomena that would perhaps show some relation to fatigue, i.e. the number and duration of machine stoppages of high and low performance subjects as well during the morning as during the afternoon shifts. In the light of the findings of Crossman (op cit) we have studied only workers whose experience in the present job was not less than two years (as already explained in Chapter V).

Method

Subjects

A total of 40 subjects, as already mentioned, was originally chosen for this study (a detail description of sampling of the subjects is given in Chapter V). But at the time of registering machine stoppages, some of them were absent, some had left the job and a few of them were transferred by the management from shift to day work. Finally, we have registered machine stoppages of the remaining 15 high and 12 low performance subjects.

Apparatus

Number and duration of the stoppages of the cigar making machines have been recorded by a punch tape data collector. The apparatus consists of two parts. The first part is a timing unit and the second part a punching unit. The timing unit has two counters. The first counter would indicate exactly when the machine has been stopped (i.e. the exact time of day when the stoppage has occurred). The second counter would indicate every time how long the machine has been stopped. The apparatus could register stopping duration of machine as small as one tenth of a second. The punching unit would register on punch tape the number and duration of hand and foot stoppages of the machine separately.

The apparatus had provisions to delete the number and duration of stoppages occurred during maintenance of machine and during 30-minutes prescribed rest pause. These data were registered in coded form in such a way that it was possible to feed them in a computer for analysis.

Procedure

We have registered the number and duration of all foot and hand stoppages of the cigar making machine of every subject once during morning shift (6:00 - 14:00 h) and once during afternoon shift (14:00 - 22:00 h). In each shift there was a 30-minutes prescribed rest pause during which the workers would not operate their machines. At the end of each shift, the workers would stop their work about 10 to 15 minutes earlier than the closing time, for cleaning their machines. Considering these differences between the subjects in time of ending their work, we have excluded from statistical analysis the number and duration of machine stoppages of all the subjects during the last 30 minutes in each shift. Finally we have analysed the number and duration of stoppages of each of the 15 high and the 12 low performance subjects for 7 hours in the morning and 7 hours in the afternoon shifts.

In order to find out whether there are differences between the two groups of subjects in number and duration of their foot stoppages, we have compared the number of foot stoppages of the high performance subjects during the morning and the afternoon shifts taken together with those of the low performance subjects, and similarly we have compared their duration of stoppages during the morning and afternoon shifts taken together with those of the low performance subjects. To study the differences between the morning and the afternoon shifts in number and duration of foot stoppages, we have compared the combined number of foot stoppages of the high and the low performance subjects in the morning shift with those of the afternoon shift and a similar comparison has been made for the duration of stoppages.

We have further analysed the foot stoppages for different half hour work periods to find out whether the number and duration of stoppages differed within such periods for the high and the low performance subjects in the morning and the afternoon shifts.

To study the influence of the 30-minutes rest pause on the foot stoppages, we have compared the number of stoppages for one hour before the rest pause and one hour after the rest pause for each group of

subjects and within each shift.

We have not analysed the hand stoppages of the subjects because the cigar making machines would be stopped by hands by the operators as well as by the maintenance workers for repairing them. Our apparatus (i.e. the punch tape data collector) had no provision to record hand stoppages of the operators and those of the maintenance workers separately. So, comparison of hand stoppages of the high and the low performance subjects would not be meaningful. Normally the operators would stop machines by hand during working hours only when they have to leave the work place for a short time such as for going to toilet, calling a maintenance worker, consulting a supervisor etc., and these kinds of incidents were not frequent. Nevertheless, short rest pauses resulting from such hand stoppages might have influenced the foot stoppages of the subjects. So, we have compared the number of foot stoppages occurring before and after hand stoppages for each group of the subjects within each shift. We have studied the effect of only those hand stoppages which occurred within an interval of not less than 10 minutes from one another and such stoppages were sorted out by computer. For every subject two sets of mean values based on the number of foot stoppages have been computed. Firstly, the mean number of foot stoppages occurring within 10 minutes, preceding every hand stoppage and secondly the mean number of foot stoppages taking place within 10 minutes, following every hand stoppage. In order to see whether these short rest pauses are more effective in the beginning or at the end of the working period, we have compared the mean number of foot stoppages for the first half of the work period (i.e. the part of the work period before the 30-minutes rest pause) with those of the second half of the work period (i.e. the part of the work period after the 30-minutes rest pause). This has been done in each shift and within each group.

So in this chapter we compare:

- the number of stoppages between the two groups of subjects (i.e. the high and low performers) and between the two shifts (i.e. the morning and afternoon shifts);
- the duration of stoppages between the two groups of subjects and

between the two shifts;

- the number of stoppages before and after the 30-minutes rest pause;
- the number of stoppages for 10 minutes before and 10 minutes after short breaks.

Results

The total number of machine stoppages of every high and low performance subject in the morning and afternoon shifts is presented in Figure VII-1.

The mean of the numbers of machine stoppages of the high and low performance subjects in the morning and afternoon shifts are shown in Table VII-1 and in Figure VII-2.

Table VII-1. Mean number of machine stoppages of the high and the low performance subjects during the morning and the afternoon shifts.

	Morning shift	Afternoon shift	t	p
High performers (N = 15)	475.20	355.73	2.29	< .05 (two-tailed)
Low performers (N = 12)	1289.08	1238.83	0.37	ns

An analysis of variance (see Table VII-2), performed on the numbers of machine stoppages of the high and the low performance subjects in the morning and the afternoon shifts shows that the number of machine stoppages of the high performers is significantly lower than that of the low performers both in the morning and the afternoon shifts ($F = 36.59$, $df = 1, 25$, $p < .01$).

The overall difference (i.e. high and low performers taken together) between the two shifts in number of stoppages is not significant. However, the graphic presentation of machine stoppages (see Figure VII-2) shows that the mean difference in number of stoppages between the morning and the afternoon shifts is larger for the high performers than for the low performers. So, in order to determine whether the mean difference between the two shifts within each group is significant or not, we have computed separate tests for the mean number of stoppages between morning and afternoon shifts within each group. The results show that the difference between morning and afternoon shifts is large enough to be statistically significant ($p < .05$, two-tailed) within the group of the high performers (see Table VII-1). Although the difference goes in the same direction for the low performers (see Figure VII-2), it is not large enough to be statistically significant.

There are significant differences in number of machine stoppages between different half hour working periods in both shifts (for the high and low performance subjects taken together) ($F = 2.56$, $df = 13, 325$, $p < .01$).

As the interaction between performance (A) and work periods (C) is significant ($F = 3.32$, $df = 13, 325$, $p < .01$) so these differences are not the same for the two groups of subjects. This may be interpreted with the help of the figure VII-3, which shows that the mean numbers of stoppages at different half hour work periods in both shifts remain on a much more constant level for the high performers than for the low performers. So this interactional effect is due to the greater variability of the mean of the low performers. For instance, we find that in the morning shift the low performers start with a low mean stoppage and thereafter the mean stoppages remain on a higher level till the second half of the morning shift while there is no such clear pattern in the afternoon shift.

The mean number of machine stoppages of the high performance subjects for one hour before and one hour after the 30-minutes rest pauses in the morning and the afternoon shifts are given in Table VII-3 and in Figure VII-4. Comparable data for the low performance subjects are given

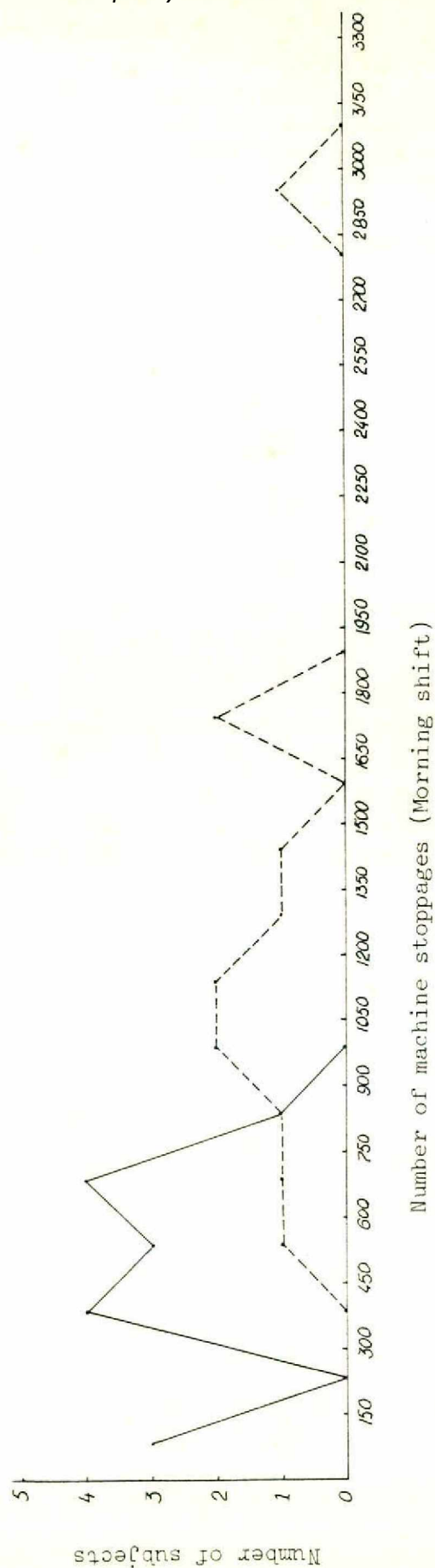
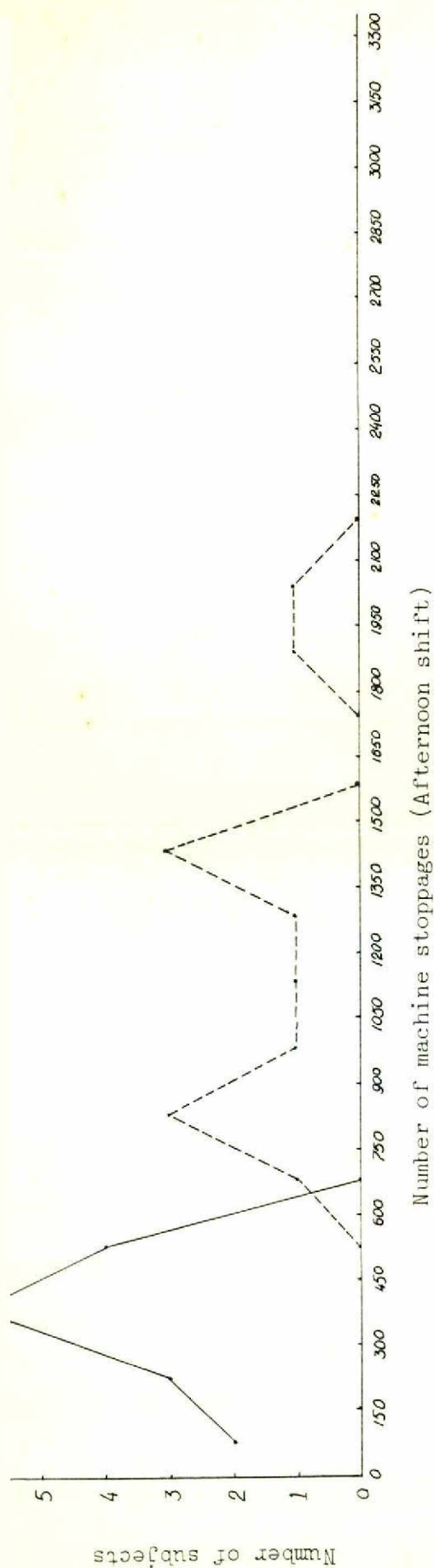


Figure VII-1. The numbers of machine stoppages of the high performance (unbroken line) and the low performance subjects (broken line) in the morning and the afternoon shifts.

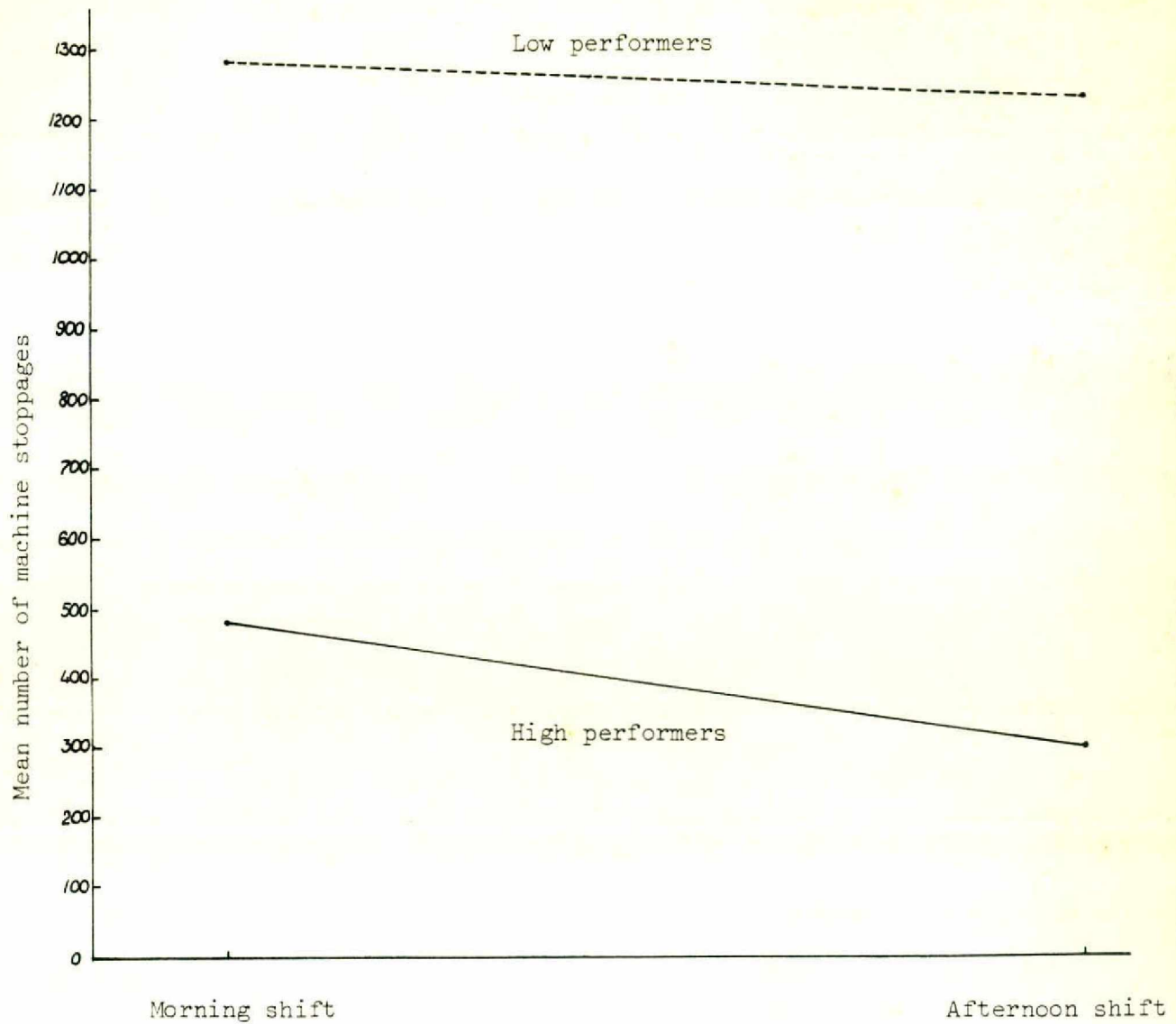


Figure VII-2. Mean number of machine stoppages during morning and afternoon shifts for the fifteen high performance subjects and the twelve low performance subjects.

Table VII-2. Summary of analysis of variance for numbers of machine stoppages of the high and the low performance subjects during the morning and the afternoon shifts.

Source	SS	df	MS	F	p
1. Between subjects	1133169.90	n-1 = 26	43583.46	—	—
2. High and low performers (A)	673173.84	p-1 = 1	673173.84	$[2/3] = 36.59$	<.01
3. Subjects within groups	459996.06	n-p = 25	18399.84	—	—
4. Within subjects	416543.54	n(qr-1)=729	571.39	—	—
5. Morning & afternoon shifts (B)	6257.44	q-1 = 1	6257.44	$[5/7] = 1.45$	ns
6. A B	446.40	(p-1)(q-1)= 1	446.40	$[6/7] = 0.10$	ns
7. B X subj. w. groups	108141.20	(n-p)(q-1)= 25	4325.65	—	—
8. Work periods of 1/2 h. durations (C)	12911.64	r-1 = 13	993.20	$[8/10] = 2.56$	<.01
9. A C	16739.19	(p-1)(r-1)= 13	1287.63	$[9/10] = 3.32$	<.01
10. C X subj. w. groups	126015.50	(n-p)(r-1)=325	387.74	—	—
11. B C	6611.41	(q-1)(r-1)= 13	508.57	$[11/13] = 1.24$	ns
12. A B C	5755.10	(p-1)(q-1)(r-1)= 13	442.70	$[12/13] = 1.08$	ns
13. B X subj. w. groups	133666.00	(n-p)(q-1)(r-1)=325	411.28	—	—
14. Total	1549713.44	nqr-1 =755	—	—	—

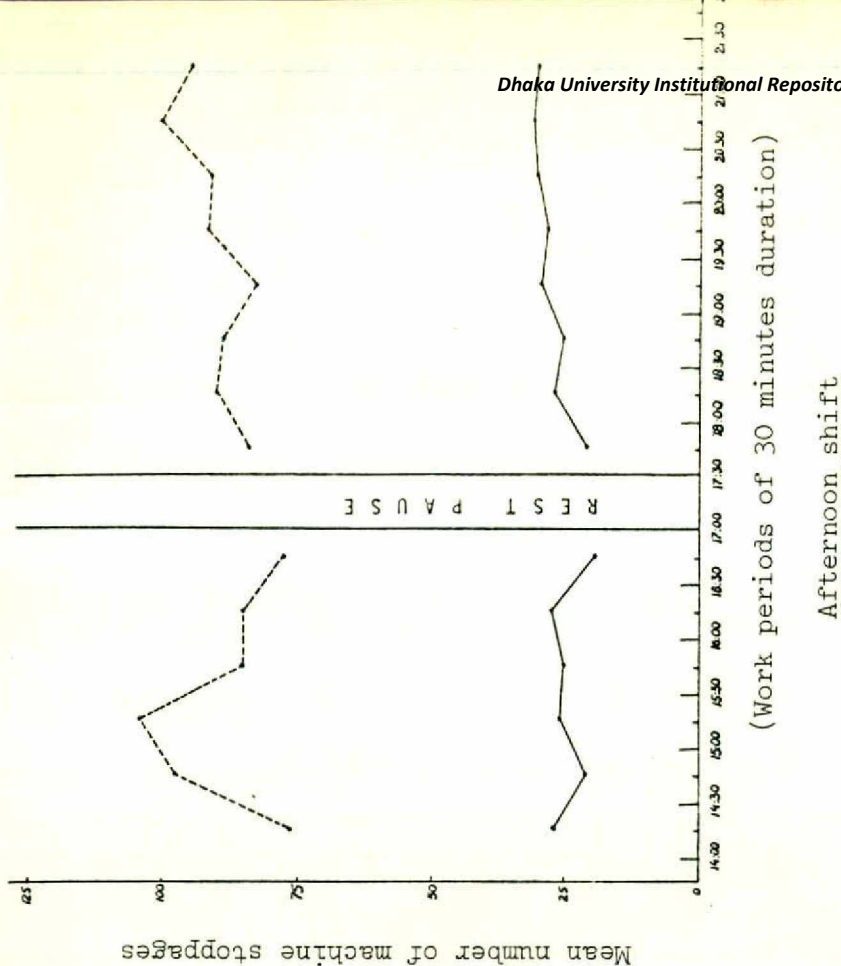
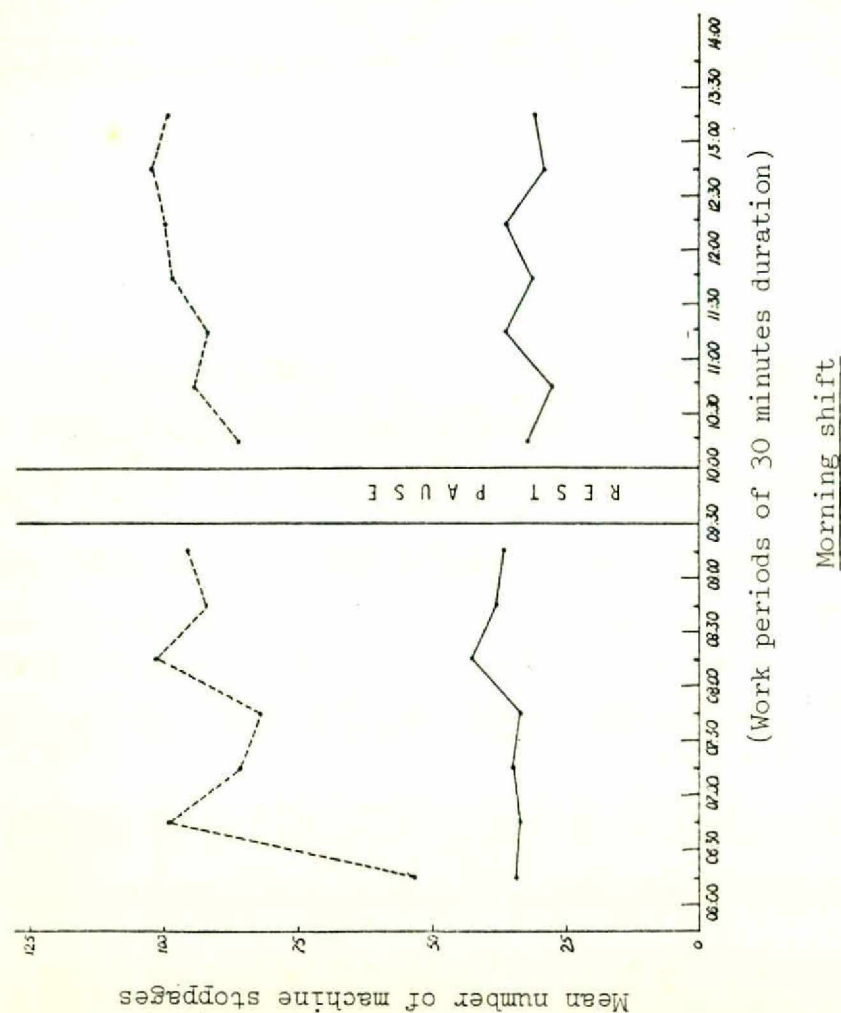


Figure VII-3. Mean number of machine stoppages for every half hour work period of the fifteen high performance subjects (unbroken line) and the twelve low performance subjects (broken line) during the morning and the afternoon shifts.

in Table VII-4 and in Figure VII-4.

It may be mentioned here that the mean numbers of machine stoppages occurring before and after the 30-minutes rest pause for each of the two groups are already shown in the Figure VII-3, which gives a comprehensive picture of the numbers of machine stoppages of the high and low performance subjects for every 30 minutes during the entire morning and afternoon shifts. But here (in Table VII-3 and VII-4) our interest is to study particularly the influence of the 30-minutes prescribed rest pause. So we are comparing the mean numbers of stoppages for one hour before and one hour after the rest pause for each of the two groups of subjects to see if there is any significant difference.

Table VII-3. The mean number of stoppages of the high performers ($N = 15$) for one hour before and one hour after 30 minutes rest pauses in the morning and the afternoon shifts.

	One hour before rest pause	One hour after rest pause	t	p
Morning shift	73.66	59.33	1.91	<.05 (one tailed)
Afternoon shift	49.20	53.06	0.54	ns

The results in Table VII-3 show that the mean number of machine stoppages of the high performers for one hour before the rest pause is significantly higher than that of one hour after the rest pause in the morning shift ($t = 1.91$, $p < .05$). This difference goes in the opposite direction in the afternoon shift (see Figure VII-4) but it is not large enough to be statistically significant.

Table VII-4. The mean number of stoppages of the low performers ($N = 12$) for one hour before and one hour after 30-minutes rest pauses in the morning and the afternoon shifts.

	One hour before rest pause	One hour after rest pause	t	p
Morning shift	196.41	180.16	0.73	ns
Afternoon shift	168.50	163.75	0.23	ns

The results in Table VII-4 show that for the low performers the difference between the mean numbers of stoppages for one hour before and after the rest pause is neither significant in the morning shift nor in the afternoon shift.

The mean numbers of foot stoppages occurring for 10 minutes before and after the occurrence of hand stoppages in the first and the second halves of the work periods in the morning and the afternoon shifts of the high performers are presented in Table VII-5 and in Figure VII-5. Comparable results of the low performers are given in Table VII-6 and in Figure VII-5.

Table VII-5. The mean number of foot stoppages occurring before and after the occurrence of hand stoppages in the first and the second halves of the work periods in the morning and the afternoon shifts of the high performers ($N = 11$).

