A Multivariate Analysis of the Non-radiation Health Effects of Video Display Terminals.

by

Julianne Polle

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A MULTIVARIATE ANALYSIS OF THE NON-RADIATION HEALTH EFFECTS OF VIDEO DISPLAY TERMINALS

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ABSTRACT

An attempt was made to test the political economy framework on a sample of VDT workers. VDT workers' non-radiation health problems (i.e. visual, stress and musculoskeletal) were related to various aspects of their work, such as: workstation design, VDT design, personal characteristics of the workers and characteristics of their work (i.e. alienated labour). It was hypothesized that the characteristics of their work would have the greatest relative impact on their health when all factors were considered simultaneously (i.e. multiple regression analysis). A nonrandom sample of 243 women VDT workers from three crown corporations in Winnipeg was used for the analysis. The data on these workers originally had been collected by the Women's Bureau in a survey they conducted the summer of 1982.

Close to forty per cent of the variance in workers': visual, visually-related musculoskeletal and stress problems was explained. The alienated labour variables emerged as having the strongest relative effects on these health problems. These results lend support to the political economy framework and cast serious doubts on the previous ergonomic analyses of VDT work situations.

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STATEMENT OF THE PROBLEM

Video display terminals (VDTs), also referred to as CRTs (cathode ray tubes) or VDUs (visual display units), are computerized keyboards attached to television-like screens. VDTs are based on the principles of microtechnology and thus are part of the current technological revolution in evidence particularly in our modern offices.

With the introduction of VDTs into offices in the 1970s there was found increasing numbers of workers reporting various health problems. Due to the relative "youth" of VDTs as new types of office equipment the state of knowledge about their non-radiation health effects is still necessarily in its infancy. The long-term effects of VDTs are presently unknown, however, in the short-term they may contribute to visual, musculoskeletal and stress problems.

Previous research has found that more VDT workers than non-VDT workers report these problems and the frequency of recurrence is usually greater for VDT workers (e.g. Dainoff, 1980; Smith et al., 1980; Murray et al., 1981; Smith et al., 1981; CLC-LESC, 1982). It is the contention here however, that it is not specifically the VDT equipment itself, but how it is utilized, in the office labour pro-

cess, which is resulting in the observed health problems among VDT workers. It has been found in some investigations that some groups of non-VDT workers report the occurrence of these health problems almost as often as some groups of VDT workers (e.g. Binaschi et al., 1980; Smith et al., 1980; Smith et al., 1981; CLC-LESC, 1982) and further, that there is variation in the occurrence and/or frequency of recurrence between groups of VDT workers (e.g. Elias et al., 1980; Ghiringhelli, 1980; CLC-LESC, 1982).

Those groups of non-VDT workers which experienced high incidences of health problems were mechanized workers whose main function was machine operation, generally, to the exclusion of other tasks. The groups of VDT workers which reported relatively low incidences of health problems tended to be the professional workers (e.g. computer programmers) whose primary function was not essentially VDT operation. These results tend to indicate that jobs which are highly specialized and involve the singular function of machine usage (whether mechanized or VDT) will promote higher occurrences of health problems.

Jobs which are specialized in function or rationalized are usually also repetitive and routinized. Work which is highly rationalized and allows the worker little control over the work process can be alienating and/or stressful. Other factors such as: the physical characteristics of the VDT equipment, characteristics of the workers,

workstation design factors and environmental factors may add to the health problems of VDT workers, but the central problem is related to how the work is organized.

Much of the previous research on the impact of VDTs primarily attempted to find out whether VDT operators were indeed more likely to experience health problems than non-VDT workers (i.e. these were used as control groups). There was often a tendency, especially by managements, to deny any problems exist initially and this is partially attributable to the commonly held belief that office work, especially in comparison to industrial work, is not hazardous to workers' health (e.g. Lambert, 1980; DeMatteo, 1981; CLC-LESC, 1982).

Another reason for the initial denial of health problems among VDT workers is that there are often no reliable objective medical tests, particularly for visual testing, which can substantiate workers' reports of health problems (e.g. Bedwell, 1978; Cakir, 1978; Stewart, 1978(1), 1978(2); Stone, 1978; Dainoff, 1980) and therefore, subjective reporting by the workers must be relied upon. However, according to Fortin, these subjective reports "are usually active reflections of the objective reality (1983:3)".

The emphasis here on the non-radiation health effects of VDTs does not exclude the possibility that there

may be radiation effects as well. However, radiation testing requires the use of precise scientific instruments by experienced specialists. Evidence to date indicates that where VDTs have been tested their radiation emissions (ionizing and non-ionizing) have been below acceptable standards, although, research in this area is still considered inconclusive (e.g. Purdham, 1980).

Recently, the Federal Health Department (Winnipeg Free Press, 1983) has announced, after testing the radiation emissions from VDTs, that the emissions are "minuscule" or "non-existent", and therefore, they should not be harmful to those using them. Notably, the statements made were based on the testing of VDTs for radiation emissions and no tests, understandably, were carried out directly on human operators and their health.

The long-term effects of low levels of radiation exposure are not yet known (e.g. Province of B.C., 1981). The radiation factor may be an unknown component of variation in the study of non-radiation effects. DeMatteo (1983), for example, suggested that various symptoms of stress may actually be due to various low frequency radiation emissions from VDTs.

Another consideration in looking at VDT workers' health problems is that these problems may also be partially related to other aspects of their lives aside from their

work (e.g. family life, etc.). The quality of their life in general, and not just the quality of their working life, is of importance in assessing their health problems. However, the concern in this thesis is to specifically determine the impact of work on workers' health.

The major objective of this thesis is to construct and statistically test multivariate models which attempt to explain the incidence of health complaints among workers who utilize VDTs. None of the previous research has sought to simultaneously explore the multiple and interacting factors operating in the VDT work situation. It is probable that prior research results are confounded by the numerous related factors not statistically controlled. The purpose is to go beyond the preliminary research done in this area and demonstrate the role of VDTs, relative to other factors operating in the work setting, in the occurrence of workers' health problems.

Chapter II

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

Most of the previous research on VDT usage and its effects has not been guided by theory. The research was essentially exploratory and was initiated due to the increased frequency of health complaints reported among VDT operators. There are two specific groups of researchers which have been concerned with VDTs and their health effects: 1) ergonomists and 2) occupational health and safety (often union or government) researchers. The majority of research has been done by European ergonomists.

Both ergonomists and occupational health researchers were eclectic in their approaches as each borrowed aspects of different sciences in their studies of VDT health effects (i.e. epidemiology, psychological/occupational stress, etc.). The methodologies used by occupational health researchers and ergonomists were very similiar if not identical. However, because both of these groups tend to ignore the historical origins of the transformation and degradation of work in capitalist societies, they often blame the equipment and its design as the major source of workers'

health problems, rather than those who dictate how the equipment is to be used.

The capitalists' focus has been on profit and control issues and little concern has been directed, until recently, towards the possible negative effects on workers' health from VDT usage. In captalist systems, profit/productivity issues take precedence over health and safety issues (Krause, 1977; Berman, 1978) and the workers' health is often sacrificed in the relentless pursuit of profit. Chernomas explained that "(t)he requisites of capital accumulation as they affect the process puts workers' health directly in opposition to the amassing of profits and the reproduction of capitalist social relations in the work place (1982:69)".

The contention of managements and governments generally with regards to VDT usage has been that these problems are not insurmountable if ergonomic principles are applied. Ergonomic or "human engineering" as defined by Shephard is the:

> scientific study of man and his work, including not only the methods of improving efficiency, in the usage of both body and tools, but also the interactions between man and machines, and the various anatomical, physiological and psychological implications for man in a working environment (1974:3).

Ergonomists have concerned themselves with the design, implementation and usage of VDTs (Stewart, 1978(1)). However, ergonomics has been in the past principally a tool of managements (Shephard, 1974).

The primary aim of ergonomics is to facilitate greater worker productivity. Stewart (1978(1)) observed that the health effects of VDTs could prove counterproductive. Health issues then are of concern because they may ultimately affect worker productivity. Ergonomists recommendations for solutions are necessarily structurally limited by the nature and organization of work in a capitalist society, as well as, profit considerations. If ergonomists are constrained within the parameters of profit maximization, it is probable their answers to the problems can only be "patchwork" solutions (Krause, 1977). This is apparent as many VDT ergonomic solutions have been utilized yet the workers' health problems still persist.