	First half of work period		Second half of work period	
	Foot stoppages occurring before hand stoppages	Foot stoppages occurring after hand stoppages	Foot stoppages occurring before hand stoppages	Foot stoppages occurring after hand stoppages
Morning shift	14.07	11.77	13.24	7.65
Afternoon shift	4.66	6.30	9.02	6.81

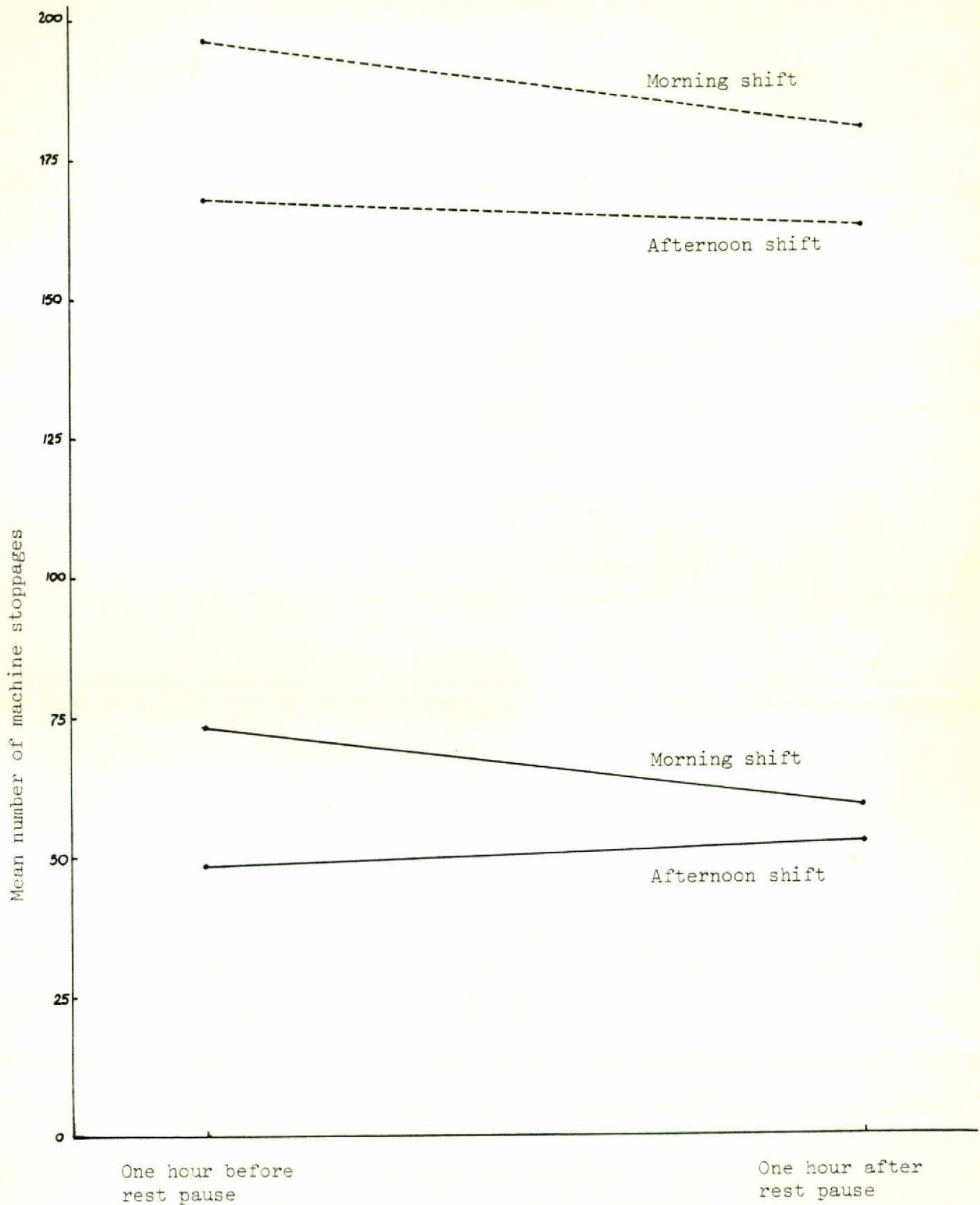


Figure VII-4. Mean number of machine stoppages of the fifteen high performance subjects (unbroken line) and the twelve low performance subjects (broken line) for one hour before and one hour after 30 minutes rest pauses in the morning and the afternoon shifts.

Table VII-6. The mean number of foot stoppages occurring before and after the occurrence of hand stoppages in the first and the second halves of the work periods in the morning and the afternoon shifts of the low performers .

	First half of work period		Second half of work period	
	Foot stoppages occurring before hand stoppages	Foot stoppages occurring after hand stoppages	Foot stoppages occurring before hand stoppages	Foot stoppages occurring after hand stoppages
Morning shift (N = 12)	26.86	26.81	23.88	19.54
Afternoon shift (N = 10)	20.73	21.13	25.58	22.00

Analysis of variances have been performed on the number of foot stoppages occurring before and after the occurrence of hand stoppages in the first and the second halves of the work periods in the morning and the afternoon shifts for the high and the low performers. The results are given in Table VII-7: high performers, morning shift; Table VII-8: high performers, afternoon shift; Table VII-9: low performers, morning shift and Table VII-10: low performers, afternoon shift.

Table VII-7. Summary of analysis of variance for the numbers of foot stoppages occurring before and after hand stoppages of the high performers in the morning shift.

Source	SS	df	MS	F	p
1. Before and after (A)	171.74	1	171.74	8.62	<.01
2. First and 2nd halves (B)	67.28	1	67.28	3.37	ns
3. AB	29.83	1	29.83	1.49	ns
4. Between subjects	1534.54	10	153.45	7.70	<.01
5. Residual	597.44	30	19.91	--	--
6. Total	2400.85	43	--	--	--

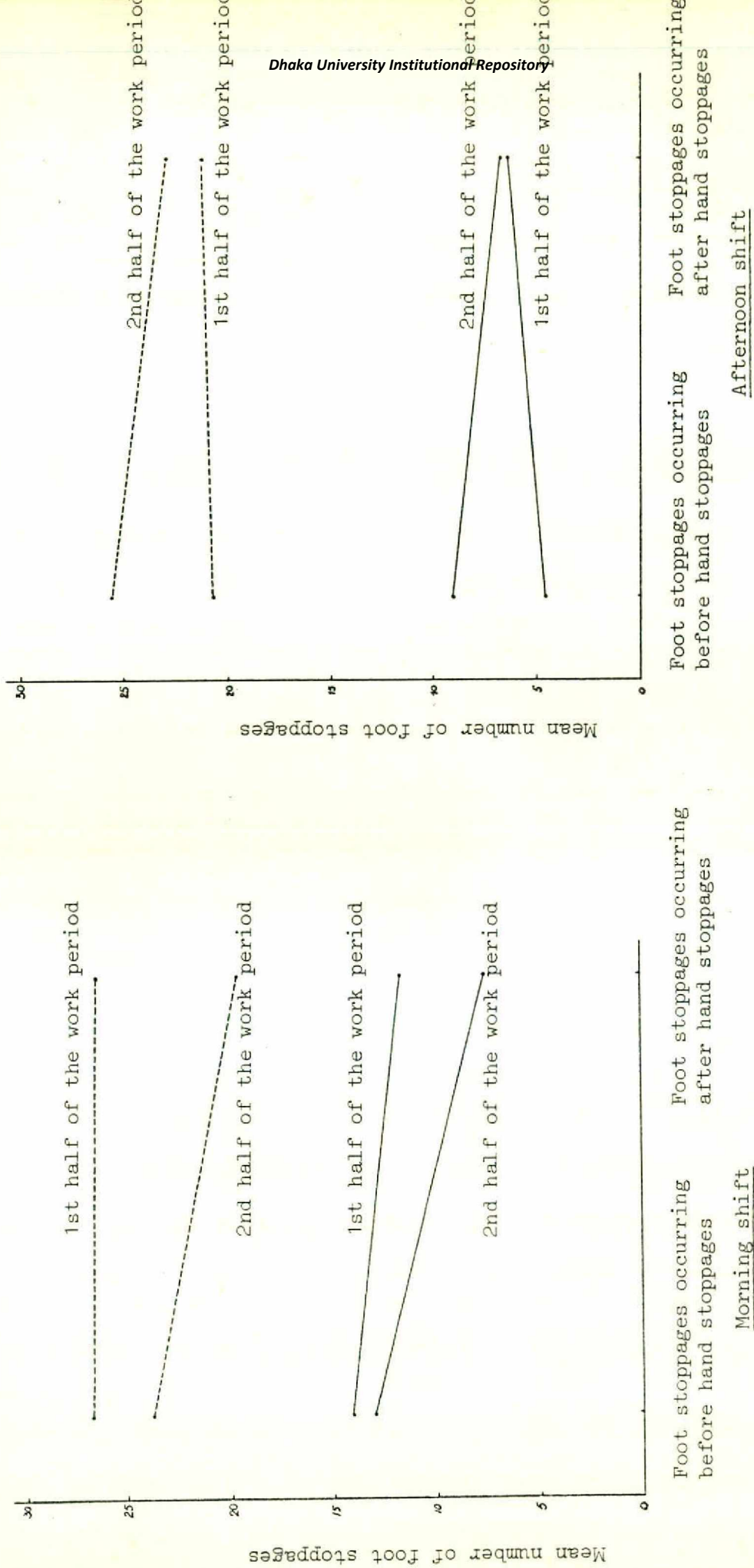


Figure VII-5. Mean numbers of foot stoppages occurring before and after the occurrence of hand stoppages in the first and the second halves of the work periods in the morning and the afternoon shifts for the eleven high performance subjects (unbroken line) and the twelve low performance subjects (broken line).

The results in Table VII-7 show that for the high performers the number of foot stoppages occurring before hand stoppages is significantly higher than those occurring after them during both the first and the second halves of the work periods in the morning shifts ($F = 8.62$, $df = 1, 30$, $p < .01$).

Table VII-8. Summary of analysis of variance for the numbers of foot stoppages occurring before and after hand stoppages of the high performers in the afternoon shift.

Source	SS	df	MS	F	p
1. Before and after (A)	0.90	1	0.90	0.06	ns
2. First and 2nd halves (B)	65.14	1	65.14	4.62	<.05
3. AB	40.66	1	40.66	2.88	ns
4. Between subjects	719.97	10	71.99	5.11	<.01
5. Residual	422.14	30	14.07	--	--
6. Total	1248.83	43	--	--	--

The results in Table VII-8 show that for the high performers the overall difference between foot stoppages occurring before and after hand stoppages in the afternoon shift is not significant.

The overall difference between the number of foot stoppages during the entire first and the entire second halves of the work periods in the afternoon shift (the mean difference can be seen in Table VII-5 and Figure VII-5) is significant ($F = 4.62$, $df = 1, 30$, $p < .05$), but this fact is not quite meaningful in the present context, because here we are interested to study the effect of hand stoppages on foot stoppages which can be observed from the significant difference between foot stoppages occurring before and after hand stoppages. Nevertheless, it is interesting to note that more numbers of stoppages in the second half than in the first half of the afternoon shift support the circadian rhythm hypothesis (explained in detail in the discussion of results).

Table VII-9. Summary of analysis of variance for the data concerning numbers of foot stoppages occurring before and after hand stoppages of the low performers in the morning shift.

Source	SS	df	MS	F	p
1. Before and after (A)	57.42	1	57.42	0.30	ns
2. First and 2nd halves (B)	315.28	1	315.28	1.69	ns
3. AB	55.29	1	55.29	0.29	ns
4. Between subjects	2328.63	11	211.69	1.14	ns
5. Residual	6126.71	33	185.65	--	--
6. Total	8883.36	47	--	--	--

Table VII-10. Summary of analysis of variance for the data concerning numbers of foot stoppages occurring before and after hand stoppages of the low performers in the afternoon shift.

Source	SS	df	MS	F	p
1. Before and after (A)	25.18	1	25.18	0.13	ns
2. First and 2nd halves (B)	81.91	1	81.91	0.45	ns
3. AB	39.52	1	39.52	0.21	ns
4. Between subjects	3553.27	9	394.80	2.18	<.05
5. Residual	4882.06	27	180.81	--	--
6. Total	8581.95	39	--	--	--

For the low performance subjects the difference between foot stoppages occurring before and after hand stoppages is neither significant in the morning shift nor in the afternoon shift.

The total duration of machine stoppages of every high and low performance subject is presented in Figure VII-6. The mean durations (in minutes) of machine stoppages of the high and the low performance subjects in the morning and in the afternoon shifts are given in Table VII-11 and in Figure VII-7.

Table VII-11. Mean durations (in minutes) of machine stoppages of the high and the low performance subjects in the morning and in the afternoon shifts.

	Morning shift	Afternoon shift
High performers (N = 15)	36.17	25.10
Low performers (N = 12)	57.85	54.08

An analysis of variance has been performed for the data of duration of machine stoppages by the high and the low performers during morning and afternoon shifts. The results are given in Table VII-12.

The mean durations of machine stoppages of the high and low performance subjects for every half hour work period in the morning and afternoon shifts are shown in Figure VII-8.

The results show that there is an overall difference between the two groups. The total duration of machine stoppages of the high performers is significantly shorter than that of the low performers both in the morning and in the afternoon shifts ($F = 31.13$, $df = 1, 25$, $p < .01$).

The overall difference between the two shifts is also significant. The duration of machine stoppages in the morning shift is significantly larger than that of the afternoon shift for both the high and the low performers ($F = 5.79$, $df = 1, 25$, $p < .05$).

There is a significant difference in duration of machine stoppages between different half hour work periods in both the shifts for both groups of the subjects ($F = 2.86$, $df = 13, 325$, $p < .01$). We consider this as a very interesting data, which will be elaborated in the discussion.

The interactional effects (AB, AC, BC and ABC) are not significant.

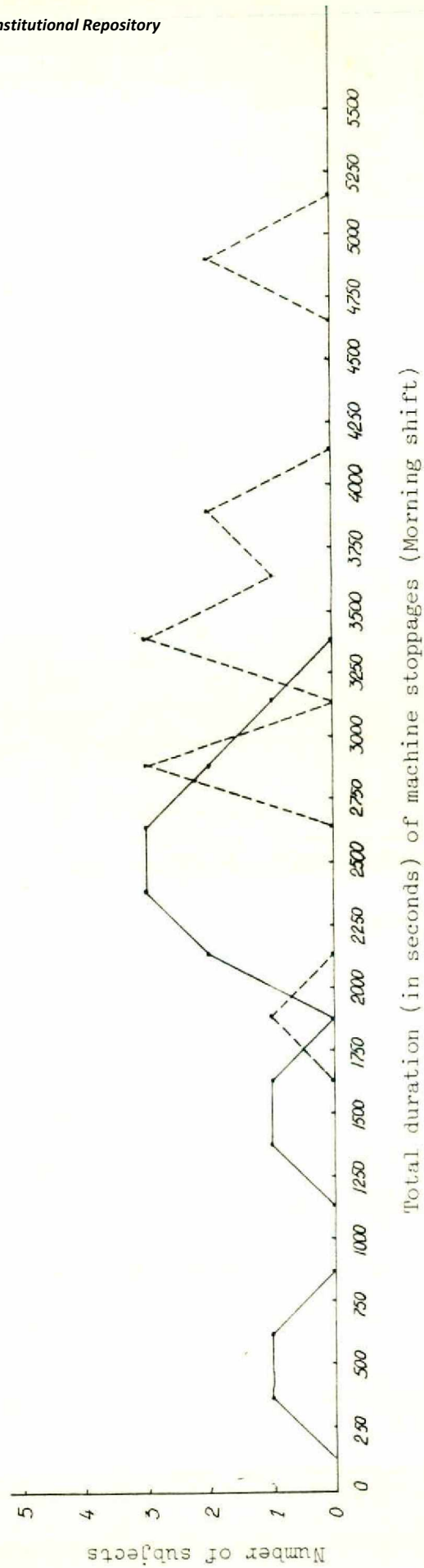
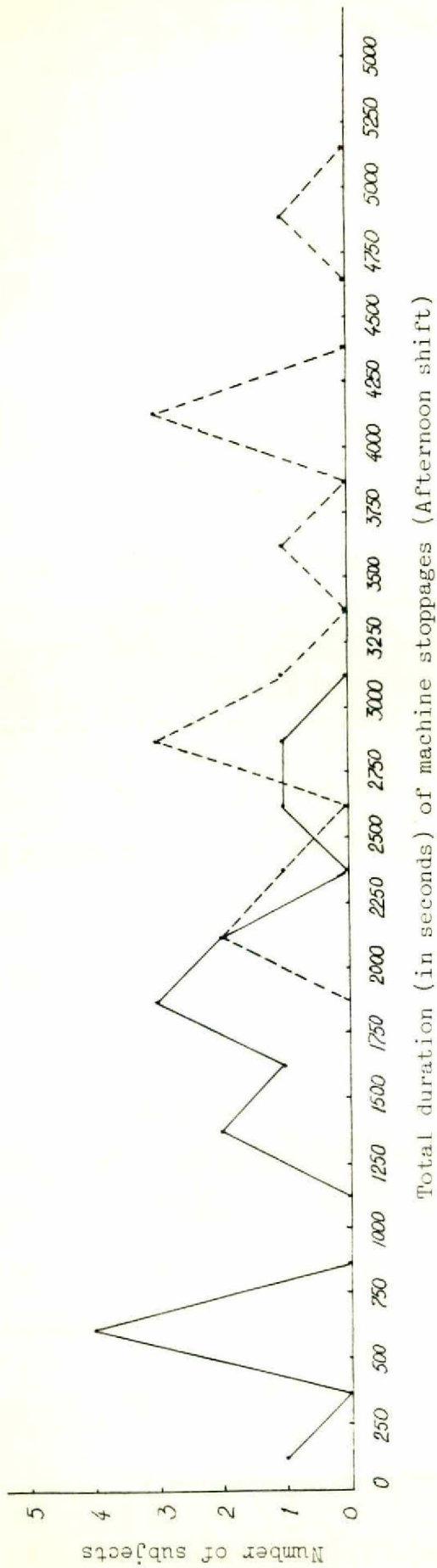


Figure VII-6. The duration of machine stoppages (in seconds) of the high performance subjects (unbroken line) and the low performance subjects (broken line) in the morning and the afternoon shifts.

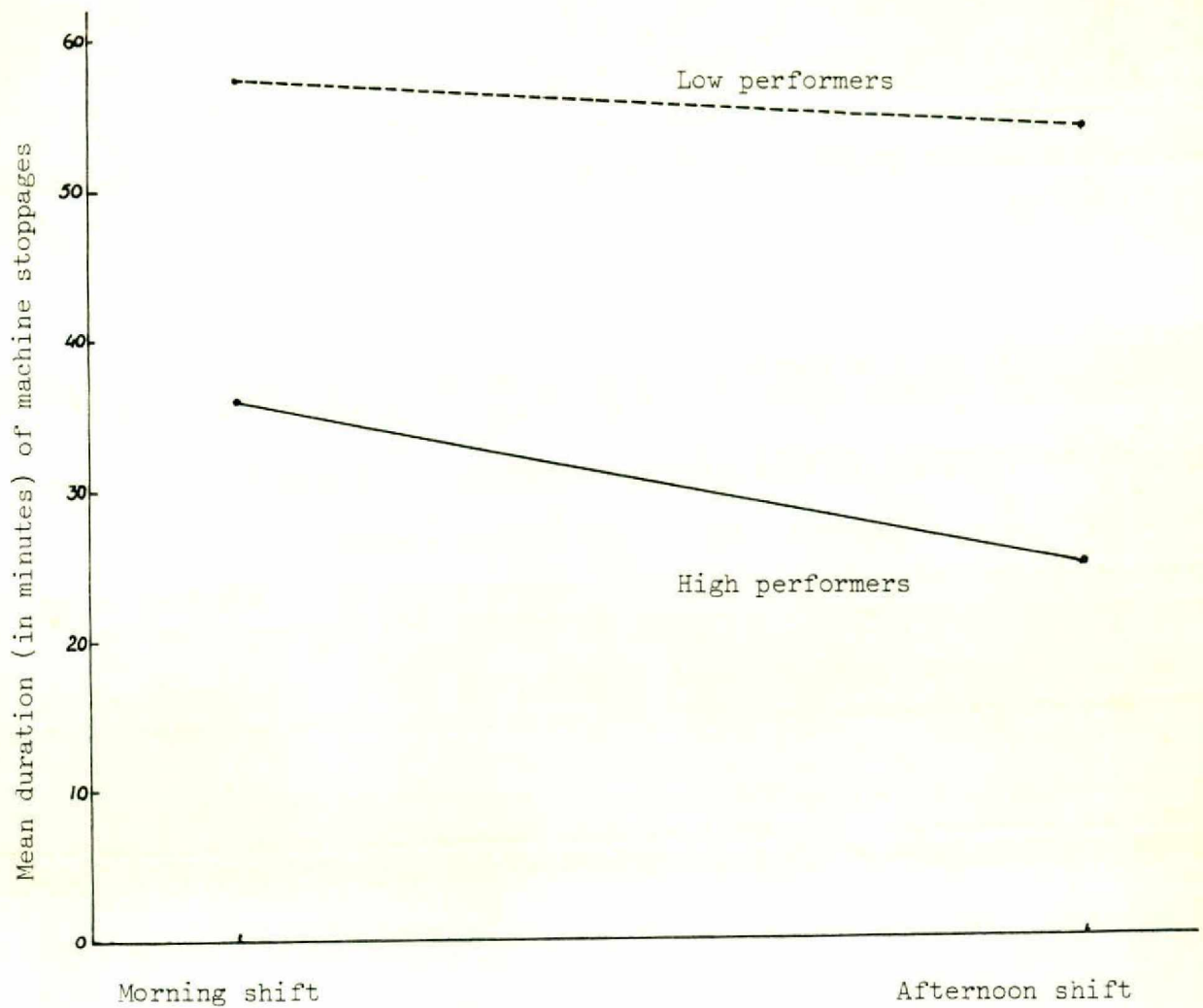


Figure VII-7. Mean duration (in minutes) of machine stoppages of the fifteen high performance subjects and the twelve low performance subjects during the morning and the afternoon shifts.

Table VII-12. Summary of analysis of variance for duration of machine stoppages of the high and the low performance subjects during the morning and the afternoon shifts.

Source	SS	df	MS	F	p
1. Between subjects	65961.81	n-1 = 26	2536.99	—	—
2. High & low performers (A)	36587.45	p-1 = 1	36587.45	$[2/3] = 31.13$	< .01
3. Subjects within groups	29374.35	n-p = 25	1174.97	—	—
4. Within subjects	42672.02	n(qr-1)=729	127.12	—	—
5. Morning & afternoon shifts (B)	3541.79	q-1 = 1	3541.79	$[5/7] = 5.79$	< .05
6. A B	774.81	(p-1)(q-1)= 1	774.81	$[6/7] = 1.26$	ns
7. B X subj. w. groups	15276.69	(n-p)(q-1)= 25	611.06	—	—
8. Work periods of 30 minutes duration (C)	2448.86	p-1 = 13	188.37	$[8/10] = 2.86$	< .01
9. A C	1321.65	(p-1)(r-1)= 13	101.66	$[9/10] = 1.54$	ns
10. C X subj. w. groups	21403.71	(n-p)(r-1)=325	65.85	—	—
11. B C	1448.93	(q-1)(r-1)= 13	111.45	$[11/13] = 0.81$	ns
12. A B C	1945.05	(p-1)(q-1)(r-1)= 13	149.61	$[12/13] = 1.09$	ns
13. B X subj. w. groups	44510.50	(n-p)(q-1)(r-1)=325	136.95	—	—
14. Total	158633.83	nqr-1 =755	210.11	—	—

Mean duration (in minutes) of machine stoppages

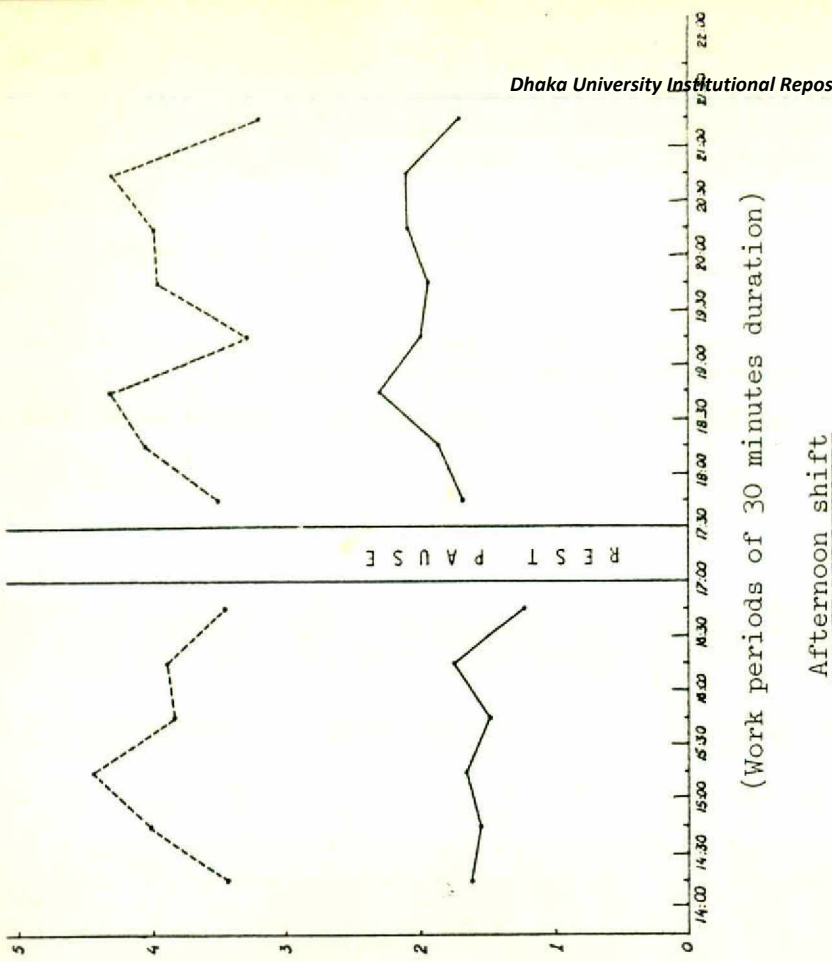
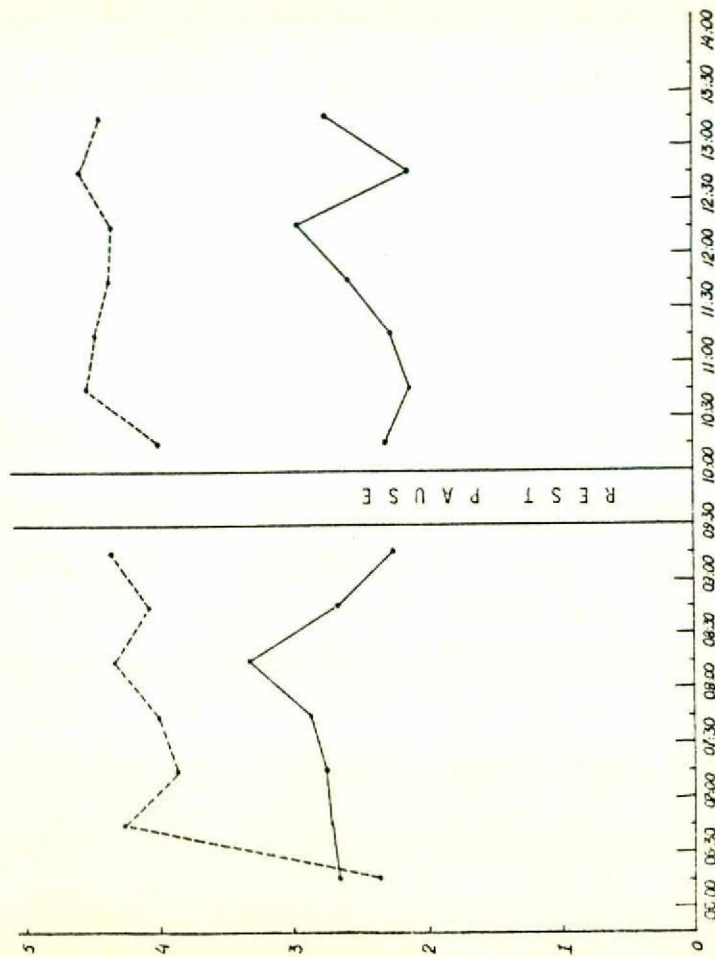


Figure VII-8. Mean duration (in minutes) of machine stoppages for every half hour work period of the fifteen high performance subjects (unbroken line) and the twelve low performance subjects (broken line) during the morning and the afternoon shifts.

Discussion

The results of the present study show that the number of machine stoppages of the high performance subjects is significantly higher in the morning than in the afternoon shift (for the low performance subjects there is no difference) and the durations of machine stoppages for both the high and the low performance subjects are significantly longer in the morning shift than in the afternoon shift.

These differences between the two shifts may be due to variation in circadian rhythm. Colquhoun (1971) pointed out that most if not all physiological processes exhibit marked circadian changes and the level of arousal varies with them, so there is a strong ground for expecting that speed and accuracy of performance is affected by such variations.

Evidence of a persisting diurnal variation in efficiency during shift work has been found in a number of studies, both in real life and in laboratory. In a review published in 1934, Freeman and Hovland prepared a table of the experimental evidence available at that time on various aspects of daily variation in sensory, motor and mental performance.

In several field studies (Browne 1949, Bjerner et al. 1955) the highest number of errors and the lowest level of output have been observed in the early morning. A study of shift-work in a steel mill (Oginski, 1966) showed that, although overall production was approximately equal in morning, afternoon and night shifts, more detailed analyses revealed a superiority of the afternoon shift over the others. Kleitman (1963) showed that a peak of performance occurs in the afternoon or early evening. In a series of experiments he found that the curves of both speed and accuracy of performance fall to a minimum level in the morning and late at night and rise to a maximum level in the afternoon. He also found that the body temperature curve is almost parallel to the performance curve.

Laboratory studies by Colquhoun et al. (1968a, 1968b and 1969) indicate that peak performance tends to occur in the evening and they shared with Kleitman (op cit) the view that there is a recognisable general pattern in the fluctuations of performance levels during the waking day. Kleitman

(op cit) relates this pattern to the 24 h sleep-wakefulness rhythm and by taking body temperature as an index of this rhythm seeks to demonstrate that temperature and performance variations are in fact concomitant during the entire course of the day. In the case of tasks involving motor activity he implies that this parallelism is mediated by the underlying relationship between body temperature and muscular tonus. Colquhoun et al. (op cit) hold similar opinion as Kleitman (op cit) that diurnal fluctuations in performance are in general associated with concomitant variations in body temperature. Loveland et al. (1963) showed that the speed of performance is greater in the afternoon than in the morning and the variation in efficiency is closely correlated with the rhythm of body temperature.

Similar diurnal effects in performance have been reported by Brown (1967) and Patkai (1969). Individual differences in physiological rhythms as related to performance trends have been extensively studied by Blake (1967). The results of those studies indicate markedly consistent time of day effects in performance (e.g. higher level of performance in the afternoon than in the morning) on a number of different tasks and also show that such variation is almost parallel to that of body temperature. However, no drop in body temperature was found to accompany the "post lunch dip" in performance in the majority of Blake's experiments, which indicate that change in body temperature is not the sole determinant of performance. In one out of two field studies, Meers (1975) found circadian variation in performance efficiency paralleling body temperature. However, he has expressed caution about the importance of body temperature to performance efficiency. He has commented that body temperature is important in laboratory studies and in some field situations but in most field situations performance is mainly dependent on system factors, nevertheless the disturbance involved in the adaptation of circadian rhythm may be important for the health of shift workers.

In our study, we did not measure body temperature of the subjects, so we do not know whether it varied during the morning and the afternoon shifts and how far this variation (if any) is related to performance.

In interpreting the extent of performance variation between the morning and the afternoon shifts, we should not place too much weight on the effect of circadian rhythm only, because of possible influence of many uncontrolled variables, which are inevitably present in this kind of field investigations. Nevertheless, it is interesting to note that there is a general agreement in a number of "on the job" investigations (see reviews by Murrell 1965, and Hockey et al. 1972) that the level of performance efficiency is lower in the morning shift than in the afternoon shift, which is confirmed by the results of the present study. A number of recent studies (Alluisi et al. 1977, Caille et al. 1977, Harris 1977, Klein et al. 1977 and Riemersma 1977) show that bodily functions, alertness, levels of arousal and performance are at low points in the early morning hours, with the lowest point somewhere between 03:00 and 06:00 hours in the morning and at high points in the mid-morning and early evening hours.

The difference between morning and afternoon shifts in number of machine stoppages is significant for the high performers and not for the low performers. If this difference is attributed to circadian rhythm then an obvious question arises as to whether the circadian rhythm has effect only for the high performers and not for the low performers? An answer to this question can be found in the study by Alluisi and Chiles (1967), which indicated that the effect of circadian rhythm on performance becomes more pronounced when the operator is overloaded or subjected to stress. This may also be true in our case, where the high performers have significantly higher subjective load than the low performers. (The results of measurements of subjective load of the high and low performers will be presented in Chapter VIII.)

A detail study of the machine stoppages shows that the mean durations of stoppages of the workers of both the groups differ significantly ($F = 3.89$, $df = 3,25$, $P < .01$) between different halves of the morning and afternoon shifts.

However a further analysis reveals that such difference is due to the significantly higher mean duration of stoppages for the second half of the morning shift than that of the first half of the afternoon shift. (The honestly significant difference - HSD - between the means is equal to 410.43. This difference was determined at a 5% - level of significance with $df = 5$ and 27. Only the difference between the second half of the morning shift and the first half of the afternoon shift exceeded this HSD criterion).

This mean difference is in line with the circadian rhythm hypothesis.

The low performance subjects have greater variability in mean number of stoppages between different 30-minutes work periods than the high performance subjects both in the morning and the afternoon shifts (see Figure VII-3 and Table VII-2). This may be due to the fact that the level of skill of the low performers is lower than that of the high performers. Similar evidence has been provided for car driving by Lewis (1956) who found that highly skilled drivers performed more consistently than less skilled.

The mean number of machine stoppages of the high performance subjects for one hour before the 30-minutes rest pause is significantly higher than that for one hour after it in the morning shift (see Table VII-3). This difference between number of stoppages may be due to the effect of the rest pause as Grandjean (1969) observed that rest pauses form an indispensable requirement for the preservation of work capacity and they are necessary not only for physical work, but also for work imposing

mental and nervous stress. He particularly stressed the importance of rest pauses in repetitive work. It is extensively documented that time losses due to introduction of rest periods do not minimize performance, rather maximize it (Farmer et al. 1922, Miles et al. 1944 and Bhatia et al. 1969).

However, the difference between the number of stoppages of the high performance subjects for one hour before and one hour after rest pause is not significant in the afternoon shift. It is not quite clear as to why for the same group of subjects the rest pause becomes effective in the morning shift and not in the afternoon shift.

It may be noted that in the morning shift the rest pause is given after 3 1/2 hours of work, on the other hand in the afternoon shift it is given half an hour earlier than that, i.e. after 3 hours of work (see Figure VII-3). It seems likely that since the rest pause is given 30 minutes later in the morning shift as compared to that of the afternoon shift, the subjects are somewhat more fatigued before rest pause in the former shift than in the latter shift. So this time difference in introduction of rest pauses in the morning and in the afternoon shifts may be one reason why rest pause is effective in the former shift and not in the latter shift, as it was pointed out by Wyatt (1927) and Murrell (1962) that the effectiveness of rest pauses is a function of the time at which they are introduced.

Another supposition may be that the subjects are more fatigued althrough the morning shift than in the afternoon shift, so the rest pause becomes more effective in the former shift than in the latter shift, irrespective of the time of its introduction. We do not have sufficient ground to think so because it was not possible for us to measure the degree of fatigue of the subjects in both the shifts. We have measured their subjective fatigue only in the afternoon shift, so we do not know whether the subjects were more fatigued in the morning shift or in the afternoon shift (concerning fatigue measurements, see Chapter VIII). However, it may be pointed out that the subjects stopped their machines for significantly longer duration in the morning shift than in the afternoon shift (see Table VII-2), which may provide an indication that they were more fatigued in the former shift

than in the latter shift. Interviews with the subjects reveal that about 60 % of them have to wake up at 05:00 h to reach the factory at 6 o'clock in the morning so that they can start work in time. So, this may be one reason why they are more fatigued in the morning shift than in the afternoon shift.

Another reason may be that in the morning shift the effect of fatigue is augmented by the unfavourable influence of the circadian cycling of arousal (i.e. the low level of arousal) and in the afternoon shift the effect of fatigue is partly compensated by the favourable influence of the circadian cycling of arousal (i.e. the high level of arousal). So the rest pause is effective in the former shift and not in the latter shift. Klein et al. (1977) have indicated that the effects of fatigue are modified by the circadian cycling of arousal.

The results show that for the low performance subjects, the difference between mean number of stoppages for one hour before and one hour after the 30-minutes rest pause is neither significant in the morning shift nor in the afternoon shift (see Table VII-4). The low performance subjects stop machine about three times more than the high performance subjects (see Table VII-1) and their duration of stoppages is about two times longer than that of the latter (see Table VII-11) both in the morning and the afternoon shifts. Thus they get much unofficial rest to recover their fatigue effect, so there is little wonder as to why the prescribed rest pause has no significant effect on them. One possible solution to the problem of unofficial or voluntary rest pauses may be the introduction of prescribed short rest pauses as it was shown by Graf (1955) that prescribed short rest pauses lead to lessening of spontaneous or voluntary pauses. McGhee and Owen (1940) reported that introduction of short rest pauses increased output 29 % and decreased the length of voluntary rest pauses 60 %.

A detailed study of the influence of small rest pauses resulting from hand stoppages of machine shows that for the high performance subjects the number of foot stoppages occurring before such pauses is significantly higher than those occurring after them during both the first and second halves of the work period in the morning shift (see Table VII-7). Thus it indicates that short rest pauses have significant effect in reducing machine stoppages of the high performance subjects. The results support

the findings of a number of other studies that short rest pauses increase performance (Schmidtke 1959, Colquhoun 1959). Lehmann (1953) indicated that several short rest pauses are more advantageous than one long one. Wyatt and Fraser (1925) reported increase in output in a repetitive work of 10 % with two shorter rest periods as compared to that of 5 % with a single longer rest period. Similar results have been reported by Murrell and Forsaith (1963). Jones (1919) showed that when workers took spontaneous rests they produced 16 pieces per hour. When working for 25 minutes and were allowed to take rest for 5 minutes production was 18 pieces per hour. When working for 17 minutes and were given 3 minutes rest production was 22 pieces per hour and when working 10 minutes and were allowed 2 minutes rest production was 25 pieces per hour.

However, the results showed no significant influence of short rest pauses resulting from hand stoppages on the number of foot stoppages of the high performance subjects in the afternoon shift (see Table VII-8).

An obvious question arises as to why short rest pauses resulting from hand stoppages have significant influence on the number of machine stoppages of the high performance subjects in the morning shift and not on those of the afternoon shift. Before trying to answer it, we want to note that the duration of hand stoppages is much shorter in the afternoon shift (e.g. mean is 20 seconds) as compared to that of the morning shift (e.g. mean is 34 seconds). It seems that in the afternoon shift the duration of hand stoppages was too short to provide any recovery effect for the subjects as it was pointed out by Ghiselli et al. (1955) that if the rest pause is too brief it does not help in overcoming work decrement, rather it interrupts the worker.

The results of the present study showed that short rest pauses resulting from hand stoppages neither influenced the foot stoppages in the morning nor in the afternoon shifts for the low performance subjects (see Table VII-9 and VII-10). For the low performance subjects, the durations of hand stoppages are very brief both in the morning (e.g. mean is 9 seconds) and the afternoon shifts (e.g. mean is 15 seconds). The same explanation, as already given, seems to be appropriate here that perhaps the pauses were too brief to be effective.

It may be remarked that in studying machine stoppages our aim was mainly to discover the effects of fatigue and influence of rest pauses in recovering such effects. Although, we do not discount the possible influence of fatigue and rest pauses on the performance of our subjects, yet we find that much of our results can be explained by the circadian rhythm. So it may be suggested that in administering rest pauses the circadian rhythm of the workers should be taken into account.

The results showed that the number of machine stoppages of the high performance subjects is significantly lower than that of the low performance subjects both in the morning and the afternoon shifts (see Table VII-2) and similarly the duration of machine stoppages of the former is significantly shorter than that of the latter in both shifts (see Table VII-12).

Somehow we expected that these two groups of subjects would differ in their number and duration of machine stoppages but it is surprising that these differences are so large (see Table VII-1 and VII-11). Considering these quite large differences in number and duration of machine stoppages between the two groups, it may be suggested that as long as the present type of cigar machine is used, the differences in speed skill between the workers should be taken into account in setting the cycle time of the machines.

CHAPTER VIII

STRAIN IN HIGH AND LOW PERFORMERS

Introduction

Several researchers, as already mentioned in Chapter II, have pointed to the adverse effects of repetitive work on the well being of the workers (e.g. Walker and Guest 1952, Guest 1955, Blauner 1964, Kornhauser 1965, Turner and Lawrence 1965, Gardell 1971) and hence on the quality of their working life. It seems quite logical to believe that these adverse effects are related among others, to high subjective costs (e.g. strain) the workers have to bear. The concept of subjective costs seems to be important in any evaluation of the quality of working life. Indeed in assessing the difficulties of a given work situation, it is clearly not enough to study performance levels (Knowles 1963, Rolfe 1976) but it is also necessary to appreciate all the working conditions (Leplat, 1978) and the effort the worker decides to spend and the resulting strain (Borg 1978).

In this chapter we shall attempt to assess and compare some forms of strain resulting from this short-cycled repetitive work in the high and low performance subjects.

Method

Subjects

It may be reminded here that the number of subjects originally chosen for this study was 40 (see Chapter V). But at the time of administering different measures of strain some of the subjects were absent and some had left the job. So the number of subjects studied are different for different tests.

Measuring Instruments

The following measuring instruments were used:

- Scale for Ratings of Perceived Effort (RPE-scale) (Borg 1962, 1970),
- Feeling of Fatigue Scale,
- Questionnaire for Subjective Symptoms of Fatigue (Yoshitake 1971),
- Critical Fusion Frequency (CFF),
- Inventory for Subjective Health (I.S.H.) (Dirken 1966, 1967).

A brief description of each of these instruments along with the results obtained will be given in the following section.

Scale for Ratings of Perceived Efforts (RPE-scale)

Before describing the RPE-scale, let us explain what we mean by perceived effort. By perceived effort we refer to the worker's experience or feeling of working hard or easily.

The RPE-scale was developed by Borg (1962, 1973). This is a fifteen-point scale for ratings of subjective perception of effort. The scale consists of numbers from 6 to 20 with descriptive phrases appearing with each odd number ranging from "very very light" at 7 to "very very hard" at 19.

In a validation study of the RPE-scale, correlation coefficients, ranging from 0.52 to 0.92, between heart rate (HR) and perceived exertion, using various rating methods, was reported by Borg (1973). Reliability coefficients ranging from 0.70 to 0.97 and validity coefficients ranging from 0.60 to 0.98 of the RPE-scale were reported by Skinner et al. (1973). Borg (1962) obtained high correlation between heart rate and perceived effort ratings, e.g. in a group of healthy people correlations between 0.80 and 0.90 were found when the work intensity was varied from light to heavy work. The fact that there is a significant correlation between perceived effort and heart rate during physical work has been confirmed by several other researchers (e.g. Frankenhaeuser et al. 1969, Ekblom and Goldbarg 1971, Bar-Or et al. 1972, Edwards et al. 1972, Pandolf et al. 1972, Gamberale 1972, Henriksson et al. 1972, Morgan 1973, Stamford 1976, Ulmer et al. 1977). Kinsman and Weiser (1976) have commented that the RPE-scale has become recognized as a valid and reliable scale.

In the present study we used the Dutch version of the RPE-scale (see Appendix E). The scale was administered to the subjects four times (14:30 hours, 17:00 hours, 19:30 and 22:00 hours) during the 8-hour day (14:00 to 22:00 hours). The subjects were instructed every time to rate their effort spent in doing the work during that period.

Mean scores for subjective effort of the high and low performance subjects at four different times of the working day are given in Table VIII-1.

Table VIII-1. Mean scores for perceived effort ratings of the high and low performance subjects at four different times of the working day.

Times of day	High performance subjects (N = 14)	Low performance subjects (N = 11)
14:30 hours	10.42	8.45
17:00 hours	11.57	9.81
19:30 hours	13.14	11.36
22:00 hours	14.14	11.81

Analysis of variance was performed on the RPE-scores for the high and low performance subjects at different times of the day (see Table VIII-2).

The results show that the subjective efforts of the high performance subjects are significantly greater than that of the low performance subjects ($p < .01$).

The effort scores for both the high and low performance subjects increased significantly at every measurement from 2:30 hours till 22:00 hours ($p < .01$).

Table VIII-2. Summary of analysis of variance for RPE data of the high and low performance subjects at four different times of the working day.

Source of variation	SS	df	MS	F	p
Overall mean	12680.02	1	12680.02	1742.22	<.01
Performance	94.44	1	94.44	12.98	<.01
Error	167.39	23	7.27	----	--
Time	185.92	3	61.97	25.85	<.01
Performance x Time	1.28	3	0.42	0.18	ns
Error	165.43	69	2.39	----	--

The results of trend analysis show that the linear component of the trend is significant ($p < .01$). The quadratic and the cubic components are not significant (see Table VIII-3).

Table VIII-3. Trend analysis for RPE data of the high and low performance subjects at four different times of the working day.

Source of variation	SS	df	MS	F	p
Linear trend for time variable at different performance levels	184.53	1	184.53	49.37	<.01
Performance x time effect for linear trend	0.30	1	0.30	0.08	ns
Error	85.97	23	3.73	----	----
Quadratic trend for time variable at different performance levels	0.33	1	0.33	0.12	ns
Performance x time effect for quadratic trend	0.92	1	0.92	0.34	ns
Error	63.01	23	2.73	----	----
Cubic trend for time variable at different performance levels	1.04	1	1.04	1.46	ns
Performance x time effect for cubic trend	0.05	1	0.05	0.08	ns
Error	16.44	23	0.71	----	----

Thus the results indicate that perceived effort of the high and low performance subjects increased linearly with the duration of work (see Figure VIII-1).

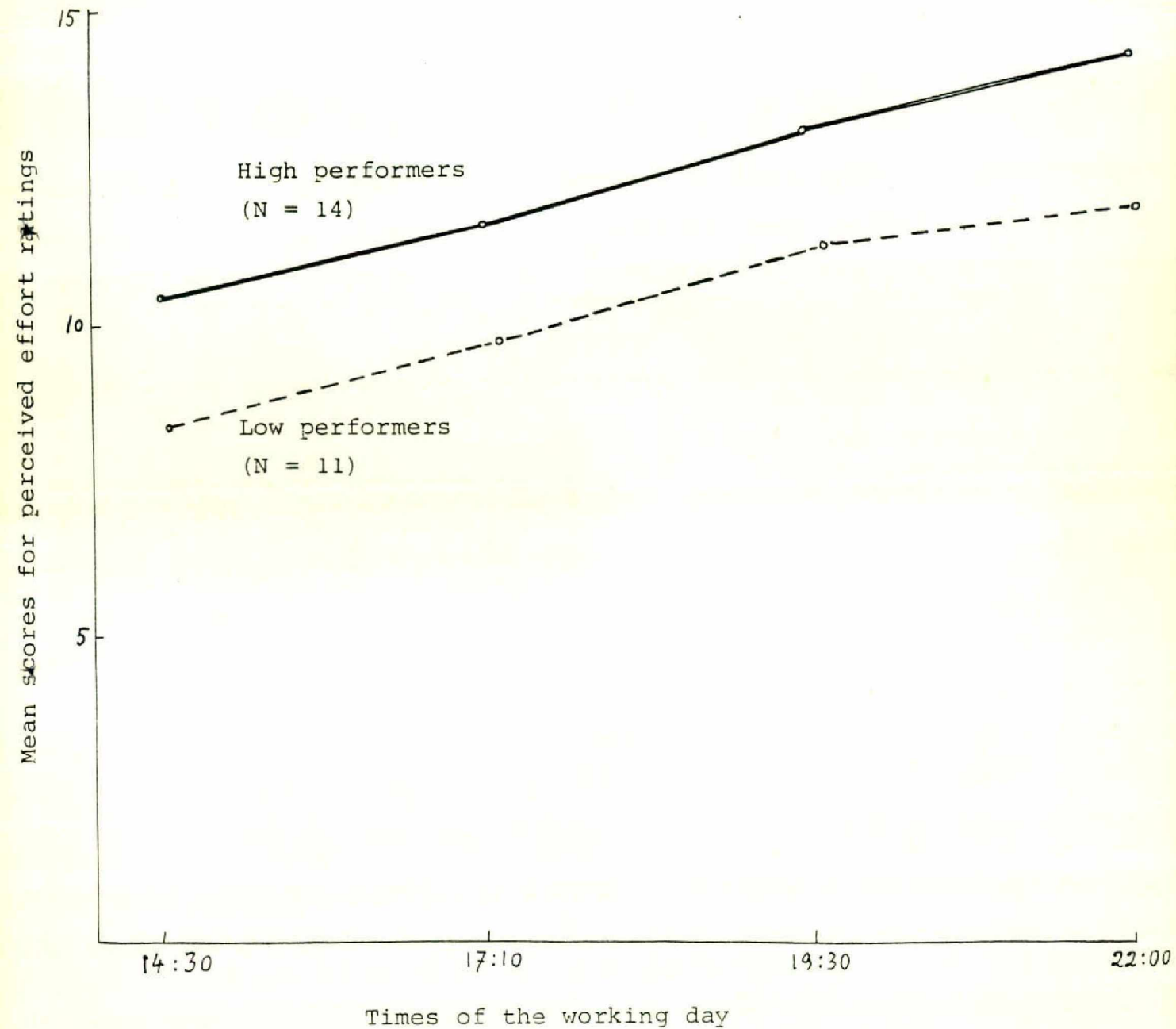


Figure VIII-1. Trend of subjective effort of the high and the low performers at different times of the working day.

Feeling of Fatigue Scale

First let us explain the concept of fatigue and then we shall describe the Feeling of Fatigue Scale.

Fatigue is a broad concept, which is often used to mean different things. Bartley (1976) states: "Not everyone means the same thing when he uses the word fatigue.". The conceptual difficulties of the term fatigue are thoroughly discussed by Simonson (1971). However, there is a substantial agreement in the definition of fatigue as transient decrease of working capacity resulting from work (Ash 1914, Durig 1927, Offner 1928, Simonson 1935, Conklin and Freeman 1939, Dill 1942, Poffenberger 1942, Bornemann 1952, Bartlett 1953, Lehmann 1962, Schmidtke 1965, Tolot 1965).

The term fatigue is commonly used in two main ways: subjective fatigue (to express a subjective feeling) and objective or physiological fatigue (to describe objective measurements).

The subjective fatigue is said to be a kind of experience, awareness or feeling. The objective fatigue is said to be manifested in performance decrement and also marked by changes in body processes. But performance decrement, as pointed by Ghiselli and Brown (1955), is not necessarily a good indicator of fatigue because reduction in performance may be caused by some other factors (e.g. defect in machine). On the other hand, Murrell (1965) points out that studying fatigue in the muscular sense (changes in neuromuscular processes) is meaningful in case of activities which involve heavy muscular exercise but not in case of light industrial work. Bartley and Chute (1945, 1947), and Bartley (1976) point out that fatigue can be considered as a condition that only the individual can identify in himself, since it is a kind of subjective experience.

Here, we shall be concerned with subjective fatigue, i.e. the feeling of fatigue. By the feeling of fatigue we mean subjective experience of reduction in working capacity.