Many of the published statements warning of the negative health effects of VDT usage have been put out by various unions (e.g. Lambert, 1980; AFL-CIO,CLC, 1981; DeMatteo, 1981). Government occupational health and safety agencies (e.g. NIOSH) have also been actively involved in the VDT issues. Generally, these groups have noted four or five reasons for these health problems such as: VDT equipment design, office lighting problems, workstation design problems, organization of work, poor machine maintenance and ocular problems (e.g. NYCOSH, 1980; Purdham, 1980; DeMatteo, 1981). These informal lists were presented as suggestive of problem areas in VDT workplaces. There have not been any paridigms formulated and tested in which the relative importance of these various factors have been assessed.

The political economy theory, which provides a broader structural understanding of work in capitalist societies and how it has varied historically, facilitates speculation on potential primary causal factors at the individual level of analysis.

2.2 THE POLITICAL ECONOMY OF WORK

According to Karl Marx, in Capital (Volume I), the driving force motivating capitalist production is the desire to accumulate capital. Capital accumulation is "the cycle of investment of prior profits, organization of production, sale of produced commodities, realization of profits (or loss), and reinvestment of new profits (Edwards, 1979:15)".

Capital is comprised of two major elements: 1) variable capital or labour-power and 2) constant capital or the means of production (materials and instruments of production). In the labour process, through the interaction of labour-power and the means of production a commodity is produced. The labour-power of the workers is "crystallized" in the commodities they produce.

Surplus value is extracted by the capitalists in the labour process through the exploitation of labour; the appropriation of unpaid labour. Surplus value is the return to the capitalists from the sale of commodities over and above the capital originally advanced to produce them.

It is only the variable (productive labour) component of capital which can expand itself in the production process, not the constant capital. Labourers' wages are based on their needs to reproduce themselves and to subsist and not on their productivity. The capitalists have the ability to appropriate unpaid labour because of their legal and contractual rights as owners of the means of production.

The capitalists' focus on capital accumulation juxtapositioned with workers "who have their own interests and needs and who retain their power to resist being treated like a commodity (Edwards, 1979:12)", has resulted in a fundamental struggle between workers and their employers. As Chernomas remarked, "(i)t is the ebb and flow of this struggle between classes that helped to establish the standards of living and the physical and psychological conditions of the workplace of capitalist society (1982:31)".

The changes in strategies to control conflict are to a large extent the explanatory roots of the historical transformation of labour (productive and nonproductive) under capitalism. It is important to view the historical transformation of both productive and nonproductive labour in order to understand labour today. Control techniques developed for one type of labour were used, if successful, to eventually control other types of labour.

Edwards (1979) studied American workplaces and described the predominant types of control strategies used in each stage of capitalist development. New control techniques were developed with each new crisis which erupted in the workplace. Control, as defined by Edwards is "the ability of capitalists and/or managers to obtain desired work behavior from workers. Such ability exists in greater or lesser degrees, depending upon the relative strength of workers and their bosses (1979:17)". The various types of worker control developed historically function to "contain" conflict due to worker resistence and to tip the balance of power to favour the capitalists.

Control then for Edwards has two separate but not mutually exclusive dimensions: 1) the ability of capitalists to prevent workers from collective action which also affects 2) their abilities to control the work process to ensure productivity. Edwards delineated three major types of control: 1) simple nonstructural (i.e. entrepreneurial or hierarchical), 2) technical structural and 3) bureaucratic structural.

In order to ensure worker productivity the capitalists attempt to gain complete control over the labour process. During the nineteenth century, in the early stages of capitalist development, simple overt direct (nonstructural) controls were effective since workplaces were still small enough that the capitalists and a small group of as-

sistants could efficiently regulate the labour process. In these early years, the workers were often skilled craftsmen brought together by the capitalists into the workplace. These workers possessed most of the knowledge about production and they could not be easily replaced, and this tipped the balance of power in their favour.

In order to increase productivity and to wrest control away from the workers, the capitalists began to divide work processes into distinct components (i.e. rationalization of the work process). As well, mechanized production techniques were introduced into workplaces. As workplaces grew in size hired foremen were used to control the workers.

With the increased division of labour and use of machinery, workers performed simplified tasks. The workers lost their conception of the overall work process. With less skills required to participate in the production process and therefore, less training, workers could be more easily substituted. The workforce was homogenized and troublesome workers could be replaced with workers from the reserve army of unemployed. During this time there was a labour surplus due to: immigration, urbanization and the use of minority group members (i.e. blacks).