The Feeling of Fatigue Scale, used in the present study, consisted of a line of 100 mm length without any prescribed point or mark on it. The words "Fit" and "Exhausted" were written at the beginning and at the end of the line respectively (the words "Fit" and "Uitgeput" were written in

the Dutch version used in this study, see Appendix F). An important advantage of this scale is that the range of answers permitted is not limited by any prescribed set of points or categories (Gambart et al. 1976).

The scale was administered to the subjects four times (14:30 hours, 17:00 hours, 19:30 and 22:00 hours) during the 8-hour day (14:00 to 22:00 hours). The subjects were instructed to rate their feeling of fatigue every time by putting a mark on the line.

Mean scores for feeling of fatigue of the high and low performance subjects at four different times of the day are given in Table VIII-4.

Table VIII-4. Mean scores for feeling of fatigue of the high and low performance subjects at four different times of the working day.

Times of day	High performance subjects (N = 11)	Low performance subjects (N = 10)
14:30 hours	19.54	4.50
17:00 hours	24.36	9.80
19:30 hours	40.81	28.89
22:00 hours	69.81	50.29

Analysis of variance was performed on the feeling of fatigue scores for the high and low performance subjects at different times of the day. The results are given in Table VIII-5. The results show that the degree of feeling of fatigue of the high performance subjects is significantly greater than that of the low performance subjects ($p < .01$).

For both groups of the subjects these feelings increased significantly at every measurement from 14:30 hours till 22 hours ($p < .01$).

Table VIII-5. Summary of analysis of variance for feeling of fatigue scores of the high and low performance subjects at four different times of the working day.

Source of variation	SS	df	MS	F	p
Overall mean	80570.37	1	80570.37	122.03	<.01
Performance	4879.98	1	4879.98	7.39	<.01
Error	12544.28	19	660.22	----	--
Time	29609.23	3	9869.74	44.84	<.01
Performance x Time	156.24	3	52.08	0.24	ns
Error	12545.28	57	220.09	----	--

The results of trend analysis show that both the linear and the quadratic trends are significant but the cubic trend is not significant (see Table VIII-6).

Table VIII-6. Trend analysis for feeling of fatigue scores of the high and low performance subjects at four different times of the working day.

Source	SS	df	MS	F	p
Overall linear trend for time variable	26698.25	1	26698.25	75.61	<.01
Performance and time interaction effect for linear trend	24.31	1	24.31	0.07	ns
Error	6708.96	19	353.10	----	----
Overall quadratic trend for time variable	2905.59	1	2905.59	12.87	<.01
Performance and time interaction effect for quadratic trend	80.26	1	80.26	0.36	ns
Error	4289.68	19	225.77	----	----
Overall cubic trend for time variable	5.39	1	5.39	0.07	ns
Performance and time interaction for cubic trend	51.66	1	51.66	0.63	ns
Error	1546.63	19	81.40	----	----

The results of the trend analysis lead to the conclusion that although there is a significant linear relationship between the feeling of fatigue and the duration of work for both the high and low performance subjects, yet linearity does not seem to be a sufficient good fit, because there is a significant curvature in the trend of the mean scores for feeling of fatigue at different times of the day for both the high and low performance groups (see Figure VIII-2).

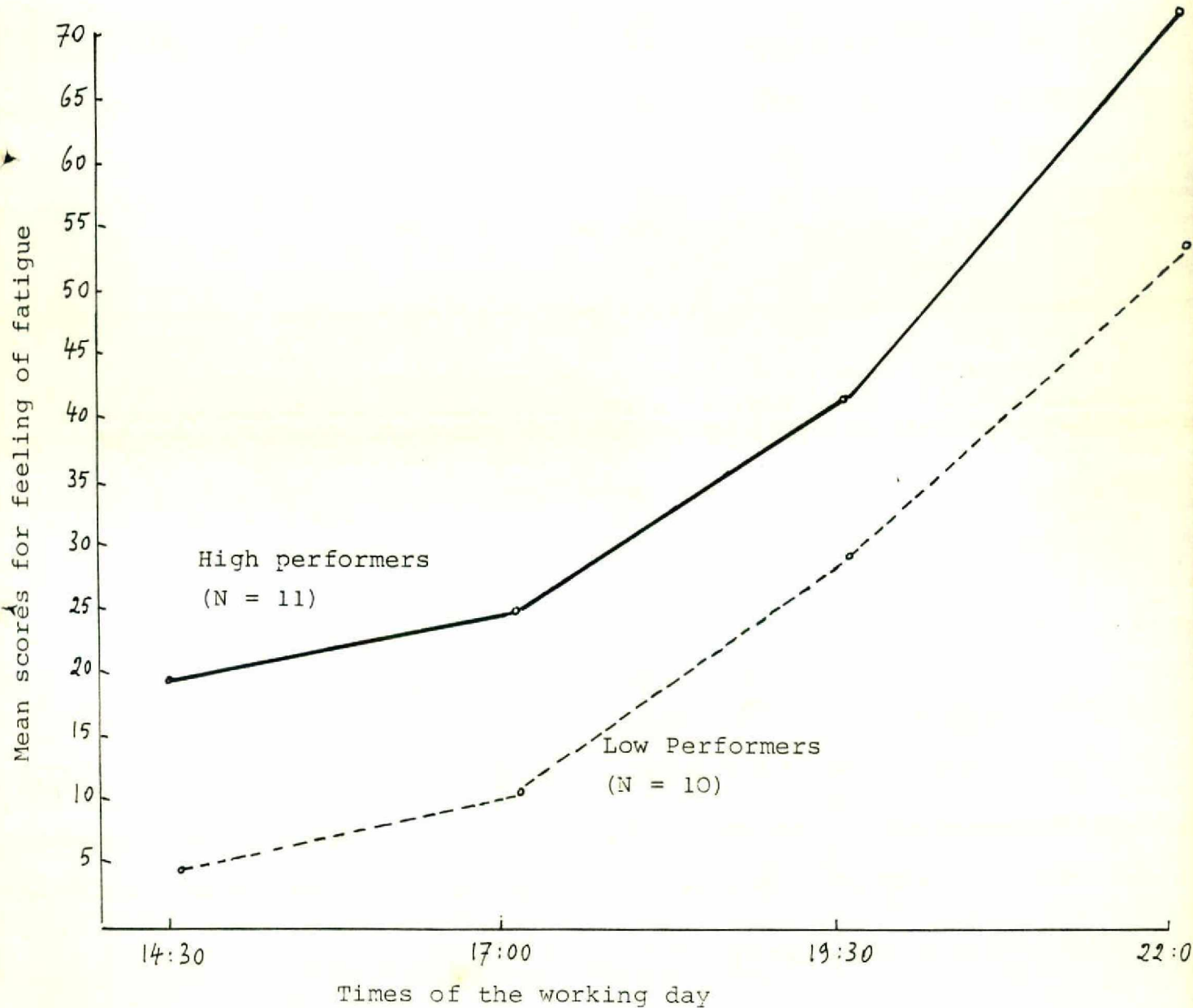


Figure VIII-2. Trend of feeling of fatigue of the high and the low performance subjects at different times of the working day.

Pearson's product moment coefficients of correlation between the scores on the RPE-scale and the Feeling of Fatigue Scale at four different times of the work period for the high and low performance subjects are given in Tables VIII-7 and VIII-8.

Table VIII-7. Pearson's product moment coefficients of correlation between the scores on the RPE-scale and the Feeling of Fatigue Scale at different times of the work period, for the high performance subjects.

		Times of administration of Fatigue Scale			
		14:30 hours	17:00 hours	19:30 hours	22:00 hours
Times of administration of the RPE-scale	14:30 hours	0.82**	0.39	0.05	-0.07
	17:00 hours		0.83**	0.61*	0.05
	19:30 hours			0.77**	0.23
	22:00 hours				0.88**

Note. N = 11; * = $p < .01$ (one tailed); ** = $p < .001$ (one tailed); the correlation coefficients without asterisk are not significant.

Table VIII-8. Pearson's product moment coefficients of correlation between the scores on the RPE-scale and the Feeling of Fatigue Scale at different times of the work period, for the low performance subjects.

		Times of administration of Fatigue Scale			
		14:30 hours	17:00 hours	19:30 hours	22:00 hours
Times of administration of the RPE-scale	14:30 hours	0.52	0.49	0.44	0.18
	17:00 hours		0.70**	0.67**	0.69**
	19:30 hours			0.58*	0.54*
	22:00 hours				0.49

Note: N = 10; * = $p < .05$ (one tailed); ** = $p < .01$ (one tailed); the correlation coefficients without asterisk are not significant.

The results show that all the "simultaneous" correlations (i.e. the correlations between the two scales at the same hours of the work period) between the scores of the RPE-scale and the Feeling of Fatigue Scale are significant for the high performers and most of them are significant for the low performers. Moreover, the "simultaneous" correlations for the high performers are significantly higher than those for the low performers (Mann-Whitney: $U = 0$, $p < .02$, one tailed).

Questionnaire for Subjective Symptoms of Fatigue

In the present study, the subjective symptoms of fatigue may be considered as specific forms of impairment experienced by the subject during work.

The Questionnaire for Subjective Symptoms of Fatigue was developed by the Industrial Fatigue Research Committee of the Japanese Association of Industrial Health. It consists of 30 items concerning general and specific bodily and mental symptoms of fatigue to which the subjects answer yes or no.

Several researchers have provided evidence of validity of this questionnaire (Kogi et al. 1970, Saito et al. 1970). In a study on bank employees, Yoshitake (1971) has found a high correlation between the frequency of complaints of fatigue and the feeling of fatigue,

In the present study, we used the Dutch version of this questionnaire (see Appendix G). The questionnaire was administered to the subjects immediately before they started work and immediately after they finished it.

Mean scores for subjective symptoms of fatigue of the high and low performance subjects immediately before and after work are given in Table VIII-9 and Figure VIII-3.

Table VIII-9. Mean scores for subjective symptoms of fatigue of the high and low performance subjects immediately before and after work.

	Before work	After work
High performance subjects (N = 14)	2.28	5.42
Low performance subjects (N = 11)	0.54	2.00

Analysis of variance was performed on the symptoms of fatigue scores immediately before and after work for the high and low performance subjects (see Table VIII-10).

Table VIII-10. Summary of analysis of variance for symptoms of fatigue scores of the high and low performance subjects immediately before and after work.

Source	SS	df	MS	F	p
Overall mean	324.20	1	324.20	16.99	<.01
Performance	82.28	1	82.28	4.31	<.05
Error	438.78	23	19.07	----	----
Time	65.09	1	65.09	14.65	<.01
Performance x time	8.77	1	8.77	1.98	ns
Error	102.22	23	4.44	----	----

Results of analysis of variance show that the high performance subjects have a greater number of complaints of fatigue than the low performance subjects ($p < .05$).

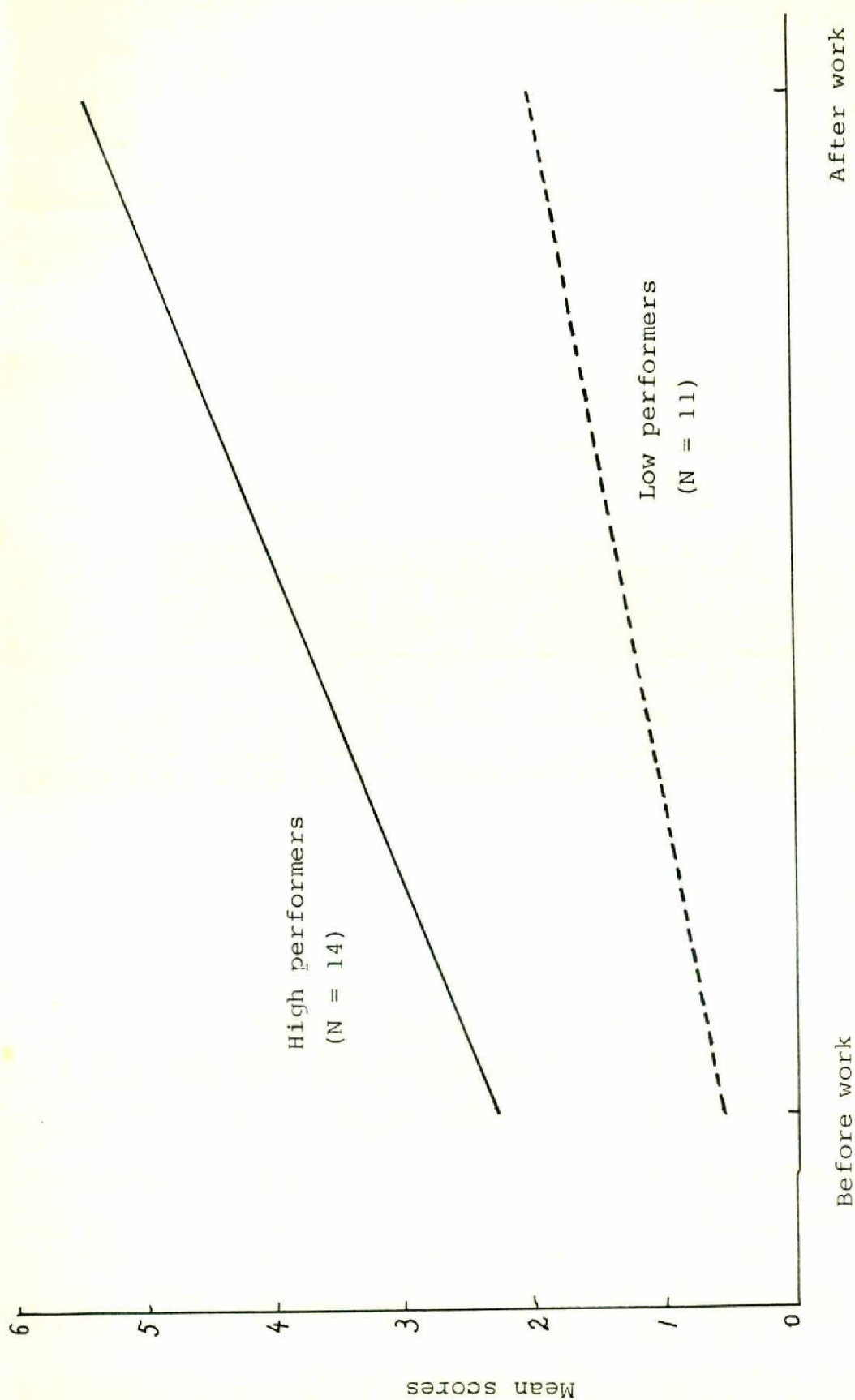


Figure VIII-3. Mean scores for subjective symptoms of fatigue of the high and the low performance subjects immediately before and after work.

The number of complaints immediately before work is significantly greater than the number of complaints immediately after work for the subjects of both groups ($p < .05$).

$\bar{Z}$ -tests for the difference between proportions were performed for the frequency of complaints concerning some specific bodily symptoms on the Questionnaire for Subjective Symptoms of Fatigue, made by the high and low performance subjects immediately after their work. The results show that significantly more high than low performers made such type of complaints as tiredness in the legs, strain in the eyes and pain in the waist (see Table VIII-11).

Table VIII-11. The distribution pattern of the frequency of complaints on the following items of symptoms of fatigue made by the high and low performance subjects immediately after their work.

	High performers		Low performers		$\bar{Z}$	p
	Yes	No	Yes	No		
Feel tired in the legs	6	8	1	10	1.83	<.05(one tailed)
Feel strained in the eyes	9	5	2	9	2.42	<.02(two tailed)
Feel pain in the waist	10	4	3	8	2.31	<.05(two tailed)

Critical Fusion Frequency (CFF)

It is well known that if one goes on increasing the frequency of an intermittent light then at a certain value one cannot perceive flicker and this frequency of light at which flicker disappears and fusion just occurs is called critical fusion frequency (CFF).

Simonson and Enzer (1941) found a significant drop of the CFF in clerical workers, laboratory technicians and in laundry workers, paralleling the sensation of subjective fatigue. Subsequent to this finding, numerous studies have been conducted about the decrease of CFF after light physical, mental and muscular work and many of these studies (see reviews by Rey 1973, and Bartley et al. 1976) have confirmed the view that drop of CFF is an indicator of fatigue.

In the present study the CFF was determined by the successive approximation method (Rey and Rey, 1963). According to this method, we alternately switched on to higher frequency (e.g. frequency of intermittent light at which the subjects could not see any flicker) and lower frequency (e.g. frequency of intermittent light at which the subjects could see flicker). The subjects were instructed to say "Yes" when they would see flicker and "No" when they would not see any flicker. The differences between the values for flicker and fusion were gradually reduced until these two values would finally converge to a point, which was regarded as the CFF value.

The subjects were tested twice (e.g. immediately before starting work and immediately after finishing it). Every subject was given 3 trials each time and the mean value for these trials was regarded as the CFF value for that time.

The results show that the CFF value immediately before work is significantly greater than the CFF value immediately after work for the subjects of both high and low performance groups (see Table VIII-12 and Figure VIII-4).

Table VIII-12. Mean CFF scores for the high and low performers immediately before and after work.

	Mean CFF value before work	Mean CFF value after work	t	p
High performers (N = 14)	31.98	30.93	2.07	<.05(one tailed)
Low performers (N = 10)	32.28	31.48	2.04	<.05(one tailed)

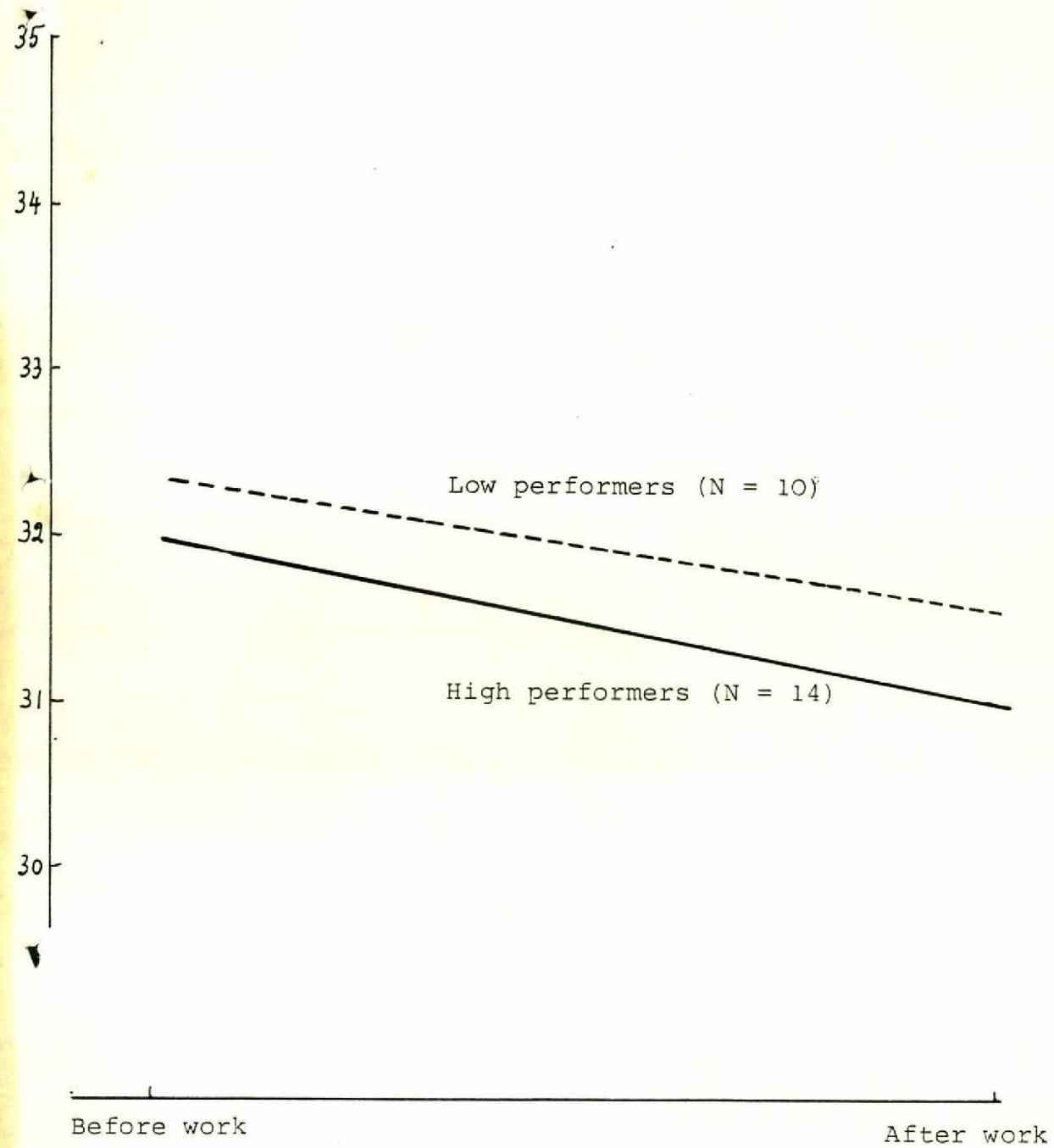


Figure VIII-4. Mean CFF value for the high and low performance subjects immediately before and after work.

Scores on the Inventory for Subjective Health (I.S.H.) of the high and low performance subjects are presented in Figure VIII-5.

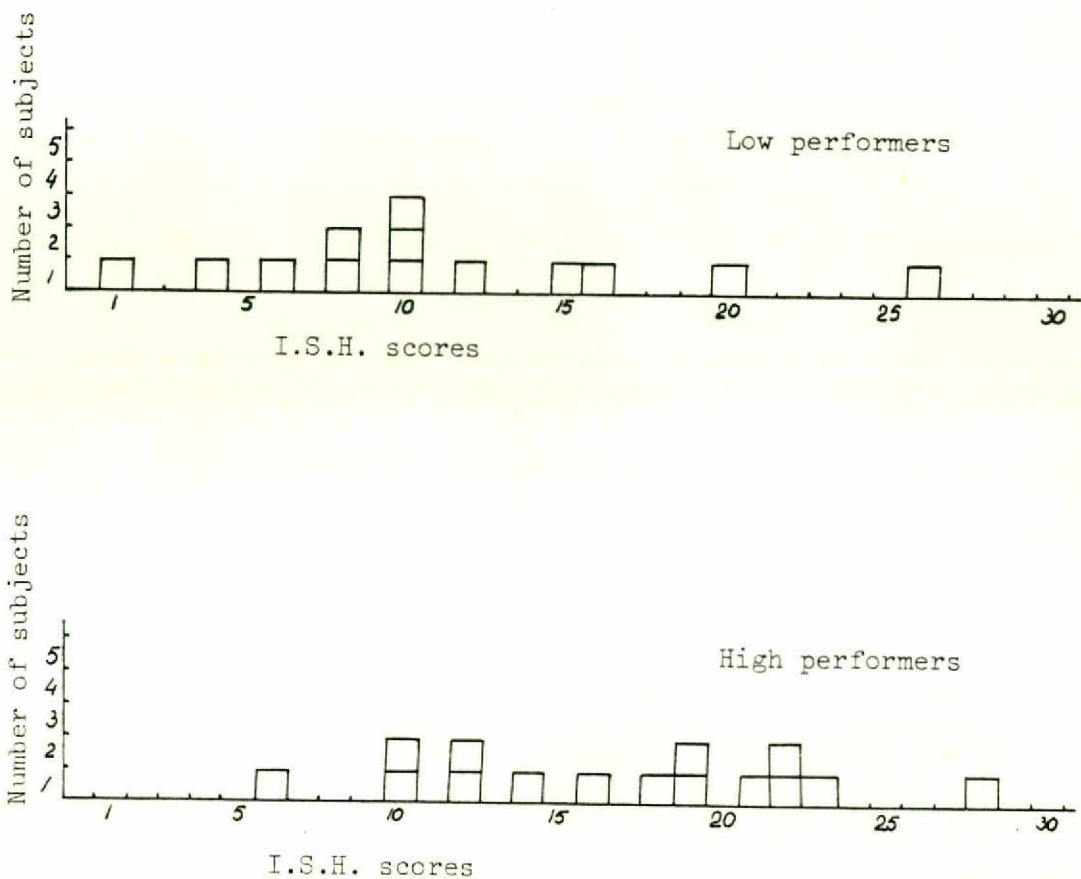


Figure VIII-5. Scores on the Inventory for Subjective Health (I.S.H.) of the high and low performance subjects.

Inventory for Subjective Health (I.S.H.)

The Inventory for Subjective Health was used to assess health complaints of the subjects. The inventory consists of 58 questions concerning health complaints of various types, to which the subject answers yes or no; 48 of those questions are used to compute a score for an inverse approximation of general health. The other 10 items serve to stimulate concentration during the filling out of the form and to prevent the effects of irrelevant response-sets.

For standardization and validation of this inventory, nearly 2500 workers in several industries were investigated (Dirken 1967). This inventory has been found significantly correlated with absenteeism and medical diagnoses and also with neuroticism as measured by the inventory of Wilde (1963). The internal consistency coefficient of .94 for this inventory has been found by Dirken (1967) in a group of 1782 manual workers.

In the present study we have used the Dutch version of the I.S.H. which is known as the V.O.E.G. (see Appendix H).

Mean scores on the Inventory for Subjective Health (I.S.H.) of the high and low performance subjects are given in Table VIII-13.

Table VIII-13. I.S.H. scores of the high and low performance subjects.

	Mean number of complaints	t	p
High performance subjects (N = 15)	16.80		
Low performance subjects (N = 15)	10.53	2.73	<.02 (two tailed)

The mean number of subjective health complaints of the high performance subjects is significantly higher than that of the low performance subjects (see Table VIII-13).