However, simple mechanization and rationalization had limited control capabilities as much of the power rested with the hired foremen. In the late nineteenth century and

the early twentieth century, with the advent of monopoly capitalism and its tendency for economic concentration, there were even larger masses of workers and hired bosses to contend with.

Other forms of control were being experimented with at that time (i.e. welfare capitalism, company unions and scientific management). These early experiments proved unsuccessful generally in circumventing worker unionization, although, some of the more useful aspects of these experiments were retained. The capitalists learned from these experiments:

> that control must emanate from a legitimate overall structure, that it must be concerned with the work itself, that jobs must be defined precisely on the basis of management's control over special knowledge, that there must be positive rewards for proper work, and that management itself, especially foremen, must also be subjected to systematic control (1979:110).

Technical structural controls came to be the predominant form of control utilized with production workers. Technical control is characterized by the total automation of a production process resulting in continuous flow assembly lines. Workers are stationed at a particular point on the assembly line, work comes to them at a steady pace and they cannot pause without falling behind in their work and disrupting the entire process. Workers have little time to interact with one another and this serves to isolate them. With technical controls the:

> (s)truggle between workers and bosses over the transformation of labor power into labor was no longer a simple and direct personal confrontation; now the conflict was mediated by the production technology itself. Workers had to oppose the pace of the line, not the (direct) tyranny of their bosses (authors' italics) (Edwards, 1979:118).

and,

> Instead of control appearing to flow from boss to workers, control emerges from the much more impersonal "technology" (Edwards, 1979:120).

Foremen no longer initiated and directed the work process, they became overseers, monitoring the workers and they could not "be held personally responsible for the oppressiveness of the production process (Edwards, 1979:120)". Recently, the introduction of computers into continuous flow systems has finely honed the capabilities of control with complex feedback systems.

Technical control was not sufficient to effectively control production workers. The interdependence of all the work tasks presented problems. If a small number of workers in a factory went on strike this could bring the whole operation to a stand still. Bureaucratic control techniques have been increasingly used to compensate for the deficiencies of technical controls.

Bureaucratic structural controls were developed in the post World War II era to control nonproductive office or white- collar workers. The number of these types of workers

dramatically increased due to: the growth in productive activities which required a parallel growth in the supportive nonproduction workers, to facilitate the realization of surplus value; intra-class competition encouraged the growth of advertising and marketing/ sales departments; the growth in government bureaucracies; and the growth of white-collar industries (e.g. banking, etc.). Office workers have been labelled non- or un-productive workers since they do not create surplus value. However, as Cromptom explained:

> as labour it (unproductive labour) will be subject to similiar constraints as productive labour- i.e. disciplined and organized in order to achieve its maximum utilization. Indeed, as the employment of such labour ultimately constitutes a drain on the process of accumulation, unproductive labour may be subjected to more pressures than productive labour... (author's italics) (1979:405).

Bureaucratic control is hierarchical control which has been institutionalized into a formal and rigid system of organizational rules. The concept of "career" was developed and each job was specifically described and the means to advance up the career ladder were specified. Employees who demonstrated loyalty to the firm and an ability to conform to the rules could expect to advance in their jobs.

Importantly, bureaucratic controls served to regulate the hired supervisors, as they too were confined by organizational rules and policy. Workers were no longer subject to inconsistent treatment by their supervisors.

Bureaucratic control "attempted to routinize all the functions of management ... (Edwards, 1979:131)".

Bureaucratic controls were successful in separating workers, and thereby preventing collective action, by instituting hierarchies of jobs. Each job was clearly defined as different from other jobs and different salary levels were assigned. This type of structure promoted an individualistic orientation if workers expected to advance up the hierarchy. Workers which displayed loyalty to the company with: a strong adherence to company rules, dependability and had internalized the goals and values of the firm, were rewarded with upward mobility and job security.

Bureaucratic controls seem to be the best controls developed to date. This type of structural control however is not without problems (i.e. industrial democracy, quasi-fixed wage bills, increasing government intervention, etc.) for the capitalists, since the underlying contradictions of capitalism are unresolved. Edwards noted that:

> Bureaucratic control has created among American workers vast discontent, dissatisfaction, resentment, frustration, and boredom with their work (1979:154).

and,

> Rising dissatisfaction and alienation among workers, made exigent by their greater job security and expectation of continuing employment with one enterprise, create problems for employers, one of which is reduced productivity (1979:154).

Today both bureaucratic and technical controls, as well as remnants from other less successful control strategies (i.e. welfare capitalism, scientific management and company unions) are all being used to control both productive and nonproductive workers in large organizations. In general, control over the labour process has developed historically from overt direct nonstructural control to covert indirect structural control. Control has become invisably embedded in the technical and social structures of large modern corporations. In this disguised form, it appears, on the surface at least, that the equipment in use or the bureaucratic rules in force are the oppressors of workers, not the capitalists themselves.

2.2.1 The Transformation of Office Work

Clerical/office work, in the nineteenth century, was a multifaceted occupation which involved a variety of tasks (Lockwood, 1958; Braverman, 1974). Office workers were originally a very small component of an organization. They performed primarily managerial or assistant-to-the-owner functions. The majority of the workers were male. The workers often initiated a work project and followed it through to its completion. As Braverman described it:

> Clerical work in its earlier stages has been likened to a craft ... Although the tools of the craft consisted only of pen, ink, other desk appurtenances, and writing paper, envelopes, and ledgers, it represented a total occupation, the object of which was to keep current the records of the financial and operating conditions of the en-

> terprise, as well as its relations with the external world (1974:298-299).

Their major function was to transfer and appropriate surplus value for the capitalists. Office work was considered to be mental work. White-collar workers were the elite workers who never dirtied their hands in physical labouring. They were usually well-educated, received good salaries (especially relative to blue-collar or productive workers) and they were often guaranteed a job for life. They tended to loyally identify with the owners as opposed to the production workers. Simple entrepreneurial nonstructural controls were adequate in controlling these workers (Edwards, 1979).

As the number of white-collar workers increased in the twentieth century, with the advent of monopoly capitalism, there was, according to Braverman, a new class of office workers in evidence. The sharp distinction between blue- and white-collar workers was blurred as the office became a factory and the office workers were proletarianized.

Owners strove to maintain control over the massive processing of paperwork. As Braverman remarked, "(a)s in the factory, the solution to the problem was found first in the technical division of labor and second in mechanization (1974:312)". There was a transformation and degradation of office work in the twentieth century.

Braverman (1974) observed that scientific management and its principles had a great impact on office procedures and a grave effect on the workers. Frederick W. Taylor developed the idea of scientific management in the late nineteenth century. It "is an attempt to apply the methods of science to the increasingly complex problems of the control of labor in rapidly growing capitalist enterprises (Braverman, 1974:86)". It involves primarily the division of labour into minute components, through such means as time and motion studies, in order to give management complete knowledge of the production processes, and thus, control. Scientific management techniques were first used to control productive labour but they began to be applied to offices in the beginning of the twentieth century.

Although the ideal office, as conceptualized by Taylor and his followers has probably never been realized in practice, the principles of rationalization and machine usage to wrest control away from the workers are clearly in evidence in modern offices. Modern versions of scientific management, because of the "bad odor of the name" (Braverman, 1974) of scientific management, have become euphemistically known as ergonomics and management consulting.

As the mass of paperwork grew in volume, rationalization of work, through the increased division of labour, separated the multiple tasks of a work process and relegated them to different individuals. Entire departments in an or-

ganization became responsible for these separate functions and office workers became very specialized . Braverman observed that:

> -in fact, even more easily than in manufacturing processes- the work of the office is analyzed and parcelled out among a great many detail workers, who lose all comprehension of the process as a whole and the policies which underlie it (1974:314).

With specialization, the office workers' work becomes standardized, repetitive and routine. The work is standardized such that the workers can execute a task with little thought; there is the "separation of conception from execution" (Braverman, 1974). The drive for increased control over the labour process is assured by removing the subjective aspects of work from the worker.

With the growing numbers of managers required, even their functions become part of the labour process, and therefore, needed to be controlled. Bureaucratic structural controls were instituted, especially in the post World War II era, to control not just the workers but the managers as well (Edwards, 1979). Notably however, long before bureaucratic controls were instituted, office mechanization had been proceeding at a rapid pace particularly in the larger corporations.

The rationalization of work facilitates the use of machinery to perform these simplified tasks. As Thackray re-

marked, "(t)here is no more efficient instrument of control from the top than machinery (1980:98)". Further, according to the ILO:

> Mechanization, and to a much greater extent automation (computerization), offer the management the promise of greater speed and accuracy in routine office operations; more rapid, complete and accurate information concerning every phase of the undertaking, and, above all, a reduction in clerical costs (Part III, 1960:366).