Discussion

The results of the RPE-scale, in the present study, show that the degree of perceived effort of the high performers is significantly greater than that of the low performers (see Table VIII-2). There are not many studies, concerning the relationship between perceived effort and performance in perceptual and mental work, with which our results can be compared. A brief review of literature in this field (Borg 1978) shows that there are some studies which provide evidence of relationship between these two parameters. Ulmer et al. (1977) reported that perceived effort is correlated with both stress and strain. Our results show that perceived effort increased linearly during the working period for the subjects of both groups (see Figure VIII-7). A study by Gross et al. (1974) indicated that there is a linear relationship between RPE-scores and work load.

The results concerning feeling and symptoms of fatigue show that the degree of feeling of fatigue is significantly greater for the high performers than for the low performers (see Table VIII-5) and the high performers have made^a significantly greater number of complaints of fatigue than the low performers (see Table VIII-10).

Significant "simultaneous" correlations between the scores of the RPE-scale and the Feeling of Fatigue Scale indicate that perhaps the subjects considered effort and fatigue as the same setting.

Analysis of specific bodily symptoms of fatigue reveals that the high performers made more complaints concerning eye strain, feeling of pain in waist and legs than the low performers (see Table VIII-11). With regard to the question as to how far these subjective ratings of fatigue relate to objective measures, we want to refer to the study by Weber et al. (1975), which provides evidence of a significant relationship between subjective and objective assessment of fatigue.

The present study provides evidence of significant decrease in CFF values after work as compared to that of before work for the subjects of both the groups (see Table VIII-12). Considering the wide individual

differences in CFF (Grandjean et al. 1971), we have not compared the CFF values for the high and the low performers. We have compared the results for before and after work within each group.

The results on the I.S.H. show that the number of health complaints of the high performers is significantly higher than that of the low performers (see Table VIII-13). This seems to be an indication of probable long term effect of continuously higher level of effort spent by the high performers to meet the task demand.

So, the results of the present study provide more or less consistent evidence that, in this repetitive work, the high performance subjects spend more effort and experience more strain as compared to the low performance subjects. A work situation like this, where a higher level of performance is attained at the cost of a greater degree of perceived effort and strain cannot be considered favourable for the quality of working life.

Reducing stress and strain by slowing down performance may not be an acceptable solution. A likely solution may be the readjustment of the bonus system, so that the workers do not impose too heavy stress on themselves for earning more money. Comparison of the amount of bonus earned by the high and low performers reveals that, as expected, the former earn a significantly ($p < .05$), one tailed) higher rate of bonus than the latter (see Appendix I). But it is quite startling to find that to earn, as already mentioned, only about 12 % more than their basic hourly wages, the workers have to produce about 60 % more cigars. Thus it gives a clear indication that the high performers seem to earn a higher rate of bonus at the cost of bearing more stress and strain.

It may be reminded here that to find whether performance is related to satisfaction in this repetitive job, we measured the job satisfaction of these two groups of subjects (see Chapter VI and Khaleque 1979) with the help of the Brayfield-Rothe Scale and Job Description Index (JDI). The results of the Brayfield-Rothe Scale revealed that the mean score of job satisfaction of the high performers is significantly ($p < .05$, two tailed) higher than that of the low performers. Scores obtained by the

Job Description Index correlated significantly ($p < .001$, two tailed) with the scores obtained by the Brayfield-Rothe scale. But the results showed that two JDI subscales (i.e. work and pay) out of the five (i.e. work, pay, promotion, supervision and co-workers) neither correlated significantly with the subscales of the same test nor with the Brayfield-Rothe test.

To find an answer to the question as to why the high performers are eager to earn more bonus at the cost of too heavy stress and strain, we have further analysed the scores of the high and low performance subjects on the JDI subscale "pay". The results show that the mean score of the high performers is significantly ($p < .05$, one tailed) lower than that of the low performers (see Appendix J). This fact seems to confirm our supposition that the high performers are subjecting themselves to more stress and strain for earning a higher rate of bonus because they are less satisfied with their pay.

The characteristic ergonomic approach to the problem as pointed out by Welford (1973) is to modify the task, so that it does not make excessive demand on the workers. Adaptation of cycle time of machine to the differences in speed skill of the workers may reduce excessive demand of this task to certain extent. Introduction of short rest pauses may also be suggested.

It seems that there is little scope for improving this job by enlarging it, because addition of some more related tasks may make the job still more difficult as the workers are already doing a bit too many of them. In some cases enlargement can make the job more stressing (Chichester-Clark 1973). However, there seem to be some possibilities for job enrichment, such as giving the worker greater responsibilities for organizing and checking own work, making schedule, maintaining machine, setting pace of machine, etc. But job rotation is not possible, firstly, because this job requires quite a long time to learn and secondly, no similar job is available for rotation.

The final solution to the problem of this repetitive job may lie in automation, which actually is going to take place in the near future.

CHAPTER IX

STRAIN IN SATISFIED AND DISSATISFIED WORKERS

Introduction

In the previous chapters the problem of strain in the high and low performance subjects has been discussed. In this chapter we will compare and discuss the strain in satisfied and dissatisfied subjects.

It may be reminded that our subjects have been divided into satisfied and dissatisfied groups on the basis of their scores in the Brayfield-Rothe scale of job satisfaction.

In this chapter our discussion will concentrate more on the heart rate than on other indices of strain. There are two reasons for it. Firstly the heart rate is the only measure on which the subjects of the satisfied and dissatisfied group have been found to differ significantly and secondly the results on other indices of strain have been discussed somewhat elaborately in the previous chapter.

The fact that the heart rate is influenced by energy expenditure during muscular work and also by thermal load has been definitively established by several studies (see recent studies as e.g. Vogt 1964, Vogt and Meyer 1968, Vogt et al. 1973). Heart rate has been found to increase almost linearly with oxygen consumption during moderately heavy or heavy physical work (Maritz et al. 1961, Wald et al. 1975).

On the other hand heart rate responds to many other influences. Besides muscle activity and climate, Monod (1967) has listed in his review another five main sources: digestion, posture, attitude, noise, and psychosensory activity.

Heart rate is also influenced by emotional stress or tension. Studies of emotional stress on heart rate have been made both in the laboratory and in more realistic situations. A number of laboratory studies have suggested that subjects show a rise in heart rate when anticipating a shock but a fall in it when the noxious stimulus is just about to occur (Dean and Zeaman 1958, Deane 1961 and Jenks et al. 1963).

Rutenfranz (1960) conducted a laboratory experiment on heart rate during work under time pressure. The idea behind this experiment was that people working on assembly lines with too short time settings might have too high heart rates. Because they cannot properly react in time due to very short machine cycle, they get frustrated and this emotional state would increase heart rate. So the hypothesis was that increase in heart rate during work under time pressure is caused by psychological factors.

Rutenfranz employed five subjects, who were presented with computational problems under three conditions: difficult computations with constant speed for 15 minutes; difficult computations with increasing speed for 25 minutes and easy problems with increasing speed for 15 minutes. The heart rate of the subjects increased significantly in all three conditions. But the heart rate was much higher in the second condition where the subjects had to work under time pressure. After stopping the experiment much longer time was required for the heart rate to come down to the resting level in the second condition compared to the other conditions. Rutenfranz comments that time pressure causes disagreeable feelings and hyperactivation, which lead to high heart rate. Some other experiments have shown small rises in heart rate during mildly stressful situations (Blatt 1961 and Johnson et al. 1967). A fall in heart rate has been found to occur when subjects are expecting a pleasant sound (Steward 1962). Doerr et al. (1965) found heart rate to increase when frustrating instructions were given. Krol and Opmeer (1969) found that heart rate differed with different levels of emotional stress. Wycherley et al. (1970) have commented that very small changes in heart rate have been found in laboratory studies and that the types of stressor used in such studies are far removed from those encountered in real life.

Studies in realistic situations have shown more substantial rises of heart rate due to emotional stress during light work or mental work. Ira et al. (1963) in a telemetry experiment showed rises in the heart rate of physicians during stressful situations. Blake et al. (1966) found increases in the heart rate of pilots and observers during 8-hours flights. Ruffel Smith (1967) in an investigation of stress in commercial airline pilots found increases of 5 to 10 per cent in the heart rate during pre-flight checks and 50 per cent increase before and after take-off. During the flight, the level fell to that of pre-flight checks, unless special hazards were encountered. Lewis et al. (1967) noted high heart rate in naval aviators during combat bombing runs and during carrier operations. Taggart and Gibbons (1967) found that during peak traffic hours drivers had heart rates of 100 to 140 beats/min, and competitive racing drivers were found to have heart rates of 150 to over 200 beats/min while awaiting the start signal for a race. Simonson et al. (1968) in a study concerning the heart rate of car drivers, found rises of 20 per cent over resting rates when driving in a rural area, 28 per cent for urban areas and 43 per cent in critical situations. In a study on the heart rate of blind and sighted pedestrians on a town route, Wycherley and Nicklin (1970) found higher rates for the blinds on the route and they indicated that this difference between blind and sighted was due to psychological rather than physical stress.

A study by Pasmooij et al. (1976) has shown the effect of emotional load on heart rate. The effect which pure emotional load can have on the heart rate of an air traffic controller is shown in Figure IX-1. The registration was made during a standard traffic situation with four aircraft simultaneously under control and a rated difficulty of the task by the observer of 10 %. The arrow indicates the moment the controller reports to a pilot that his aircraft is 12 miles off track and in military airspace. This was a very unusual situation, because this flight takes place each day at the same time, and therefore is a fairly routine one for both controller and pilot. The alarm of the controller produced an excessive increase of his heart rate while neither the controller, nor the observer outwardly showed any emotion.

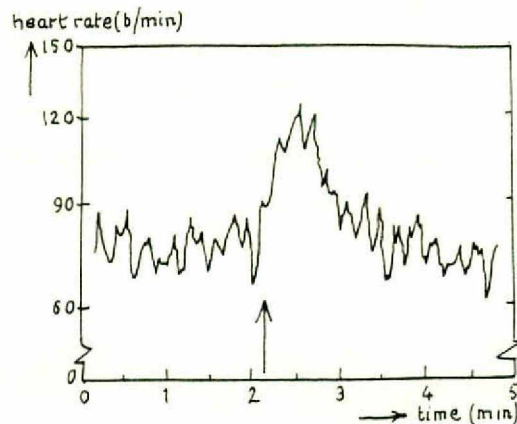


Figure IX-1. The effect of emotional load on heart rate (Fig. 5 from C.K. PASMOOLIJ, D.H.J.M. OPMEER and B.W. HYNDMAN, Work load in Air Traffic Control, in Th.B. SHERIDAN and G. JOHANNSEN (Eds.), Monitoring Behavior and Supervisory Control, New York and London, 1976, Plenum Press, p. 115).

The studies mentioned above do not, however, include any investigation of heart rate due to emotional stress or tension during a typical routine industrial workday of 7 or 8 hours.

In a study of workday stress on the heart rate of industrial managers. Hennigan et al. (1975) indicated that stressful situations cause high heart rate. Monod and Lille (1976) reported a case in which during constant monitoring of the heart rate of an automobile assembly line worker the heart rate increased when a trivial incident happened (see Figure IX-2). The worker was unable to fix a ring clamp on a radiator-hose because of a defective screw.

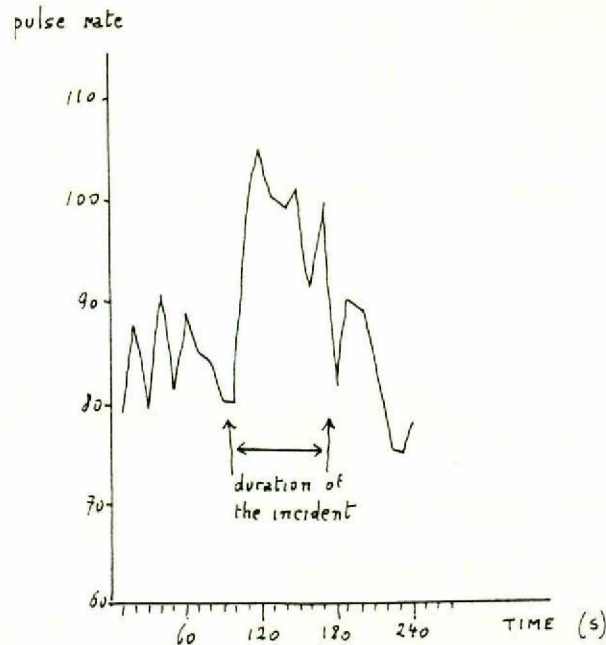


Figure IX-2. Effect of an incident on heart rate of an automobile assembly line worker. (after Figure 26 from H. MONOD and F. LILLE, *L'évaluation de la charge de travail, Archives des maladies professionnelles, de médecine du travail et de Sécurité Sociale*, 1976, 37, no 1-2, p. 1-96.)

We have measured the heart rate of the subjects to study the influence of performance and job satisfaction on it. In the previous chapter we have compared the heart rates of the high and low performance subjects and in this chapter we will compare and discuss the heart rates of satisfied and dissatisfied subjects. It may be mentioned here that originally we had no plan to measure the heart rate of the subjects. However, later on we decided to measure it in order to understand their strain in the present job as comprehensively as possible.

Method

Subjects

A total of 40 subjects, as already mentioned, was originally chosen for this study (a detail description of subjects' sampling is given in Chapter V). On the basis of their scores in the Brayfield-Rothe scale of job satisfaction 26 of them were categorized as satisfied and 14 as dissatisfied subjects. But later on, when we measured heart rate and other indices of strain, some of them were absent and some had left the job. So, the numbers of subjects are different for different tests.

Apparatus

The heart rate of our subjects was measured by a very simple heart beat detector with an ear lobe transducer. This apparatus consists of a small box containing appropriate electronic circuitry. On the cover of the box there is a red signal lamp. The box is connected by a 1.5 m long wire with an ear clip, which is equipped with a small lamp at one side and a photoelectric cell at the other side. The clip would be fixed with the ear lobe of the subjects and the signal lamp put on. The translucency of the ear lobe changes with each pulse wave. This causes variation in the current produced by the photoelectric cell with each heart beat. This varying current is conducted to the small box containing the circuitry which flashes the red signal lamp at each heart beat. Thus heart beats would be displayed as light flashes. We counted the number of these flashes for one minute and with every subject five such measurements were taken with intervals of about one and a half hour. Before starting the measurement, the apparatus was introduced to each subject individually so that they were used to it when measuring their heart rate during work. We used this simple apparatus so that the subjects could continue their work quite comfortably at their usual speed during heart rate measurement.

Procedure

To study strain in the satisfied and dissatisfied subjects we have compared their scores on the following measures of strain:

1. Heart rate: we have compared the mean heart rate scores of the satisfied and dissatisfied groups. Considering the limitation of this comparison due to quite smaller number of subjects in the dissatisfied group we have calculated the correlation coefficient between the heart rate scores and job satisfaction scores of the subjects.
2. Feeling of fatigue: we have compared the feeling of fatigue scores between these two groups at four different times of the day and performed analysis of variance to see whether they differ significantly.
3. Subjective health complaints: we have compared the mean scores of the satisfied and dissatisfied groups on the Inventory for Subjective Health and performed t-test to find whether there is a significant difference between the means.

To study the subjective effort (*) of the satisfied and dissatisfied subjects we have analysed their scores on the ratings of perceived effort (RPE) scale. We have also studied the correlation between the heart rate and the RPE scores of the subjects. The results of all these comparisons are presented in the following section in the same order.

Results

Heart rate scores of the satisfied and dissatisfied subjects are presented in Figure IX-3 and the mean scores in Table IX-1.

Table IX-1. Mean scores of heart rate of the satisfied and dissatisfied subjects.

	Mean scores	t	p
Satisfied subjects (N = 15)	81.93	2.74	<.02 (two tailed)
Dissatisfied subjects (N = 7)	91.69		

* As said earlier it is not possible to consider subjective effort solely as a strain. It is as much a stress as a strain.

The results in Table IX-1 show that the mean heart rate of the dissatisfied subjects is significantly ($p < .02$) higher than that of the satisfied subjects.

Pearson's product-moment coefficient of correlation between heart rate scores and job satisfaction (Brayfield-Rothe scale) scores of the satisfied and dissatisfied subjects taken together is given in Table IX-2 and graphic presentation of the correlation is given in Figure IX-4.

Table IX-2. Pearson's product-moment coefficient of correlation between heart rate scores and job satisfaction (Brayfield-Rothe scale) scores of the subjects.

	N	r	p
Correlation between heart rate and job satisfaction	22	-0.53	$< .01$ (two tailed)

The correlation between heart rate and job satisfaction scores is significant ($p < .01$).

The mean scores for feeling of fatigue of the satisfied and dissatisfied subjects at four different times of the day are given in Table IX-3.

Table IX-3. Mean scores for feeling of fatigue of the satisfied and dissatisfied subjects,

Times of day	Satisfied subjects (N = 15)	Dissatisfied subjects (N = 6)
14:30 hours	15	5.83
17:00 hours	19.13	13.16
19:30 hours	38.66	26.33
22:00 hours	61.73	57.50

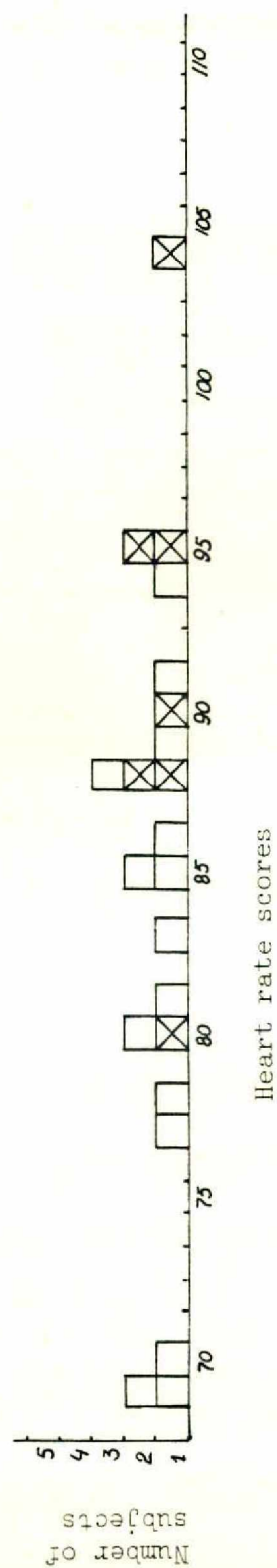


Figure IX-3. Heart rates of the satisfied subjects (□) and dissatisfied subjects (⊠).

Analysis of variance has been performed for the feeling of fatigue scores of the satisfied and dissatisfied subjects at four different times of day. The results are given in Table IX-4.

Table IX-4. Summary of analysis of variance for feeling of fatigue scores of the satisfied and dissatisfied subjects.

Source of variation	SS	df	MS	F	p
Overall mean	60367.31	1	60367.31	70.16	<.01
Satisfied and dissatisfied (A)	1076.66	1	1076.66	1.25	n s
Error	16347.62	19	860.40	---	---
Time (B)	24999.19	3	8333.06	37.89	<.01
A x B	164.73	3	54.91	0.25	n s
Error	12536.80	57	219.94	---	---

The results in Table IX-4 show that there is no significant difference between the satisfied and dissatisfied subjects in their feeling of fatigue. However, the feeling of fatigue differed significantly ($F = 37.89$, $df = 3$, $p < .01$) between different times of day for the subjects of both the groups. But this fact is not quite meaningful in the present context because here we are mainly interested in studying the effects of satisfaction and dissatisfaction on the feeling of fatigue.

The mean scores for the subjective health complaints of the satisfied and dissatisfied subjects are presented in Table IX-5.

Table IX-5. Mean scores for the subjective health complaints of the satisfied and the dissatisfied subjects.

	Mean	t	p
Satisfied subjects (N = 18)	12.61	1.02	ns
Dissatisfied subjects (N = 12)	15.25		

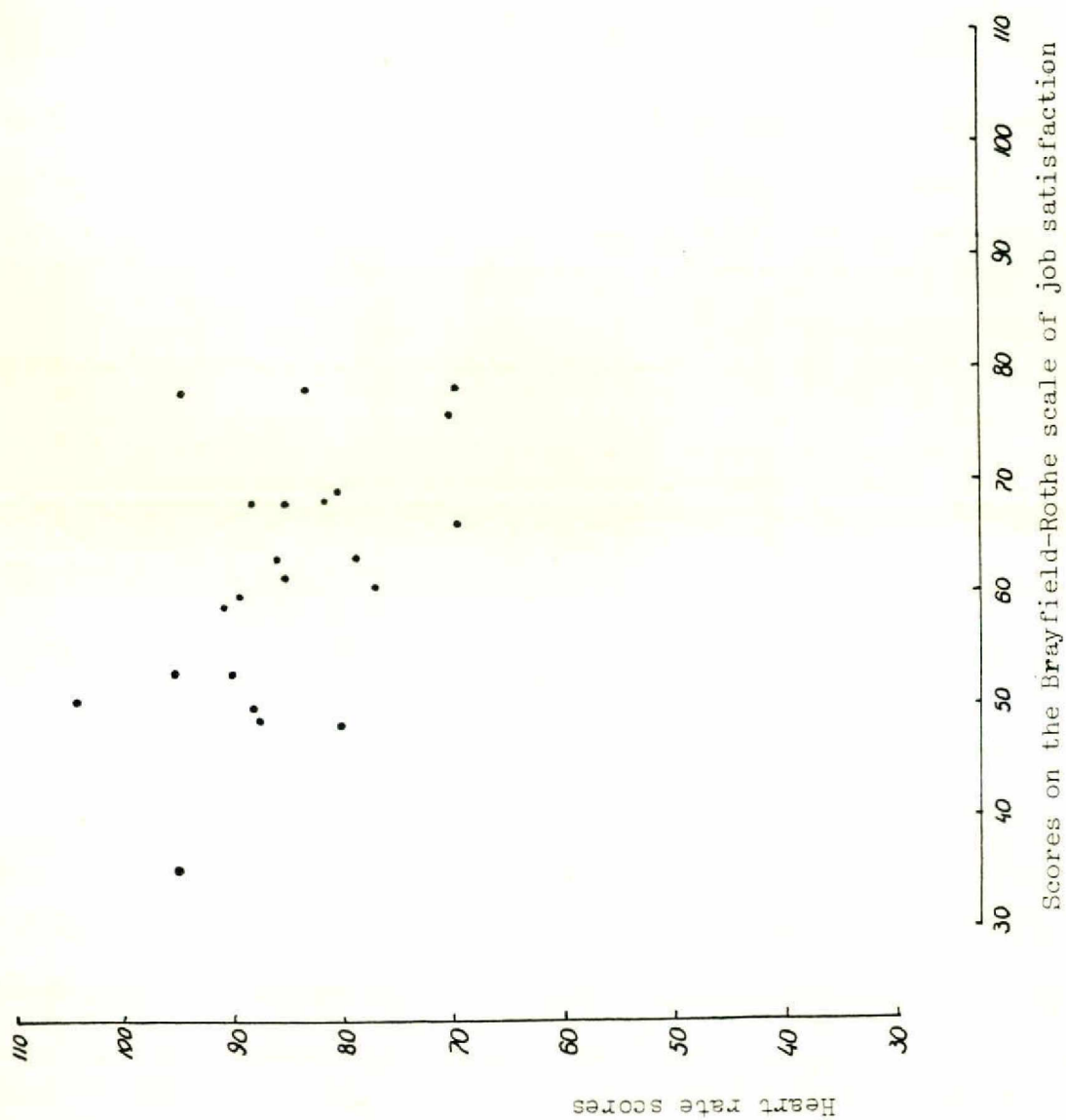


Figure IX-4. Relationship between heart rate and job satisfaction (N = 22).

The mean difference between the subjective health complaints of the satisfied and dissatisfied subjects is not significant.

Pearson's product-moment coefficient of correlation between heart rates and subjective health complaints of the satisfied and dissatisfied subjects taken together is given in Table IX-6.

Table IX-6. Pearson's product-moment coefficient of correlation between heart rates and subjective health complaints.

	N	r	p
Correlation between heart rates and subjective health complaints	21	0.03	ns

The correlation between heart rates and subjective health complaints is not significant.

The mean scores for ratings of perceived effort (RPE scores) of the satisfied and dissatisfied subjects are given in Table IX-7.

Table IX-7. Mean scores for ratings of perceived effort (RPE scores) of the satisfied and dissatisfied subjects.

Times of day	Satisfied subjects (N = 18)	Dissatisfied subjects (N = 7)
14:30 hours	9.61	9.42
17:00 hours	10.61	11.42
19:30 hours	12.05	13.14
22:00 hours	12.61	13.57

Analysis of variance has been performed on the perceived effort scores of the satisfied and dissatisfied subjects at four different times of day. The results are presented in Table IX-8.

Table IX-8. Summary of analysis of variance for RPE scores of the satisfied and dissatisfied subjects.

Source of variation	SS	df	MS	F	p
Overall mean	10771.60	1	10771.60	968.24	<.01
Satisfied and dissatisfied (A)	9.06	1	9.06	0.82	ns
Error	255.87	23	11.12	----	---
Time (B)	158.83	3	52.94	21	<.01
A x B	5.07	3	1.69	0.69	ns
Error	169.90	69	2.46	----	---

There is no significant difference between the two groups of subjects in their perceived effort. However, the perceived effort differed significantly ($F = 21$, $df = 3$, $p < .01$) between different times of day for the subjects of both the groups. But here we are not much interested in this fact as our main interest was to study the effect of satisfaction and dissatisfaction on the perceived effort of the subjects.

We have computed Pearson's product-moment coefficient of correlation between the heart rate and perceived effort scores of the satisfied and dissatisfied subjects taken together. The results are presented in Table IX-9.