Different types of machines (i.e. mechanization) have been used in offices since the 1890s but it was not until the post World War II period that electronic computers (i.e. computerization) began to be adopted for office tasks (ILO, Part I, 1960).

The drive for increasing control and cost efficiency made the eventual introduction of computers into offices inevitable. With computers, the rationalization of work progresses even further. Mental operations are taken over by the computer (ILO, 1960; Braverman, 1974). This results in what Thackray (1980) described as "mentally sterile workers".

Mann and Williams (1970) observed in their research, that with the introduction of EDP (electronic data processing), many of the organizational rules and policies could be programmed right into the computer system and this ultimately restricted individual decision making. This allowed for centralized and standardized decision making which

increases upper managements' control over the labour process.

The increasing use of computers, which reduces office workers to semi-skilled machine operators performing simplified tasks would help to alleviate the problem of quasi-fixed wage bills in firms. Phillips and Phillips remarked that "(o)ffice costs now run from around 50 per cent of total operating costs for major U.S. corporations, up to 75 per cent of costs for the financial industry and government. Wages account for 80 per cent of these office costs (1983:110)". They further explained that employers had to either reduce wages or to increase productivity to ensure greater profitability. Since wages could not be easily reduced, the introduction of new computerized equipment was the best solution. Employers are then able to reduce their overall wage bills since the total number of workers required is often less and, if not less, those who do work have lower status semi-skilled jobs and, thus, lower wages. These workers would become more easily expendable and substitutable and this serves partially to control the workers. Another factor, noted by Braverman is "(t)he sex barrier that assigns most office jobs to women, and that is enforced by custom and hiring practice, has made it possible to lower wage rates in the clerical category, ... ,below those in any category of manual labour (1974:353)".

With the historical transformation of office work there was the concomitant transformation in the sex composition of the office labour force. There occurred what has been labelled the "feminization" of the office clerical labour force (Davies, 1975). Clerical/office work which was historically male work has become progressively, in the twentieth century the domain of women workers (Lakewood, 1958; Braverman, 1974; Davies, 1975; Armstrong & Armstrong, 1978; Phillips & Phillips, 1983).

According to Canadian statistics reported in Phillips & Phillips (1983), in 1901 women comprised 22.1 per cent of the clerical workers and this had risen to 78.4 per cent by 1980. Women are increasingly taking over the deskilled, low paying, low status jobs created by rationalization and mechanization/ computerization of office work. It is evident that women workers will be those most affected by the micro-chip revolution now occurring in our offices. VDT usage and its possible health effects becomes, although not exclusively, a women's issue.

VDTs are computerized keyboards attached to television-like screens. VDTs, which began to be introduced into offices in the 1970s (Province of B.C., 1981), have allowed for radical changes in the office labour processes. VDTs have been introduced into all areas of office work. They are very versatile equipment as they can be used as "graphic, data- and word- processing systems (Province of B.C., 1981:1)".

Potentially all departments in an organization could be interconnected by VDTs leading to an automated system. Dainoff et al. stated that "the appearance of VDTs is indicative of a growing trend toward automation of office procedure (1981:421)". Originally , it was only the accounts and sales departments which were computerized (Thackray, 1980) and now VDTs allow also for the computerization of words.

Word processing is a classic example of the rationalization of work. Word processing is essentially a task that all secretarial workers have performed (e.g. typing letters, etc.). However, today the term is applied specifically to the types of VDT equipment utilized to perform these tasks.

Secretarial work was originally composed of two general functions: 1) correspondence and 2) administrative support. These two functions are often separated with the introduction of VDTs into offices (Braverman, 1974; Russell, 1978). One group of workers will be responsible only for word processing and another group is concerned only with administrative support (e.g. answering telephones, etc.). As Makower described:

> Secretaries who once handled a letter from dictation to transcription to final copy to mailing may find themselves simply transcribing notes - or assembling preprogrammed paragraphs - onto VDTs for six or seven hours per day, while the other tasks are handled by other individuals on the word-processing assembly line (1981:98).

In large organizations these functions will be centralized into physically distinct departments. This implies a complete reorganization of the office and the office work processes. The centralization into word processing pools is to ensure employers greater control and to maximize their investment in the equipment by allowing for continual usage. This also chains word processing operators to their terminals and enhances the chances that these workers will suffer ill health effects. Notably, managers themselves are not too receptive to the idea of word processing pools as many lose a source of prestige, their own personal secretary.

2.2.2 Alienation

Marx utilized the concept of alienation to describe and explain the devalued condition of humans in a capitalist society. He wrote his fullest explanation of this concept in 1844 in his Economic and Philosophical Manuscripts (1971).

Labour loses itself in the process of production (i.e. objectification and externalization of humans in their product) and due to appropriation of the product by the property owners, labour is alienated from its product. What the propertyless workers give of themselves in their labouring, lessens them as human beings. As Marx remarked "(w)hat the product of his labour is, that he is not (1971:135)".

The consequences of performing alienated labour are that humans are further alienated: from themselves, from their "species-beings" and from other humans. Alienation, according to Marx, is an economic fact of capitalism.

Since the product is eternalized labour, owned and dominated by the capitalists, labour consequently becomes alienated from itself (i.e. self-alienation) and powerless. The worker, according to Marx, "does not confirm himself in his work, he denies himself, feels miserable instead of happy, deploys no free physical and intellectual energy, but mortifies his body and ruins his mind (1971:137)". Thus, alienated work affects humans physically, intellectually and emotionally.

Those characteristics of humans which distinguish them from other animals are lost in a capitalist society in the labour process. Since the labour process is owned and controlled by others, the workers are not allowed to freely express themselves, it is no longer a conscious creative endeavor, and so, humans are alienated from their very essence or "species-being". Work becomes instrumental and compulsory, a means to sustain physical existence; it has become dehumanized.

Finally, the end result is humans are alienated from their fellow men. Marx does not go into details as to the consequences of this for society although it is probable

it will lead to isolation. Some theorists have used Durkheim's concept of anomie to explain this aspect of alienation. They expect there to be a lack of community and, consequently, a state of normlessness (e.g. Blauner, 1970; Faunce, 1970; Seemans, 1970; Shepard, 1971).

That labour will be alienated in a capitalist society is a necessary truth or maxim for Marx, although, the degree of alienation will vary with the extent of capitalist development. Advances in productive technology, with its concomitant increasing control over the labour process by the capitalists, will be accompanied by increasing worker alienation. Further, the more labour produces for capital, the greater the power of the capitalist. Marx explained that "the misery of the worker is in inverse proportion to the power and size of his production (1971:133)".

There has been considerable theoretical speculation as to the causal relationship between automation and alienation. Some theorists would suggest that automation causes alienation (e.g. Sheridan, 1980). Other theorists in this area have presented the hypothesis, in contradistinction to Marx, that workers in automated systems will not be alienated, or if alienated, they will be less alienated than those working in mechanized systems (e.g. Blauner, 1970; Faunce, 1970; Seeman, 1970; Shepard, 1971; Timmins, 1975).

These theorists which propose this hypothesis are usually working from a social psychological perspective rather than a political economy one. They attribute the reduction of alienation in automated systems to the job enlargement and rotation possibilities in automated systems which are thought to be beneficial ways of organizing work. This hypothesis has been tested on groups of blue-collar and white-collar workers (e.g. Shepard, 1971).

As previously noted, few office workers work in continuous flow systems and thus, this debate is of little relevance to the present thesis. This literature does however demonstrate the difficulty in grasping the somewhat vague, amorphous concept of alienation, and therefore, the problems of operationalizing it become apparent in reviewing the empirical literature.

A large part of the empirical tradition surrounding the concept of alienation stems from Seeman's (1970, 1976) non-Marxist conceptualization of this concept. According to Archibald "(t)he problem with all to (sic) many Marxists who have written about alienation, ... , is that they have disregarded comparative research, leaving the field open to distortion prone non-Marxists (1976:70)". The empirical studies which have followed Seeman's framework (Nightingale & Toulouse, 1978; Shepard, 1971) usually involve surveys in which workers subjectively describe their work and from these descriptions workers are assumed to be more or less alienated.

This seems to be a general problem inherent in most of this literature (Geyer & Schweitzer, 1976; Kasl, 1978; Schweitzer, 1981; Anthony, 1982), although some researchers have attempted to overcome these problems (Nightingale & Toulouse, 1978). As Anthony explained "(t)here is a fundamental confusion here between the process by which work overwhelms the worker and the condition it produces in him (1982:143)", and further, "(t)he process of alienation is explained by certain characteristics in the job and those characteristics come to stand for the condition of being alienated by it (1982:144)".