Table IX-9. Pearson's product-moment coefficient of correlation between heart rate scores and RPE scores of the subjects.

	N	r	p
Correlation between heart rate and perceived effort	21	0.01	ns

The correlation between the heart rate and the RPE scores is not significant.

So in brief the findings are: the mean heart rate of the dissatisfied subjects is significantly ($p < .01$) higher than that of the satisfied

subjects; significant ($p < .01$) negative correlation between heart rate and job satisfaction scores for the two groups taken together; the mean number of health complaints is higher for the dissatisfied than the satisfied subjects but this difference is not large enough to be statistically significant; these two groups neither differ in subjective fatigue nor in perceived effort; the correlation between perceived effort and heart rate is not significant and the correlation between subjective health complaints and heart rate is also not significant.

Discussion

The results of heart rate measurement show that the mean heart rate of the dissatisfied subjects is significantly ($p < .02$) higher than that of the satisfied subjects and there is significant ($p < .01$) negative correlation between heart rate and job satisfaction scores of the satisfied and dissatisfied subjects taken together. We do not have any convincing explanation as to why the dissatisfied subjects have higher heart rate. One reason for it might be the difference between these two groups in effort expended during work. But this is not true because there is no significant difference between the satisfied and dissatisfied subjects in perceived effort (see Table IX-7).

An alternative explanation, which seems plausible, is that the dissatisfied subjects have higher emotional stress or tension than the satisfied subjects which causes higher heart rate in the former group. This explanation seems to be supported by the findings of Hoppock (1935), which show that there are fewer indications of emotional maladjustments among the satisfied as compared to the dissatisfied people. Morse (1953) indicates that job dissatisfaction leads to tension within the individual. Blum and Naylor (1968) state: "An individual's emotional stability is likely to manifest itself in satisfaction or dissatisfaction in a specific job. ... It is very likely that when everything is going smoothly the emotional stable and unstable show little difference. However, when the pressure is on and difficult situations develop, petty annoyances take on a major significance."

However, we do not want to put much emphasis on the results of heart rate because we could not measure the heart rate of the subjects with sophisticated apparatus immediately before starting work and continuously during their work.

Moreover, there is another reason why the significant difference between the heart rate of the satisfied and dissatisfied subjects should be treated with caution; for instance, the number of subjects in the dissatisfied category is very small. So these results may be considered just an additional information concerning strain of the subjects. These findings do not permit to make any definite conclusion about the relation between job satisfaction and heart rate. However, they indicate the possibility of the existence of such relationship. Clearly, much further research is required before any definite conclusion can be made about the relationship between these two parameters.

In spite of all these limitations concerning heart rate measurement, it must be noted that in general the heart rate of our subjects are too high to be ignored. So, in any case this problem deserves further study.

We have not found any significant correlation between heart rate and perceived effort of the subjects. But in several studies (e.g. Borg 1962, Borg and Linderholm 1967, Skinner et al. 1969, Borg 1970, Bar-Or et al. 1972, Skinner et al. 1973, Stamford 1976, Ulmer et al. 1977) high correlations between heart rate and perceived effort have been found during physical work. So it seems that perceived effort is related to heart rate when people are engaged in heavy physical work but in light physical or mental work, psychological factors such as emotional stress or tension plays an important role in influencing heart rate.

CHAPTER X

CONCLUSIONS

The present study was an attempt to arrive at a better understanding of short-cycled repetitive work or perhaps more precisely of a given type of short-cycled repetitive work.

However, after completing this study, our understanding of the problems of repetitive work in general still remains incomplete and a great deal of work is yet to be done before a full understanding of the problems of such work will be achieved. Nevertheless, the findings of the present investigation might lead to a greater insight into the problems of this special repetitive work and suggest some means to deal with some of them.

To draw conclusions for the entire study, it seems necessary to repeat some of the conclusions already stated in the relevant sections of the text.

Contrary to the argument that repetitive work is dissatisfying, the present study provides evidence that a substantial number of the workers who actually carry out this work find some satisfaction in it even though they consider the work as routine and simple. The present study indicates the importance of supervision and co-workers in enhancing overall satisfaction in this repetitive work that seems to be not so intrinsically rewarding. Our study further suggests that boredom depends more on characteristics of the worker than on those of the work. This fact points to the importance of proper selection of the worker in removing boredom and providing satisfaction.

It is found that the low performance workers stop their machine about three times more and about two times longer than the high performance workers. Considering these quite large differences between the two groups it may be suggested that as long as the present type of machine is used, the differences in speed skill between the workers should be taken into account in setting the cycle time of the machines.

However it may be noted that in case of repetitive work, even if all the parts that have to be assembled are in a perfect condition, i.e. have a very small variability, still it is not possible to have the same human cycle time; there is always some variability within and between subjects. In the situation we studied, the variability of the parts to be assembled, actually biological products, is tremendously large compared to the variability of mechanical engineering components. This high variability interacting with human variability makes a machine cycle time setting, that is always of the right duration, almost impossible. The introduction of self-paced (versus machine paced) machines may ease this problem to some extent but further research is necessary before making any definite suggestion about it.

Further study is also possible about the hand movement patterns of the worker to find out the efficient and precise movement patterns for this work, so that the worker can be trained to do this work in a relatively more economic way.

The present study provides evidence that the high performance workers are sustaining a greater degree of strain to obtain their higher level of performance. The findings of this study also indicate that the high performance workers are subjecting themselves to more stress and strain for earning a higher rate of bonus because they are, evidently, less satisfied with their pay. But it is amazing to find that to earn a bonus of about 12 % more than the basic hourly wage, a worker has to produce about 60 % more cigars. So a readjustment of the bonus system seems to be necessary so that the workers do not impose on themselves too heavy stress to earn more money.

Introduction of short rest pauses may help in alleviating to some extent, the excessive strain of the high performance workers and may reduce quite longer unofficial restpauses taken by the low performance workers by frequently stopping machine.

However, in administering rest pauses the circadian rhythm of the workers should be taken into account as the fatigue effect seems to be modified by the circadian cycling of arousal.

Another possible step for reducing work load seems to make arrangement for sorting out the defective tobacco leaves beforehand so that the worker has not to spend time to inspect tobacco leaves when feeding the machine.

There seems little scope for improving this job by enlarging it because the worker is already doing a great variety of tasks.

Job rotation is also not possible because the job requires too long learning time and no similar job is available for rotation.

However, there seems to be some possibilities for enriching this work by giving the worker greater responsibilities for organizing and checking her own work, maintaining machine etc.

Finally this short-cycled repetitive work, in its present form, does not seem to be an ergonomically acceptable job because it requires too long learning time for a quite simple thing to do. Moreover, even after learning, only a very small fraction of people is able to reach the speed and precision standards set by the organization. Those who can reach these standards, do so at the cost of excessive stress and strain. The final solution of the problems of this work may lie in automation.

REFERENCES

- ALLUISI, E.A., & CHILES, W.D., 1967, Sustained performance, work-rest scheduling and diurnal rhythms in man. *Acta Psychologica*, 27, 436-442.
- ALLUISI, E.A., COATES, G.D., & MORGAN, B.B., 1977, Effects of temporal stressors on vigilance and information processing. In *Vigilance* (Ed. R.R. MACKIE) (New York: PLENUM PRESS).
- ASH, I.E., 1914, Fatigue and its effect upon control. *Archive of Psychology*, 31, 1.
- BALKE, B., MELTON, C.E.Jr., & BLAKE, C., 1966, Physiological stress in areal missions. *Aerospace Medicine*, 3, 221-227.
- BARNES, R.M., 1949, *Motivation and Time Study* (New York: JOHN WILEY).
- BARNES, R.M., 1964, *Motion and Time Study* (New York: JOHN WILEY).
- BARNES, R.M., & MUNDEL, M.E., 1938, Studies of hand motions and rhythm in factory work. *University of Iowa Studies in Engineering, Bulletin*, 12, Iowa City.
- BAR-OR, O., SKINNER, J.S., BUSKIRK, E.R., & BORG, G., 1972, Physiological and perceptual indicators of physical stress in 40 to 60 year old men who vary in conditioning level and in body fatness. *Medicine and Science in Sports*, 4, 96-100.
- BARTLETT, F., 1953, Psychological criteria of fatigue. In *Symposium on Fatigue* (Eds. W.F. FLOYD and W.T. WELFORD) (London: LEWIS & Co.), Pp. 1-5.
- BARTLEY, S.H., 1976, What do we call fatigue? In *Psychological Aspects and Physiological Correlates of Work and Fatigue* (Eds. E. SIMONSON and P.C. WEISER) (Springfield: THOMAS).
- BARTLEY, S.H., & CHUTE, E., 1945, Preliminary clarification of concept. *Psychological Review*, 52, 169.
- BARTLEY, S.H., & CHUTE, E., 1947, *Fatigue and Impairment in Man* (New York: MCGRAW-HILL).
- BARTLEY, S.H., & SIMONSON, E., 1976, Use of visual methods for measurement of general fatigue. In *Psychological Aspects and Physiological Correlates of Work and Fatigue* (Eds. E. SIMONSON and P.C. WEISER) (Springfield: THOMAS).
- BHATIA, N., & MURRELL, K.F.H., 1969, An industrial experiment in organized rest pauses. *Human Factors*, 11, 167-174.

- BJERNER, B., HOLM, A., & SVENSSON, A., 1955, Diurnal variation in mental performance. *British Journal of Industrial Medicine*, 12, 103-110.
- BLACKBURN, J.M., 1936, The Acquisition of Skill - An Analysis of Learning Curves. Industrial Health Research Board, Report No. 73.
- BLAKE, M.J.F., 1967, Time of day effects on performance in a range of tasks. *Psychonomic Science*, 9, 349-350.
- BLATT, S.J., 1961, Cardiac arousal during mental activity. *Journal of Abnormal and Social Psychology*, 63, 272-282.
- BLAUNER, R., 1964, Alienation and Freedom (Chicago: UNIVERSITY OF CHICAGO PRESS).
- BLUM, M.L., & NAYLOR, J.C., 1968, *Industrial Psychology* (New York: HARPER & ROW), p. 387.
- BOLLEN, M., 1970, Description of the work situation. A translation, application and evaluation of the Job Descriptive Index for measuring job satisfaction. Unpublished Master's Degree dissertation (in Dutch), Leuven.
- BOOK, W.F., 1925, *The Psychology of Skill* (New York: GREGG-OREY).
- BORG, G., 1962, Physical Performance and Perceived Exertion (Lund: GLEERUP).
- BORG, G., 1970, Perceived exertion as an indicator of somatic stress. *Scandinavian Journal of Rehabilitation Medicine*, 2, 92-98.
- BORG, G., 1973, Perceived exertion: a note on history and methods. *Medicine and Science in Sports*, 5, 90-93.
- BORG, G., 1978, Subjective aspects of physical and mental load. *Ergonomics*, 21, 215-220.
- BORG, G., & LINDERHOLM, H., 1967, Perceived exertion and pulse rate during graded exercise in various age groups. *Acta Medica Scandinavica*, 472, 194-204.
- BORNEMANN, E., 1952, Grundlagen der Ermüdungsverhütung. In *Ermüdung*. Cited in: *Physiology of Work Capacity and Fatigue* (Ed. E. SIMONSON) (Springfield: THOMAS, 1976).
- BRABANDERE, F. De, 1971, Research on the value of the two factor theory of Herzberg. Unpublished Master's Degree dissertation (in Dutch), Leuven.

- BRAYFIELD, A.H., & CROCKETT, W.H., 1955, Employee attitude and employee performance. *Psychological Bulletin*, 52, 396-424.
- BRAYFIELD, A.H., & ROTHE, H.F., 1951, An Index of Job Satisfaction. *Journal of Applied Psychology*, 35, 5, 307-311.
- BRAYFIELD, A.H., WELLS, R.V., & STRATE, M.W., 1957, Interrelationships among the measures of job satisfaction and general satisfaction. *Journal of Applied Psychology*, 41, 201-205.
- BRIGHT, J., 1958, *Automation and Management* (Boston: HARVARD BUSINESS SCHOOL).
- BROWN, I.D., 1967, Measurement of control skills, vigilance and performance on a subsidiary task during 12 hours car driving. *Ergonomics*, 10, 665-673.
- BROWNE, R.C., 1949, The day and night performance of teleprinter switchboard operators. *Occupational Psychology*, 23, 1-6.
- BRYAN, W.L., & HARTER, N., 1897, Studies in the telegraphic language. *Psychological Review*, 4, 27.
- BUCKNER, D.N., 1963, In *Vigilance - a symposium* (Eds. D.N. BUCKNER & J.J. McGRATH) (New York: McGRAW-HILL), p. 181.
- BUXEY, G.M., CARNALL, C.A., SLACK, N.D.C., & WILD, R., 1974, The future of assembly lines. In *Development of Production Systems* (Eds. C.H. GUDNASON & E.N. CORLETT) (London: TAYLOR & FRANCIS).
- CAILLE, E.J., & BASSANO, J.L., 1977, Biorhythm and watchrhythm: hemeral watch rhythm and anhemeral watchrhythm in simulated permanent duty. In *Vigilance* (Ed. R.R. MACKIE) (New York: PLENUM PRESS).
- CAMPBELL, D.T., FISKE, D.W., 1959, Convergent and discriminant validation by the multitrait-multi-method matrix. *Psychological Bulletin*, 56, 81-105.
- CHAPANIS, A., 1967, The relevance of laboratory studies to practical situations. *Ergonomics*, 10, 557-577.
- CHICHESTER-CLARK, R., 1973, On the quality of working life. *Personnel Management*, 5, 11, 26-29.
- CHINOY, E., 1964, Manning the machine - the assembly line worker. In *The Human Shape of Work: Studies in Occupational Sociology* (Ed. P.L. BERGER) (New York: McMILLAN).

- COLQUHOUN, W.P., 1959, The effects of short rest pauses on inspection efficiency. *Ergonomics*, 2, 367-372.
- COLQUHOUN, W.P., 1971, Circadian variations in mental efficiency. In *Biological Rhythms and Human Performance* (Ed. W.P. COLQUHOUN) (London: ACADEMIC PRESS) Pp. 39-108.
- COLQUHOUN, W.P., BLAKE, M.J.F., & EDWARDS, R.S., 1968a, Experimental studies of shift work I: A comparison of rotating and stabilised 4-hour shift systems. *Ergonomics*, 11, 437-453.
- COLQUHOUN, W.P., BLAKE, M.J.F., & EDWARDS, R.S., 1968b, Experimental studies of shift work II: Stabilised 8-hour shift systems. *Ergonomics*, 11, 527-546.
- COLQUHOUN, W.P., BLAKE, M.J.F., & EDWARDS, R.S., 1969, Experimental studies of shift work III: Stabilised 12-hour shift systems. *Ergonomics*, 12, 856-882.
- CONKLIN, E.S., & FREEMAN, F.S., 1939, *Introductory Psychology for Students of Education* (New York: HENRY HOLT).
- CONRAD, R., 1951a, The study of skill by motion and time study and by psychological experiment. *Research*, 4, 8, 353.
- COOK, D., 1967, The impact of the Hawthorne effect in experimental designs in education research. Washington, D.C., U.S. Office of Education, n° 0726. Reported in: *Handbook of Industrial and Organizational Psychology*. (Edited by M.D. DUNNETTE) (Chicago: RAND McNALLY, 1976).
- COPE, D., 1979, Understanding the concept of job satisfaction. In *Satisfaction in Work Design: Ergonomics and Other Approaches* (Eds. R.G. SELL and PATRICIA SHIPLEY) (London: TAYLOR & FRANCIS).
- COX, J.W., 1934, *Manual Skill* (London: CAMBRIDGE UNIVERSITY PRESS).
- COX, T., & MACKAY, C.J., 1979, The impact of repetitive work. In *Satisfaction in Work Design: Ergonomics and Other Approaches* (Eds. R.G. SELL and PATRICIA SHIPLEY) (London: TAYLOR & FRANCIS).
- CROSSMAN, E.R.F.W., 1959, A theory of the acquisition of speed-skill. *Ergonomics*, 2, 153-166.
- DARCUS, H.D., 1954, The range and strength of joint movement. In *Human Factors in Equipment Design* (Eds. W.F. FLOYD and A.T. WELFORD) (London: H.K. LEWIS).

- DEANE, G.E., 1961, Human ~~Heart Rate~~ ^{Phaka University Institutional Repository} during experimentally induced anxiety. *Journal of Experimental Psychology*, 61, 489-493.
- DEANE, G.E., & ZEAMAN, D., 1958, Human heart rate during anxiety. *Perceptual and Motor Skills*, 8, 103-106.
- DIAMOND, S.S., 1974, Hawthorne effects: Another look. Unpublished manuscript. University of Illinois at Chicago. Reported in: *Handbook of Industrial and Organizational Psychology* (Edited by M.D. DUNNETTE) (Chicago: RAND McNALLY, 1976).
- DILL, D.B., 1942, Physiology of fatigue: Factors and criteria of endurance. *Journal of Laboratory and Clinical Medicine*, 28, 596.
- DIRKEN, J.M., 1966, Industrial shift work: decrease in well-being and specific effects. *Ergonomics*, 9, 115-124.
- DIRKEN, J.M., 1967, *Arbeid en Stress* (Groningen: WOLTERS).
- DOERR, H.O., & HOKANSON, J.E., 1965, A relation between heart rate and performance in children. *Journal of Personality and Social Psychology*, 2, 70-76.
- DURIG, A., 1927, Theorie der Ermüdung. In *Körper und Arbeit* (Ed. E. ATZLER). Cited in: *Physiology of Work Capacity and Fatigue* (Ed. E. SOMONSON) (Springfield: THOMAS, 1976).
- EDWARDS, R.H.T., MELCHER, A., HESSER, C.M., WIGERTZ, O., & EKELUND, L.G., 1972, Physiological correlates of perceived exertion in continuous and intermittent exercise with the same average power output. *European Journal of Clinical Investigation*, 2, 108-114.
- EKBLOM, B., & GOLDBARG, A.N., 1971, The influence of physical training and other factors on the subjective rating of perceived exertion. *Acta Psychologica Scandinavica*, 83, 399-406.
- EWEN, R.B., 1964, Some Determinants of Job Satisfaction: a Study of the Generality of Herzberg's Theory. *Journal of Applied Psychology*, 48, 161-163.
- EWEN, R.B., 1967, Weighting components of job satisfaction. *Journal of Applied Psychology*, 51, 68-73.
- FARMER, E., 1921, Time and Motion Study. Industrial Fatigue Research Board, Report 14 (London: H.M. STATIONERY OFFICE).
- FARMER, E., & BEVINGTON, S.M., 1922, An experiment in the introduction of rest pauses. *Journal of the National Institute of Industrial Psychology*, 1, 89-92.

FORD, R.N., 1969, *Motivation through the work itself* (New York: AMERICAN MANAGEMENT ASSOCIATION).
Dhaka University Institutional Repository

FRANKENHAEUSER, M., POST, B., NORDHEDE, B., & SHOEBERG, H., 1969, Physiological and subjective reactions to different physical work loads. *Perceptual and Motor Skills*, 28, 343.

GAMBERALE, F., 1972, Perceived exertion, heart rate, oxygen uptake and blood lactate in different work operations. *Ergonomics*, 15, 545-554.

GAMBART, R., MYNCKE, H., & COPS, A., 1976, Study of annoyance by traffic noise in Leuven (Belgium). *Applied Acoustics*, 9, 193-203.

GARDELL, B., 1971, Alienation and mental health in the modern industrial environment. In *Society, Stress and Disease* (Ed. L. LEVI) (London: OXFORD UNIVERSITY PRESS), Vol. 1, Pp. 148-180.

GARDELL, B., 1973, Quality of work and non-work activities and rewards in affluent societies. Reports from the Psychological Laboratories, University of Stockholm, No. 403. Cited in: COX, T., & MACKAY, C.J., 1979, The impact of repetitive work. In *Satisfaction in Work Design: Ergonomics and other Approaches* (Eds. R.G. SELL and PATRICIA SHIPLEY) (London: TAYLOR & FRANCIS).

GHISELLI, E.E., & BROWN, C.W., 1955, *Personnel and Industrial Psychology* (New York: MCGRAW-HILL).

GRAF, O., 1955, Forschungsbericht Nr. 115 des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen, Köln und Opladen. Cited in: *Fitting the Task to the Man* (by E. GRANDJEAN) (London: TAYLOR & FRANCIS, 1969).

GRANDJEAN, E., 1969, *Fitting the Task to the Man: An Ergonomic Approach* (London: TAYLOR & FRANCIS), Pp. 72-80.

GRANDJEAN, E.P., WOTZKA, G., SCHAAD, R., & GILGEN, A., 1971, Fatigue and stress in air traffic controllers. *Ergonomics*, 14, 159-165.

GROSS, R., WILBERT, G., LÖLLGEN, H., & ULMER, H.V., 1974, Der Einfluss von Tretgeschwindigkeit und Schwungmasse auf das Leistungsempfinden bei Fahrradergometer-arbeit. Cited in: ULMER, H.V., JANZ, U., & LÖLLGEN, H., 1977, Aspects of the validity of Borg's scale. Is it measuring stress or strain? In *Physical Work and Effort* (Ed. G. BORG) (Oxford: PERGAMON PRESS).

GUEST, R.H., 1955, Men and machines: An assembly line worker looks at his job. *Personnel*, 31, 3-10.

HARLOW, H.F., 1953, Mice, monkeys, men and motives. *Psychological Review*, 60, 23-32.

- HARRIS, W., 1977, Fatigue, Circadian rhythm and truck accidents. In Vigilance (Ed. R.R. MACKIE) (New York: PLENUM PRESS).
- HARTNETT, O.M., & MURRELL, K.F.H., 1973, Some problems of field research. Applied Ergonomics, 4, 219-221.
- HENNIGAN, J.K., & WORTHMAN, A.W., 1975, Analysis of workday stresses on industrial managers using heart rate as a criterion. Ergonomics, 18, 675-681.
- HENRIKSSON, J., KNUTTGEN, H.G., & BONDE-PETERSEN, F., 1972, Perceived exertion during exercise with concentric and eccentric muscle contractions. Ergonomics, 15, 537-544.
- HENSHAW, E.M., LANGDON, J., & HOLMAN, P., 1933, Manual dexterity: Effects of training. Industrial Health Research Board, Report No. 67.
- HERZBERG, F., MAUSNER, B., PETERSON, R.O., CAMPBELL, D.F., 1957, Job attitudes: Review of research and opinion. (Pittsburgh: PSYCHOLOGICAL SERVICE PITTSBURG).
- HOCKEY, G.R.J., & COLQUHOUN, W.P., 1972, Diurnal variation in human performance: a review. In Aspects of Human Efficiency (Ed. W.P. COLQUHOUN) (London: THE ENGLISH UNIVERSITIES PRESS).
- HOPPOCK, R., 1935, Job satisfaction (New York: HARPER & ROW).
- HOXIE, R.F., 1915, Scientific Management and Labour (New York: D. APPLETON & CO).
- KAKAR, S., 1970, Frederick Taylor: A study in personality and innovation (Cambridge, Mass.: THE M.I.T. PRESS). Cited in KUIPER, J.P., 1979, Spel en arbeid: een kwestie van leven of dood. Tijdschrift voor Sociale Geneeskunde, 57, 239-243.
- KATZ, R., & VAN MAANEN, J., 1976, The loci of work satisfaction. In Personal Goals and Work Design (Ed. P. WARR) (London: JOHN WILEY).
- KHALEQUE, A., 1979, Performance and job satisfaction in short-cycled repetitive work. In Satisfaction and Work Design: Ergonomics and Other Approaches (Eds. R.G. SELL & PATRICIA SHIPLEY) (London: TAYLOR & FRANCIS), 95-100.
- KILBRIDGE, N.D., 1960, Do Workers prefer larger Jobs? Personnel, 37, 45-48.

- IRA, G.H.Jr., WHALEN, R.E., and BOGDONOFF, M.D., 1963, Heart rate changes in physicians during daily stressful tasks. *Journal of Psychosomatic Research*, 147-150.
- JAHNS, D.W., 1973, Operator work load: what is it and how should it be measured? In *Crew System Design* (Santa Barbara, California: ANACAPA SCIENCES INC.).
- JENKS, R.S. and DEANE, G.E., 1963, Human heart rate responses during experimentally induced anxiety, a follow-up. *Journal of Experimental Psychology*, 65, 109-112.
- JESSUP, G., 1974, Job satisfaction and job design. Work Research Unit Paper No. 1. Department of Employment. United Kingdom. Cited in: COX, T., & MACKAY, C.J., 1979, The impact of repetitive work. In *Satisfactions in Work Design: Ergonomics and Other Approaches* (Eds. R.G. SELL & PATRICIA SHIPLEY) (London: TAYLOR & FRANCIS).
- JOANES, E.D., 1919, *The administration of industrial enterprises* (New York: LONGMAN)
- JOHNSON, H.J. and CAMPOS, J.J., 1967, Effect of cognitive tasks on the heart rate. *Psychophysiology*, 4, 143.
- JONG, J.R. De, 1957, The effects of increasing skill on cycle time and its consequences for time standards. *Ergonomics*, 1, 51-60.

- KINSMAN, R.A., & WEISER, P.C., 1976, Subjective symptomatology during work and fatigue. In Psychological Aspects and Physiological Correlates of Work and Fatigue (Eds. E. SIMONSON & P.C. WEISER) (Springfield: THOMAS).
- KLEIN, K.E., HERRMANN, R., KUKLINSKI, P., & WEGMANN, H.M., 1977, Circadian performance rhythms: Experimental studies in air operations. In Vigilance (Ed. R.R. MACKIE) (New York: PLENUM PRESS).
- KLEITMAN, N., 1963, Sleep and Wakefulness (Chicago: CHICAGO UNIVERSITY PRESS).
- KNOWLES, W.B., 1963, Operator loading tasks. Human factors, 5, 155-161.
- KOGI, K., SAITO, Y., & MITSUHASHI, T., 1970, Validity of three components of subjective fatigue feelings. Journal of Science of Labour, 46, 251.
- KORNHAUSER, A., 1965, Mental Health of the Industrial Worker, a Detroit Study (New York: WILEY).
- KORNHAUSER, A., & SHARP, A., 1932, Employee Attitudes: Suggestions from a study in a factory. Personnel Journal, X, 393-401.
- KOTEN, J.W., 1978, Het medisch functioneren binnen de GMD na 10 jaar, of de groei naar een nieuw verzekerings-geneeskundig paradigma, Tijdschrift voor Sociale Geneeskunde, 56, 420.
- KROL, J.P., & OPMEER, C.H.J.M., 1969, Sinus arrhythmia, heart rate and respiratory rate with parachute jumpers. Report TNO - Laboratory of Ergonomic Psychology.
- LAWLER, E.E., 1969, Job design and employee motivation. Personnel Psychology, 22, 426-435.
- LEHMANN, G., 1953, Praktische Arbeitsphysiologie (Stuttgart: THIEME-VERLAG). Cited in: Fitting the Task to the Man (by E. GRANDJEAN) (London: TAYLOR & FRANCIS, 1969).
- LEHMANN, G., 1962, Praktische Arbeitsphysiologie (Stuttgart: THIEME-VERLAG). Cited in: Physiology of Work Capacity and Fatigue (Ed. E. SIMONSON) (Springfield: THOMAS, 1971).
- LEPLAT, J., 1978, Factors determining work load, Ergonomics, 21, 143-149.
- LEVI, L., 1972, Stress and distress in Response to Psychosocial Stimuli. International Series of Monographs in Experimental Psychology, Vol 17 (Oxford: PERGAMON PRESS).

- LEWIS, R.E.F., 1956, Consistency and car driving skill. *British Journal of Industrial Medicine*, 13, 131-141.
- LEWIS, C.E.Jr., JONES, W.L., AUSTIN, F., & ROMAN, J., 1967, Flight research programma: IX. Medical monitoring of carrier pilots in combat - II. *Aerospace Medicine*, 38, 581-592.
- LINDHOLM, R., & NORSTEDT, J.P., 1975, *The Volvo Report* (Stockholm: NÄRINGSLIVETS FÖRLAGSDISTRIBUTION).
- LOCKE, E.A., 1969, What is job satisfaction? *Organizational Behavior and Human Performance*, 4, 309-336.
- LOCKE, E.A., 1970, Job satisfaction and Performance: a theoretical analysis. *Organizational Behavior and Human Performance*, 5, 484-500.
- LOCKE, E.A., 1976, The nature and causes of job satisfaction. In *Handbook of Industrial and Organizational Psychology* (Ed. M.D. DUNNETTE) (Chicago: RAND McNALLY).
- LOCKE, E.A., SMITH, P.C., KENDALL, L.M., HULIN, C.L., & MILLER, A.M., 1964, Convergent and discriminant Validity for Areas and Methods of Rating Job Satisfaction. *Journal of Applied Psychology*, Vol 48, 5, 313-319.
- LOVELAND, N.T., & WILLIAMS, H.L., 1963, Adding sleep loss and body temperature. *Perceptual and Motor Skills*, 16, 923-929.
- MARCELIN, J., 1975, L'état ostéo-articulaire des travailleurs de 40 à 50 ans. Recommandations ergonomiques, in *Age et Contraintes de Travail, Aspects sociologiques, psychologiques, physiologiques*, A. LAVILLE, C. TEIGER, A. WISNER (Eds.), (Jouy-en-Josas, N.E.B., EDITIONS SCIENTIFIQUES) Pp. 87-113.
- MARITZ, J.S., MORRISON, J.F., PETER, J., STRYDOM, N.B., & WYNDHAM, C.H., 1961, A practical method of estimating an individual's maximal oxygen intake. *Ergonomics*, 4, 97-122.
- MCCORMIC, E.J., 1964, *Human Factors Engineering* (New York: McGRAW HILL).
- MCGHEE, W., & OWEN, E.B., 1940, Authorized and unauthorized rest pauses in clerical work. *Journal of Applied Psychology*, 24, 605-614.
- MEERS, A., 1975, Performance on different turns of duty within a three-shift system and its relation to body temperature - two field studies. In *Experimental Studies of Shiftwork* (Eds. P. COLQUHOUN, S. FOLKARD, P. KNAUTH, & J. RUTENFRANZ) (Opladen: WESTDEUTSCHER VERLAG).

- MILES, G.H., & SKILBECK, O. 1944. An experiment on change of work.
Occupational Psychology, 18, 192-195.
- MONOD, H., 1967, La validité des mesures de fréquence cardiaque en
ergonomie. Ergonomics, 10, 485-537.
- MONOD, H., & LILLE, F., 1976, L'évaluation de la charge de travail,
Archives des Maladies Professionnelles, de Médecine du Travail et
de Sécurité Sociale (Paris), 37, Pp. 1-96.
- MONTPELLIER, G. DE, 1935, Les Altérations Morphologiques des Mouvements
Rapides: Etude Expérimentale. (Louvain: Editions de l'Institut
Supérieur de Philosophie).
- MORGAN, C.T., COOK, J.S., CHAPANIS, A., & LUND, M.W., (Eds.), 1963,
Human Engineering Guide to Equipment Design (New York:McGRAW HILL).
- MORGAN, W.P., 1973, Psychological factors influencing perceived
exertion. Medicine and Science in Sports, 5, 97-103.
- MORSE, N.C., 1953, Satisfaction in the white-collar job (Ann Arbor:
UNIVERSITY OF MICHIGAN PRESS).
- MURRELL, K.F.H., 1962, Operator variability and its industrial consequences.
International Journal of Production Research, 1, 39-55.
- MURRELL, K.F.H., 1963, Laboratory studies of repetitive work I:
Paced work and its relationship to unpaced work. International Journal
of Production Research, 2 (3).
- MURRELL, K.F.H., 1965, Ergonomics (London: CHAPMAN & HALL).
- MURRELL, K.F.H., 1968, On the validity of ergonomic data. Occupational
Psychology, 42, 71-76.
- MURRELL, K.F.H., & FROSAITH, B., 1963, Laboratory studies in repetitive
work II: Results from two subjects. International Journal of
Production Research, 2, 247-264.
- NAATÄNEN, R., & SUMMALA, H., 1976, Road User Behavior and Traffic
Accidents (New York: Amsterdam, Oxford: NORTH-HOLLAND PUBLISHING CO).
- NICHOLSON, N., BROWN, C.A., & CHADWICK-JONES, T.K., 1976, Absence from
work and job satisfaction. Journal of Applied Psychology, 61, 6,
728-737.
- OFFNER, M., 1928, Die geistige Ermüdung. Cited in: Physiology of
Work Capacity and Fatigue (Ed. E. SIMONSON) (Springfield: THOMAS, 1971).

OGINSKI, A., 1966, In Proceedings of XV International Congress of Occupational Medicine, 4, 95-98. Cited in W.P. COLQUHOUN, 1971, Circadian variations in mental efficiency. In Biological Rhythms and Human Performance (London: ACADEMIC PRESS), Pp. 39-108.

PAILLARD, J., 1960, The patterning of skilled movements. In Handbook of Physiology - Neurophysiology. III (Eds. J. FIELD, H.W. MAGOUN, & V.E. HALL) (Washington: AMERICAN PHYSIOLOGICAL SOCIETY), Pp. 1679-1708.

PANDOLF, K.B., CAFARELLI, E., NOBLE, B.J., & METZ, K.F., 1972, Perceptual responses during prolonged work. Perceptual and Motor Skills, 35, 975-985.

PASMOOIJ, C.K., OPMEER, C.H.J.M., & HYNDMAN, B.W., 1976, Work load in air traffic control. In Monitoring Behavior and Supervisory Control (Eds. Th. B. SHERIDAN and G. JOHANSEN) (New York: PLENUM PRESS), p. 115.

PATKAI, P., 1969, Interindividual differences in diurnal variations in alertness, performance and adrenaline excretion. University of Stockholm Psychological Laboratories, Report No. 273.

PEAR, T.H., 1924, Skill in Work and Play (London: METHUEN).

PHILIPS, 1969, Work Structuring: A Summary of Experiments at N.V. Philips.

POFFENBERGER, A.T., 1942, Principles of Applied Psychology (New York: APPLETON).

PRENTING, T.O., 1966, Efficient manual assembly operations. Automation, September, 67. Cited in BUXEY, G.M., CARNALL, C.A., SLACK, N.D.C., & WILD, R., 1974, The future of assembly line. In Development of Production Systems (Eds. C.H. GUDNASON & E.N. CORLETT) (London: TAYLOR & FRANCIS).

RADLOFF, R.W., 1973, Naturalistic observation of isolated experimental groups in field settings. In Man in Isolation and Confinement (Ed. J.E. RASMUSSEN) (Chicago, Illinois: ALDINE PUBLISHING COMPANY).

REY, P., 1973, The interpretation of changes in critical fusion frequency. In Measurement of man at work (Eds. W.T. SINGLETON, J.G. FOX, & D. WHITFIELD) (London: TAYLOR & FRANCIS).

REY, P., & REY, J.P., 1963, Les effets comparés de deux éclairages fluorescents sur une tâche visuelle et des tests de "fatigue". Ergonomics, 6, 393-402.

RIEMERSMA, J.B.J., SANDERS, A.F., WILDERVANCK, C., & GAILLARD, A.W., 1977, Performance decrement during prolonged night driving. In Vigilance (Ed. R.R. MACKIE) (New York: PLENUM PRESS).

- RING, K., 1967, Experimental social psychology: Some sober questions about some frivolous values. *Journal of Experimental Social Psychology*, 3, 113-123.
- ROLFE, J.M., 1976, The measurement of human response in man-vehicle control situations. In *Monitoring Behavior and Supervisory Control* (T.B. SHERIDAN & G. JOHANSSON, Eds.) (New York: PLENUM PRESS).
- ROSENTHAL, R., & ROSNOW, R.L., 1969, *Artifact in Behavioral Research* (New York: ACADEMIC PRESS).
- ROY, D.F., 1959, Banana Time: Job satisfaction and informal interaction. *Human Organisation*, 18, 158-168.
- RUCH, T.C., 1951, Motor Systems. In *Handbook of Experimental Psychology* (Ed. S.S. STEVENS) (New York: JOHN WILEY & SONS), Pp. 154-208.
- RUFELL SMITH, H.P., 1967, Heart rate of pilots flying aircraft on scheduled airline routes. *Aerospace Medicine*, 38, 1117-1119.
- RUNDQUIST, E.A., & SLETTTO, R.F., 1936, *Personality in the depression* (Minneapolis: UNIVERSITY OF MINNESOTA PRESS).
- RUTENFRANZ, J., 1960, Ueber das Verhalten der Pulsfrequenz bei Arbeit unter Zeitdruck. *International Zeitschrift für Angewandte Physiologie einschliesslich Arbeitsphysiologie*, 18, 264-279.
- SAITO, Y., KOGI, K. & KASHIWAGI, S., 1970, Factors underlying subjective feelings of fatigue. *Journal of Science of Labour*, 46, 205.
- SCHMIDTKE, H., 1959, Biological Factors in the arrangements of working periods. *International Zürich Conference on Fitting the Job to the Worker*, European Productivity Agency. Cited in: *Work Design: A System Concept* (by G. NADIER) (Homewood, Illinois: RICHARD D. IRWIN, 1970).
- SCHMIDTKE, H., 1965, *Die Ermüdung* (Bern: VERLAG HANS HUBER). Cited in *Physiology of Work Capacity and Fatigue* (Ed. E. SIMONSON) (Springfield: THOMAS, 1971).
- SCHNEIDER, B., & DACHLER, H.P., 1978, A note on the stability of the Job Descriptive Index. *Journal of Applied Psychology*, 63, 650-653.
- SCHUH, A.J., 1967, The predictability of employee tenure: A review of the literature. *Personnel Psychology*, 20, 133-152.

SCIENCE RESEARCH ASSOCIATES EMPLOY INVENTORY, 1952, General manual for
Dhaka University Institutional Repository
 the SRA (Chicago: SCIENCE RESEARCH ASSOCIATES).

- SELYE, H., 1936, A syndrome produced by diverse noxious agents, *Nature*, 138, 32.
- SELYE, H., 1956, *The Stress of Life* (New York: McGRAW HILL).
- SELYE, H., 1964, The stress of life: new focal point for understanding accidents, *Industrial Medicine and Surgery*, 33, 621-625.
- SEYMOUR, W.D., 1966, *Industrial Skills* (London: PITMAN).
- SHEPPARD, H.L., & HERRICK, N., 1972, Where have all the robots gone? (New York: FREE PRESS).
- SIDDALL, C.J., 1954, Variations in movement time in an industrial repetitive task. Medical Research Council, Applied Psychology Research Unit, Cambridge, 216/54.
- SIMONSON, E., 1935, Der Heutige Stand der Theorie der Ermüdung. *Ergebn. Physiologie*, 37, 299. Cited in: *Physiology of Work Capacity and Fatigue* (Ed. E. SIMONSON) (Springfield: THOMAS, 1971).
- SIMONSON, E., 1971, *Physiology of Work Capacity and Fatigue* (Springfield: THOMAS).
- SIMONSON, E., & ENZER, N., 1941, Measurement of fusion frequency of flicker as a test for fatigue of the central nervous system. *Journal of Industrial Hygiene and Toxicology*, 23, 83.
- SIMONSON, E., BAKER, C., BURNS, N., KEIPER, C., SCHMITT, O.H. & STACKHOUSE, S., 1968, Cardiovascular stress (electrocardiographic changes) produced by driving an automobile. *American Heart Journal*, 75, 125-135.
- SINGLETON, W.T., 1974, Comment. In *Life Stress and Illness* (E.K.E. GUNDERSON & R.H. RAHE, Eds.) (Springfield, Illinois: CHARLES C. THOMAS PUBLISHER), Pp. 34-40.
- SINGLETON, W.T., 1976, Personal Communication.
- SKINNER, J.S., MUTSLER, R., BERGSTEINOVA, V., & BUSKIRK, E.R., 1973, The validity and reliability of a rating scale of perceived exertion. *Medicine and Science in Sports*, 5, 94-96.
- SMADER, R., & SMITH, K.U., 1953, Dimensional analysis of motion: VI. The component movements of assembly motions. *The Journal of Applied Psychology*, 37, 308-314.
- SMITH, P.C., 1955, The prediction of individual differences in susceptibility to industrial monotony. *Journal of Applied Psychology*, 39, 320-329.

- SMITH, P.C., KENDALL, L.N., & HULIN, C.L., 1969, The measurement of job satisfaction in work and retirement. (Chicago: RAND McNALLY).
- SPERANDIO, J.C., Charge de travail et variations des modes operatoires, Thèse Doct. Lettre. Sc. Hum., Paris, 1972, 286 p. (stencilled)
Cited by MONOD, H., & LILLE, 1976, L'évaluation de la charge de travail, Archives des Maladies Professionnelles, de Médecine du Travail et de Sécurité Sociale (Paris), 37, Pp. 1-96.
- STAMFORD, B.A., 1976, Validity and reliability of subjective ratings of perceived exertion during work. Ergonomics, 19, 53-60.
- STEWART, J.R., 1962, Effect on the heart rate of warnings of pleasant and unpleasant stimuli. Dissertation Abstracts, 1803.
- TAGGART, P., & GIBBONS, D., 1967, Motor-car driving and the heart rate. British Medical Journal, 1, 411-412.
- TEIGER, C., 1978, Regulation of activity: an analytical tool for studying work load in perceptual motor tasks. Ergonomics, 21, 203-213.
- TOLOT, M.F., 1965, La Fatigue. Lyon Médical, 213, 1509, Cited in: Physiology of Work Capacity and Fatigue (Ed. E. SIMONSON) (Springfield: THOMAS, 1971).
- TURNER, A.N., & LAWRENCE, P.R., 1965, Industrial Jobs and the Worker (Boston: Division of Research, HARVARD BUSINESS SCHOOL).
- ULMER, H.V., JANZ, U., & LOLLGEN, H., 1977, Aspects of the validity of Borg's scale. Is it measuring stress or strain? In Physical Work and Effort (Ed. G. BORG) (Oxford: PERGAMON PRESS), Pp. 181-196.
- VAN BEEK, H.G., 1964, The influence of assembly line organisation on output, quality and morale. Occupational Psychology, 38, 161-172.
- VEIL, C., 1964, Hygiene Mentale du Travail (Paris: LIBRAIRIE LE FRANÇOIS).
- VERHAEGEN, P., 1979, Work satisfaction in present-day working life: ergonomics and work satisfaction. In Satisfaction in Work Design: Ergonomics and Other Approaches (Eds. R.G. SELL & Patricia SHIPLEY) (London: TAYLOR & FRANCIS).
- VITELES, M.S., 1932, Industrial Psychology (New York: NORTON), p. 547.
- VOGT, J.J., 1964, Repérage de la contrainte thermique au moyen de critères physiologiques, Thèse de Doctorat en Médecine, Strasbourg.

- VOGT, J.J., & MEYER-SCHWERTZ, M.T., 1968, Repérage des ambiances thermiques au moyen d'un indice de charge physiologique. Actes du 3ème Congrès de la Société d'Ergonomie de Langue Française. I. Vol., 390 Pp., 12, 25, P.U. Bruxelles (Edit.).
- VOGT, J.J., MEYER-SCHWERTZ, M.T., METZ, B., & FOEHR, R., 1973, Motor thermal and sensory factors in heart rate variation: a methodology for indirect estimation of intermittent muscular work and environmental heart loads. *Ergonomics*, 16, 45-60.
- VROOM, V.H., 1964, *Work and Motivation* (New York: JOHN WILEY).
- WAGRET, Geneviève, 1964, Fatigue nerveuse et rythmes de travail dans les entreprises de petite mécanique. In *Industrialization and Mental Health, Proceedings of the Seventh Annual Meeting, World Federation of Mental Health, Bern, August 1964, Genève.*
- WALD, A., & HARRISON, L.B., 1975, Oxygen consumption and heart rate: changes and relations in static work. *Ergonomics*, 18, 299-309.
- WALKER, C.R., 1950, The problem of the repetitive job. *Harvard Business Review*, 28, 54-58.
- WALKER, C.R., & GUEST, R.P., 1952, *The man on the assembly line* (Cambridge: HARVARD UNIVERSITY PRESS).
- WANOUS, J.P., & LAWLER, E.E., 1972, Measurement and meaning of job satisfaction. *Journal of Applied Psychology*, 56, 95-105.
- WEBER, A., JERMINI, C., & GRANJEAN, E.P., 1975, Relationship between objective and subjective assessment of experimentally induced fatigue. *Ergonomics*, 18, 151-156.
- WEITZ, J., 1952, A neglected concept in the study of job satisfaction. *Personnel Psychology*, 5, 201-205.
- WELFORD, A.T., 1952, An electronic digital recording machine -- the SETAR. *Journal of Scientific Instruments*, 29, 1-4.
- WELFORD, A.T., 1968, *Fundamentals of skill* (London: METHUEN).
- WELFORD, A.T., 1973, Stress and performance. *Ergonomics*, 16, 567-580.
- WELFORD, A.T., & BOURNE, L.E., 1976, *Skilled Performance: Perceptual and Motor Skills* (Glenview, Illinois: SCOTT, FORESMAN & CO.).
- WILD, R., 1972, *Mass Production Management* (London: WILEY).

- WILDE, G.J.S., 1963, Neurotische labiliteit gemeten volgens de vragenlijst-methode (Amsterdam: VAN ROSSEN).
- WILKINS, W.L., 1974, Social Stress and Illness in Industrial Society. In Life Stress and Illness (E.K.E. GUNDERSON and R.H. RAHE, Eds.) (Springfield, Illinois: CHARLES C. THOMAS PUBLICATION), Pp. 242-254.
- WYATT, S., 1927, Rest pauses in industry. Industrial Fatigue Research Board, Report No. 42.
- WYATT, S., & FRASER, J.A., 1925, Studies in repetitive work with special reference to rest pauses. Industrial Fatigue Research Board, Report No. 32.
- WYCHERLEY, R.J., & NICKLIN, B.H., 1970, The heart rate of blind and sighted pedestrians on a town route. *Ergonomics*, 13, 181-192.
- YOSHITAKE, H., 1971, Relations between the symptoms and the feeling of fatigue. *Ergonomics*, 14, 175-186.
- YOSHITAKE, H., 1978, Three characteristic patterns of subjective fatigue symptoms. *Ergonomics*, 21, 231-233.
- ZUBEK, J.P., 1969, Sensory deprivation: Fifteen years of research (New York: APPLETON CENTURY CROFTS).

APPENDICES

APPENDIX A

Rank order of the workers considered as high performers, low performers and inconsistent performers according to the criteria of "numbers of defectless cigars produced per hour" and "weight of tobacco leaves used per 1000 cigars" with different types of tobacco leaves during November, 1975.

Single and double asterisks used in this table indicate:

- * inconsistent performance within the same types of tobacco leaves, i.e. high in number of defectless cigars produced (above the median of defectless cigars) and low in economy in using leaves (above the median of weight of tobacco leaves used) or vice versa;
- ** inconsistent performance among different types of tobacco leaves, i.e. high in number of defectless cigars produced (above the median of defectless cigars) and also high in economy in using leaves (below the median of weight of tobacco leaves used) with some types of tobacco leaves but low in number of defectless cigars produced (below the median of defectless cigars) and also low in economy in using leaves (above the median of weight of tobacco leaves used) with some other type of tobacco leaves.

Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
0046CA2V	11	1759 (L.P.)	7	8
		1772 (L.P.)	9	10
		2183 (L.P.)	10	9
		2276 (L.P.)	11	11
		1183 (H.P.)	4	5
		1435 (H.P.)	1	4
		2081 (H.P.)	5	2
		2184 (I.P.) *	8	3
		1624 (I.P.) *	3	7
		2196 (I.P.) **	6	1
		1605 (I.P.) **	2	6
0046CA2S	11	1759 (L.P.)	6	10
		1772 (L.P.)	9	11
		1850 (L.P.)	11	8
		2183 (L.P.)	7	9
		2276 (L.P.)	10	7
		1183 (H.P.)	4	5
		1435 (H.P.)	1	3
		2081 (H.P.)	2	1
		2184 (I.P.) *	8	4
		2245 (I.P.) **	5	6
		1624 (I.P.) **	3	2

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Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
0046CA3V	5	1759 (L.P.)	4	3
		1772 (L.P.)	3	2
		2081 (H.P.)	1	1
		1605 (I.P.) **	2	4
		2245 (I.P.) **	5	5
0086CAMS	6	1917 (L.P.)	5	5
		2321 (L.P.)	4	4
		2196 (I.P.) **	1	2
		2209 (I.P.) **	3	6
		61 (I.P.) **	2	3
		1866 (I.P.) *	6	1
0083SU3V	7	1917 (L.P.)	5	6
		2201 (L.P.)	7	7
		2321 (L.P.)	6	4
		61 (I.P.) **	4	1
		2209 (I.P.) **	2	2
		2196 (I.P.) *	1	5
		1765 (I.P.) **	3	3
0064SU3V	15	296 (L.P.)	11	12
		1553 (L.P.)	14	11
		1983 (L.P.)	12	10
		2283 (L.P.)	10	15
		2288 (L.P.)	13	14
		2494 (L.P.)	15	13
		1747 (H.P.)	1	6
		1876 (H.P.)	3	2
		2001 (H.P.)	6	3
		2098 (H.P.)	7	4
		2296 (H.P.)	4	1
		1901 (I.P.) **	8	5
		2126 (I.P.) **	5	7
		2242 (I.P.) **	9	8
		1660 (I.P.) *	2	9
0026MEX	4	1873 (L.P.)	3	4
		2167 (H.P.)	2	1
		1861 (I.P.) *	4	2
		2045 (I.P.) *	1	3
0082SU3V	9	1404 (L.P.)	6	5
		1983 (L.P.)	9	8
		2201 (L.P.)	7	7

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Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
		584 (H.P.)	1	2
		2013 (H.P.)	2	4
		2092 (I.P.) **	5	3
		1902 (I.P.) **	8	9
		2239 (I.P.) *	4	6
		989 (I.P.) **	3	1
0082SU3S	4	584 (H.P.)	1	1
		2445 (I.P.) *	4	2
		2154 (I.P.) **	3	4
		2239 (I.P.) **	2	3
0080SU2S	6	2201 (L.P.)	5	4
		2439 (L.P.)	4	5
		584 (H.P.)	1	1
		2190 (H.P.)	3	2
		2239 (I.P.) **	2	3
		1830 (I.P.) **	6	6
0063CAS2	14	832 (L.P.)	9	14
		1134 (L.P.)	14	9
		1692 (L.P.)	13	13
		1854 (L.P.)	12	11
		2318 (L.P.)	11	12
		1003 (H.P.)	1	3
		1809 (H.P.)	4	2
		2098 (H.P.)	7	6
		1830 (I.P.) *	10	4
		2242 (I.P.) *	5	8
		2126 (I.P.) *	3	10
		1901 (I.P.) **	6	7
		2130 (I.P.) *	8	5
		2238 (I.P.) **	2	1
0022RCA2V	5	1772 (L.P.)	5	5
		1979 (L.P.)	3	4
		2130 (I.P.) *	4	2
		1481 (I.P.) **	2	3
		2238 (I.P.) **	1	1
1083SU1S	5	2206 (L.P.)	3	4
		2295 (L.P.)	4	5
		1747 (H.P.)	2	2
		2339 (I.P.) **	1	1
		2320 (I.P.) **	5	3

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Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
1083SU1S	5	2206 (L.P.)	3	4
		2295 (L.P.)	4	5
		1747 (H.P.)	2	2
		2339 (I.P.) **	1	1
		2320 (I.P.) **	5	3
1127JAV	6	2201 (L.P.)	5	4
		1276 (H.P.)	2	3
		2248 (H.P.)	1	1
		2205 (I.P.) **	4	6
		2079 (I.P.) **	3	5
		1859 (I.P.) *	6	2
0063CA1S	11	1134 (L.P.)	11	11
		1692 (L.P.)	10	10
		2318 (L.P.)	8	8
		2098 (H.P.)	5	3
		1901 (I.P.) *	7	2
		2242 (I.P.) **	1	6
		1830 (I.P.) **	3	1
		2239 (I.P.) *	9	5
		2130 (I.P.) **	6	4
		2045 (I.P.) *	2	9
		2238 (I.P.) *	4	7
0082U2S	5	1965 (L.P.)	3	4
		1876 (H.P.)	1	1
		2013 (H.P.)	2	3
		1830 (I.P.) *	5	2
		2092 (I.P.) **	4	5
0150JA3V	7	1462 (L.P.)	7	7
		1979 (L.P.)	6	4
		2250 (L.P.)	4	6
		1989 (H.P.)	1	2
		2081 (H.P.)	2	1
		1481 (I.P.) *	3	5
		1752 (I.P.) *	5	3
0081SU3S	9	29 (L.P.)	7	7
		1404 (L.P.)	8	9
		1936 (L.P.)	5	6
		2013 (L.P.)	1	5
		2001 (H.P.)	4	4
		2121 (H.P.)	2	1
		2244 (H.P.)	6	3
		2309 (I.P.) *	9	2
		1866 (I.P.) *	3	8

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Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
1081JAV	24	51 (L.P.)	17	19
		1399 (L.P.)	19	18
		1639 (L.P.)	18	20
		1962 (L.P.)	20	23
		2088 (L.P.)	21	22
		2206 (L.P.)	14	16
		2272 (L.P.)	24	24
		1548 (H.P.)	5	6
		1747 (H.P.)	6	5
		2070 (H.P.)	4	9
		2248 (H.P.)	2	1
		2285 (H.P.)	10	12
		2081 (I.P.) *	9	21
		2339 (I.P.) **	8	8
		2205 (I.P.) **	15	15
		1902 (I.P.) **	11	13
		1822 (I.P.) *	16	4
		2079 (I.P.) **	7	2
		1765 (I.P.) *	22	7
		1859 (I.P.) *	23	3
		2320 (I.P.) **	13	10
		2336 (I.P.) *	3	17
		1732 (I.P.) **	12	14
		989 (I.P.) **	1	11
1087POL	12	1068 (L.P.)	11	11
		1962 (L.P.)	12	12
		1966 (L.P.)	10	10
		2153 (L.P.)	8	8
		2293 (L.P.)	9	9
		1242 (H.P.)	4	5
		1747 (H.P.)	2	1
		2243 (I.P.) **	3	2
		2288 (I.P.) *	6	3
		1900 (I.P.) **	1	4
		1955 (I.P.) **	5	7
		2045 (I.P.) **	7	6
1103POLT	24	1447 (L.P.)	20	24
		1714 (L.P.)	18	16
		1829 (L.P.)	17	12
		2090 (L.P.)	22	22
		2156 (L.P.)	14	17
		2237 (L.P.)	15	18
		2288 (L.P.)	24	21
		2414 (L.P.)	23	23

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Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
		1027 (H.P.)	1	4
		1555 (H.P.)	5	5
		1651 (H.P.)	2	8
		1809 (H.P.)	3	3
		2110 (H.P.)	7	10
		2121 (H.P.)	11	7
		2154 (I.P.) *	8	19
		1472 (I.P.) *	4	13
		2208 (I.P.) *	9	15
		1821 (I.P.) *	13	2
		2158 (I.P.) **	19	20
		2136 (I.P.) **	6	6
		1765 (I.P.) *	16	1
		1935 (I.P.) *	21	11
		1958 (I.P.) **	10	9
		1068 (I.P.) *	12	14
0254SU3V	4	2043 (L.P.)	4	4
		1952 (H.P.)	1	1
		2126 (I.P.) **	2	2
		2205 (I.P.) **	3	3
1103POL	26	1447 (L.P.)	19	14
		1714 (L.P.)	21	19
		2090 (L.P.)	14	23
		2156 (L.P.)	18	20
		2237 (L.P.)	15	13
		2414 (L.P.)	26	21
		1759 (L.P.)	11	8
		1027 (H.P.)	1	7
		1555 (H.P.)	7	2
		1651 (H.P.)	2	11
		2110 (H.P.)	5	6
		2121 (H.P.)	8	9
		1472 (I.P.) **	3	12
		2154 (I.P.) *	12	18
		1765 (I.P.) **	24	24
		989 (I.P.) *	4	22
		1935 (I.P.) **	22	16
		1958 (I.P.) **	16	26
		1968 (I.P.) **	23	15
		1902 (I.P.) **	10	10
		2136 (I.P.) **	9	4
		1821 (I.P.) *	13	3
		2158 (I.P.) **	20	25
		2287 (I.P.) *	25	1
		2205 (I.P.) **	17	17
		2208 (I.P.) **	6	5

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Type of tobacco leaves	Number of the workers	Token number of the workers	Rank in terms of number of defectless cigars produced per hour	Rank in terms of weight of tobacco leaves used per 1000 cigars
2411JA3V	12	1903 (L.P.)	9	8
		1986 (L.P.)	7	11
		2288 (L.P.)	12	10
		107 (H.P.)	1	1
		2231 (H.P.)	3	5
		2136 (I.P.) *	8	2
		2158 (I.P.) *	11	4
		1765 (I.P.) **	6	3
		2045 (I.P.) *	2	9
		2178 (I.P.) *	4	7
		1474 (I.P.) *	5	12
		2277 (I.P.) *	10	6
1243JA2V	6	2040 (L.P.)	6	6
		1920 (H.P.)	3	3
		1342 (I.P.) **	5	4
		2155 (I.P.) **	2	2
		2205 (I.P.) *	4	1
		989 (I.P.) *	1	5
0085CAEV	4	1917 (L.P.)	3	2
		2196 (I.P.) **	4	4
		2209 (I.P.) *	1	3
		1866 (I.P.) **	2	1
1083SU2V	4	2295 (L.P.)	4	3
		1747 (H.P.)	1	2
		2339 (I.P.) **	3	4
		2320 (I.P.) **	2	1

APPENDIX B

Rank order of workers considered as high and low performers according to the criteria of "number of defectless cigars" and "weight of tobacco leaves used per 1000 cigars" with different types of tobacco leaves during November, 1975.

Type of tobacco leaves	Token number	Rank in terms of numbers of defectless cigars	Rank in terms of weight of tobacco leaves used
0046CA2V (N = 11)	1759 (L.P.)	7	8
	1772 (L.P.)	9	10
	2183 (L.P.)	10	9
	1183 (H.P.)	4	5
	1435 (H.P.)	1	4
	2081 (H.P.)	5	2
0046CA2S (N = 11)	1759 (L.P.)	6	10
	1772 (L.P.)	9	11
	1850 (L.P.)	11	8
	2183 (L.P.)	7	9
	2276 (L.P.)	10	7
	1183 (H.P.)	4	5
	1435 (H.P.)	1	3
	2081 (H.P.)	2	1
0046CA3V (N = 5)	1759 (L.P.)	4	3
	1772 (L.P.)	3	2
	2081 (H.P.)	1	1
0086CAMS (N = 6)	1917 (L.P.)	5	5
	2321 (L.P.)	4	4
0083SU3V (N = 7)	1917 (L.P.)	5	6
	2201 (L.P.)	7	7
	2321 (L.P.)	6	4
0064SU3V (N = 15)	296 (L.P.)	11	12
	1553 (L.P.)	14	11
	1983 (L.P.)	12	10
	2283 (L.P.)	10	15
	2288 (L.P.)	13	14
	2494 (L.P.)	15	13
	1747 (H.P.)	1	6
	1876 (H.P.)	3	2
	2001 (H.P.)	6	3
	2098 (H.P.)	7	4
	2296 (H.P.)	4	1

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Type of tobacco leaves	Token number	Rank in terms of numbers of defect-less cigars	Rank in terms of weight of tobacco leaves used
0026MEX (N = 4)	1873 (L.P.)	3	4
	2167 (H.P.)	2	1
0082SU3V (N = 9)	1404 (L.P.)	6	5
	1983 (L.P.)	9	8
	2201 (L.P.)	7	7
	584 (H.P.)	1	2
	2013 (H.P.)	2	4
0082SU3S (N = 4)	584 (H.P.)	1	1
0080SU2S (N = 6)	2201 (L.P.)	5	4
	2439 (L.P.)	4	5
	584 (H.P.)	1	1
	2190 (H.P.)	3	2
0063CA2S	832 (L.P.)	9	14
	1134 (L.P.)	14	9
	1692 (L.P.)	13	13
	1854 (L.P.)	12	11
	2318 (L.P.)	11	12
	1003 (H.P.)	1	3
	1809 (H.P.)	4	2
	2098 (H.P.)	7	6
0022RCA2V (N = 5)	1772 (L.P.)	5	5
	1979 (L.P.)	3	4
1083SU1S (N = 5)	2206 (L.P.)	3	4
	2295 (L.P.)	4	5
	1747 (H.P.)	2	2
1127JAV (N = 6)	2201 (L.P.)	5	4
	1276 (H.P.)	2	3
	2248 (H.P.)	1	1
0063CA1S (N = 11)	1134 (L.P.)	11	11
	1692 (L.P.)	10	10
	2318 (L.P.)	8	8
	2098 (H.P.)	5	3
0082SU2S (N = 5)	1965 (L.P.)	3	4
	1876 (H.P.)	1	1
	2013 (H.P.)	2	3
0150JA3V (N = 7)	1462 (L.P.)	7	7
	1979 (L.P.)	6	4
	2250 (L.P.)	4	6
	1989 (H.P.)	1	2
	2081 (H.P.)	2	1

Type of tobacco leaves	Token number	Rank in terms of numbers of defect-less cigars	Rank in terms of weight of tobacco leaves used
0081SU3S (N = 9)	29 (L.P.)	7	7
	1404 (L.P.)	8	9
	1936 (L.P.)	5	6
	2013 (L.P.)	1	5
	2001 (H.P.)	4	4
	2121 (H.P.)	2	1
	2244 (H.P.)	6	3
1081JAV (N = 24)	517 (L.P.)	17	19
	1399 (L.P.)	19	18
	1639 (L.P.)	18	20
	1962 (L.P.)	20	23
	2088 (L.P.)	21	22
	2206 (L.P.)	14	16
	2272 (L.P.)	24	24
	1548 (H.P.)	5	6
	1747 (H.P.)	6	5
	2070 (H.P.)	4	9
	2248 (H.P.)	2	1
	2285 (H.P.)	10	12
1087POL (N = 12)	1068 (L.P.)	11	11
	1962 (L.P.)	12	12
	1966 (L.P.)	10	10
	2153 (L.P.)	8	8
	2293 (L.P.)	9	9
	1242 (H.P.)	4	5
	1747 (H.P.)	2	1
1103POLT (N = 24)	1447 (L.P.)	20	24
	1714 (L.P.)	18	16
	1829 (L.P.)	17	12
	2090 (L.P.)	22	22
	2156 (L.P.)	14	17
	2237 (L.P.)	15	18
	2288 (L.P.)	24	21
	2414 (L.P.)	23	23
	1027 (H.P.)	1	4
	1555 (H.P.)	5	5
	1651 (H.P.)	2	8
	1809 (H.P.)	3	3
	2110 (H.P.)	7	10
	2121 (H.P.)	11	7
0254SU3V (N = 4)	2043 (L.P.)	4	4
	1952 (H.P.)	1	1

Type of tobacco leaves	Token number	Rank in terms of numbers of defect-less cigars	Rank in terms of weight of tobacco leaves used
1103POL (N = 26)	1447 (L.P.)	19	14
	1714 (L.P.)	21	19
	2090 (L.P.)	14	23
	2156 (L.P.)	18	20
	2237 (L.P.)	15	13
	2414 (L.P.)	26	21
	1027 (H.P.)	1	7
	1555 (H.P.)	7	2
	1651 (H.P.)	2	11
	2110 (H.P.)	5	6
	2121 (H.P.)	8	9
2411JA3V (N = 12)	1903 (L.P.)	9	8
	1986 (L.P.)	7	11
	2288 (L.P.)	12	10
	107 (H.P.)	1	1
	2231 (H.P.)	3	5
1243JA2V (N = 6)	2040 (L.P.)	6	6
	1920 (H.P.)	3	3
0085CAEV (N = 4)	1917 (L.P.)	3	2
1083SU2V (N = 4)	2295 (L.P.)	4	3
	1747 (H.P.)	1	2

APPENDIX CThe Dutch version of the Brayfield-Rothe Scale.

Sommige soorten werk zijn interessanter en geven meer voldoening dan andere. We wensen te weten hoe verschillende mensen denken over hun werk. Deze vragenlijst omvat een reeks uitspraken over het werk. U moet onder elke uitspraak het woord onderlijnen dat het best aangeeft wat u denkt over uw huidig werk. Er zijn geen goede of verkeerde antwoorden. We wensen uw eerlijke mening te hebben voor elk van de uitspraken.

0. Er zijn aan mijn werk bepaalde dingen die zouden kunnen verbeterd worden.

Volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

1. Mijn werk is als een liefhebberij voor mij.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

2. Mijn werk is gewoonlijk interessant genoeg om te beletten dat ik me begin te vervelen.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

3. Het lijkt dat mijn vrienden meer belangstelling hebben voor hun werk.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

4. Ik vind mijn werk eerder onaangenaam.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

5. Ik geniet meer van mijn werk dan van mijn vrije tijd.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

6. Ik verveel me dikwijls in mijn werk.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

7. Ik voel me tamelijk tevreden in mijn werk.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

8. Meestal moet ik mezelf ertoe dwingen te gaan werken.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

9. Voorlopig ben ik tevreden met mijn werk.

volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

10. Ik heb de indruk dat mijn werk niet interessanter is dan ander werk dat ik had kunnen krijgen.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
11. Ik heb bepaald een hekel aan mijn werk.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
12. Ik heb de indruk dat ik in mijn werk gelukkiger ben dan de meeste andere mensen.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
13. De meeste dagen ben ik enthousiast over mijn werk.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
14. Elke werkdag geeft me de indruk dat er nooit een einde zal aan komen.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
15. Ik hou meer van mijn werk dan een doorsnee-werkster.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
16. Mijn werk is gewoonweg niet interessant.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
17. Ik vind een waar genot in mijn werk.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord
18. Ik ben er over ontgoocheld dat ik ooit met dit werk begonnen ben.
 volledig akkoord akkoord onbeslist niet akkoord absoluut niet akkoord

Kies onder de volgende uitspraken deze, die het best weergeeft, in welke mate u van uw werk houdt. Plaats een kruisje in het bolletje voor die uitspraak.

- ☐ Ik ben zeer enthousiast over mijn werk
- ☐ Ik hou veel van mijn beroep
- ☐ Ik hou nogal van mijn beroep
- ☐ Mijn beroep laat me onverschillig
- ☐ Ik hou niet van mijn beroep
- ☐ Ik hou helemaal niet van mijn beroep
- ☐ Ik heb een grondige hekel aan mijn beroep

Katholieke Universiteit te Leuven

Faculteit der Psychologie en

Pedagogische Wetenschappen

Afdeling Industriële Psychologie
en Ergonomie

BESCHRIJVING VAN DE WERKSITUATIE

Vul eerst het codenummer in en sla daarna dit blad om.

Denk aan Uw huidig werk. Hoe is het voor het merendeel van de tijd?

Schrijf naast elk woord (of uitspraak) :

"J" voor "JA", zo het Uw werk beschrijft

"N" voor "NEEN", zo het Uw werk NIET beschrijft

" ? " zo U niet kunt beslissen

MIJN WERK

_____ boeiend
_____ routine
_____ schenkt voldoening
_____ vervelend
_____ goed
_____ vergt nieuwe ideeën van je
_____ het is werk dat gewaardeerd wordt
_____ aangenaam
_____ nuttig
_____ werk dat moeizaam vooruitgaat
_____ gezond
_____ het vraagt je helemaal
_____ staand werk
_____ warm
_____ het loopt vaak vast
_____ zeer eenvoudig
_____ er komt geen einde aan
_____ geeft het gevoel iets voltooid te hebben.

Zie verder volgende bladzijde.

Denk aan het loon dat U nu verdient.

In hoeverre beschrijven de volgende woorden of uitspraken Uw huidig loon?

Schrijf naast elk woord (of uitspraak) :

"J" voor "JA", zo het Uw loon beschrijft

"N" voor "NEEN", zo het Uw loon NIET beschrijft

" ? " zo U niet kunt beslissen

MIJN HUIDIG INKOMEN

_____ inkomen is voldoende om rond te komen

_____ een bevredigend aandeel in de winst

_____ je kunt er nauwelijks van leven

_____ slecht

_____ stelt in staat tot enig luxe

_____ inkomen is minder dan ik in feite verdien te ontvangen

_____ het werk is zeer goed betaald

_____ het werk is onvoldoende betaald

_____ niet zeker

Denk aan de mogelijkheden tot promotie die U nu hebt.

In hoeverre beschrijven de volgende woorden of uitspraken die mogelijkheden?

Schrijf naast elk woord (of uitspraak) :

"J" voor "JA", zo het Uw promotiekansen beschrijft

"N" voor "NEEN", zo het die NIET beschrijft

" ? " zo U niet kunt beslissen

PROMOTIEKANSEN

_____ goede mogelijkheid tot promotie

_____ mogelijkheden zijn tamelijk beperkt

_____ promotie op basis van bekwaamheid

_____ geen promotiekansen

_____ goede promotiekansen

_____ oneerlijke promotiepolitiek

_____ promoties komen zelden voor

_____ regelmatige promotiekansen

_____ tamelijk goede promotiekansen

Denk aan het soort toezicht bij Uw werk.

In hoeverre beschrijven de volgende woorden of uitspraken dit toezicht?

Schrijf naast elk woord (of uitspraak) :

"J " voor "JA ", zo dit het toezicht beschrijft dat U ontvangt bij

Uw werk

"N " voor "NEEN", zo het dit NIET beschrijft

" ? " zo U niet kunt beslissen

TOEZICHT BIJ HUIDIG WERK

_____ vraagt mij om raad

_____ moeilijk tevreden te stellen

_____ onbeleefd

_____ prijst goed werk

_____ taktvol

_____ heeft invloed

_____ modern

_____ geeft onvoldoende leiding

_____ opvliegend

_____ zegt waar je aan toe bent

_____ irriterend

_____ koppig

_____ kent het werk

_____ slecht

_____ verstandig

_____ laat me vrij

_____ is er als het nodig is

_____ lui

Zie verder volgende bladzijde.

Denk aan de meeste mensen waarmee U samenwerkt of waarmee U te maken hebt in verband met Uw werk.

In hoeverre beschrijven de volgende woorden of uitspraken deze mensen?

Schrijf naast elk woord (of uitspraak) :

"J" voor "JA", zo het de mensen beschrijft waarmee U werkt

"N" voor "NEEN", zo het deze NIET beschrijft

" ? " zo U niet kunt beslissen

DE MENSEN IN UW HUIDIG WERK

- _____ zetten aan tot werken
- _____ vervelend
- _____ traag
- _____ willen vooruitkomen
- _____ dom
- _____ hebben verantwoordelijkheidsgevoel
- _____ vlug
- _____ verstandig
- _____ je maakt makkelijk vijanden
- _____ praten te veel
- _____ slim
- _____ lui
- _____ onaangenaam
- _____ bemoeiziek
- _____ actief
- _____ weinig belangstelling
- _____ trouw
- _____ moeilijk om mee in contact te komen

The Dutch version of the Scale for Ratings of Perceived Effort (RPE-scale)

Naam: :

Voornaam:

Datum :

Uur : :

Gedurende de voorbije 30 minuten was
mijn inspanning bij mijn werk:

6

7 zeer, zeer licht

8

9 zeer licht

10

11 nogal licht

12

13 een tikje zwaar

14

15 zwaar

16

17 zeer zwaar

18

19 zeer, zeer zwaar

20

Feeling of Fatigue Scale

Naam :
Voornaam:
Datum :
Uur :

Fit _____ Uitgeput

APPENDIX G

Dhaka University Institutional Repository

The Dutch version of the Questionnaire for Subjective Symptoms of Fatigue

Naam en voornaam:

Datum :

Uur :

Zet een streepje voor de dingen die U op dit ogenblik bij Uzelf ervaart.

- A.
1. Zwaartegevoel in het hoofd
 2. Vermoeidheid over heel het lichaam
 3. Zwaartegevoel in de benen
 4. Neiging om te geeuwen
 5. Benevelde geest
 6. Slaperigheid
 7. Vermoeide ogen
 8. Stijfheid of onhandigheid in de bewegingen
 9. Niet stevig op de benen staan
 10. Zin om te gaan liggen.
- B.
11. Moeilijk kunnen nadenken
 12. Geen zin hebben om te praten
 13. Prikkelbaarheid
 14. Zich niet kunnen concentreren
 15. Voor niets interesse hebben
 16. Gemakkelijk allerlei dingen vergeten
 17. Gemakkelijk fouten maken
 18. Zich onbehaaglijk voelen
 19. Niet in staat zijn om flink recht te zitten
 20. Zonder energie
- C.
21. Hoofdpijn
 22. Stijfheid rondom de schouders
 23. Pijn in de rug
 24. Moeilijk kunnen ademen
 25. Zich dorstig voelen
 26. Een schorre stem
 27. Duizelig zijn
 28. Spierschokjes in de oogleden
 29. Bevende ledematen
 30. Zich misselijk voelen

The original (Dutch) version of the Inventory for Subjective Health (I.S.H.)

V. O. E. G.

Vragenlijst voor Onderzoek van de Ervaren Gezondheidstoestand *

door Dr. J. M. DIRKEN

Uitgegeven voor het Nederlands Instituut voor
Praeventieve Geneeskunde TNO te Leiden

H.D. TJEENK WILLINK GRONINGEN

VERTROUWELIJK

De volgende vragenlijst dient om een inzicht te krijgen in de gezondheidstoestand van werknemers. Er worden daarom vragen gesteld, die met ja of met nee beantwoord moeten worden.

De vragen hebben betrekking op U persoonlijk, maar Uw antwoorden worden strikt vertrouwelijk door de onderzoekers behandeld. Uw werkgever krijgt dus geen inzage in de antwoorden van de afzonderlijke werknemers, maar alleen wordt hem de gezondheidstoestand van het personeel in zijn geheel meegedeeld.

Beschouwt U het antwoorden op deze vragen als een gesprek met de dokter. Antwoordt U er dus goed op. Spreekt U er niet over met Uw collega's; ook niet terwijl U de vragenlijst invult. Vult U de vragen dus naar waarheid in, maar denkt U er niet te lang over na; spontaan beantwoorden is het beste.

U mag geen vragen overslaan.

U kunt antwoorden door het gedrukte woord *ja* of het gedrukte woord *nee* te omcirkelen. Als U 'ja' antwoordt op een vraag zet U dus een rondje om ja en andersom nee.

Als voorbeeld:

vraag: Gebruikt U een leesbril? ja ☒ nee

Als iemand nee zou antwoorden op deze vraag en dus niet een leesbril gebruikt, zou hij een rondje zetten om het woord nee (zoals in dit voorbeeld is gedaan).

Als hij ja zou antwoorden, zou hij een rondje zetten om ja.

*Handleiding en verantwoording in 'Arbeid en stress' door Dr.J.M.Dirken.

H.D. Tjeenk Willink Groningen

VRAGENLIJST

ja of nee omcirkelen

Hebt U geregeld last van hoesten?	ja	nee
Hebt U nogal eens pijn in Uw borst of hartstreek?	ja	nee
Hebt U nogal eens hartkloppingen of bonzingen in Uw hartstreek?	ja	nee
Hebt U geregeld last van koude vingers, handen of voeten?	ja	nee
Hebt U het idee dat U overmatig dorstig bent?	ja	nee
Is Uw eetlust minder dan U normaal acht?	ja	nee
Hebt U nogal eens een opgezet of drukkend gevoel in Uw maagstreek?	ja	nee
Bent U gauw kortademig?	ja	nee
Hebt U nogal eens pijn in Uw maagstreek?	ja	nee
Hebt U vaak een vieze of zoetige smaak in Uw mond?	ja	nee
Is Uw maag nogal eens van streek?	ja	nee
Hebt U nogal eens last van prikkende of tranende ogen?	ja	nee
Hebt U last van oorsuizen?	ja	nee
Voelt U zich de laatste tijd fit?	ja	nee
Moet U vaak Uw keel schrapen?	ja	nee
Hebt U vaak pijn in of rondom Uw ogen?	ja	nee
Hebt U vaak niesbuien?	ja	nee
Is Uw neus geregeld verstopt?	ja	nee
Hebt U vaak een hongergevoel?	ja	nee
Hebt U het nogal eens benauwd op Uw borst?	ja	nee
Hebt U nogal eens last van een prikkend gevoel in Uw neus?	ja	nee
Slaapt U makkelijk in en slaapt U goed?	ja	nee
Hebt U klachten over pijn in botten en spieren?	ja	nee