Some Marxist scholars have reacted to this trend in the literature by maintaining that alienation is primarily an objective structural characteristic of work and not a subjective individual phenomenon (Schweitzer, 1981). Although Marx himself recognized alienation also to be a subjective condition it was not well developed by him and, to date, remains a vague concept.

Shepard (1971), for example, did an empirical study of both blue-collar and white-collar workers and the relationship between mechanized/automated work and worker alienation. He operationalized a variety of dimensions of alienation (e.g. powerlessness, normlessnes, self-estrangement, etc.), however, he confused cause with effect in his formulations. To capture the variable of powerlessness, for example, he asked questions such as : "To what extent can

you vary the steps involved in doing your job?" or "To what extent can you increase or decrease the speed at which you work?". These questions actually only describe the work. Yet, he infers from the workers' responses to these questions, that work which is characterized by lack of worker control, automatically, creates in the workers feelings of powerlessness. He has captured the workers' subjective perceptions or attitudes towards their jobs but not the effects of work on the workers.

Alternatively, it would seem possible that the objective conditions of alienated labour may be evident, yet, the workers may not subjectively experience alienation. This is a possibility that these researchers, such as Shepard, do not anticipate. It cannot be assumed that objective conditions of alienated labour automatically result in subjective alienation without empirical testing of both the objective conditions and the subjective effects.

Some scholars note how Marx seemed to have abandoned the concept of alienation in his later writings (McCarthy, 1978; Schweitzer, 1981; Anthony, 1982). Archibald (1976) observed that Marx concerned himself in his later writings with the structural phenomenon of commodity fetishism or reification. Schweitzer (1981) remarked on how in 1972 alienation was declared a dead issue. However, Marxist and non-Marxists have continued to use this concept and as Schweitzer stated "that while Marx may have abandoned the

term 'alienation', he did not abandon the idea or the fundamental questions raised by it (1981:529)".

Labour is "the actual human effort in the process of production (Edwards, 1979:12)" and is synonymous with the word "work". Labour which is alienated is primarily characterized as work in which workers have little control. As Anthony explained:

> The division of labour entails the crippling of mind and body. The separation of intelligence as a special function of the production process and what we have come to see as the highly specialized development and extension of management means that intelligence is drawn out of work and made into a function of control. The progressive withdrawal of intelligence from work ends by leaving labour cretinized ... (1982:148).

Recent Marxist scholars (Braverman, 1974; Chernomas, 1979; Edwards, 1979) tend to use alienation as a structural concept descriptive of labour. As Schweitzer remarked about Braverman, for example, "(h)is approach toward a rehabilitated treatment of alienation narrows on the specific condition of the working class and the very history of the producer's loss of control over the process of production (1981:528)".

Workers who perform work which can be characterized as alienated labour will experience stress (Chernomas, 1979). Researchers who investigate occupational stress have looked at the characteristics of work (e.g. lack of worker

control, repetitive work, etc.) as stressors, causal of workers' health problems.

2.3 HEALTH IN CAPITALIST SOCIETIES

Chernomas (1982) provides a theoretical and historical link between capitalist economic structure and disease. Each stage of capitalist development can be characterized by the predominance of certain types of diseases: acute diseases such as tuberculosis and pneumonia, dissemated the working classes during the period of nineteenth century industrial capitalism; chronic diseases, for example heart disease and cancer, plague workers in the twentieth century monopoly capitalism.

He disputes the prominent medical theory which attributes disease to germs or viruses and demonstrates the roots of health problems to arise from changes in the methods of capital accumulation. The accumulation process is a product of the interacting influences of workers' resistance and capitalist competition (1982:32). The struggle between these two antagonistic forces historically has produced social and working conditions which affect individual susceptability to disease.

Although Chernomas takes an holistic approach to the incidence of disease, inclusive of social factors (i.e. air, water and land pollution; dietary problems related to

the excessive consumption of saturated fats and sugar products, overprocessed foods full of chemical preservatives and artificial coloring; urban living; etc.), of primary importance to this thesis, is his description of the mechanisms of monopoly capitalism and their affects on: work, the work environment and health.

Under industrial capitalism, the emphasis was on the accumulation of absolute surplus value to create profit through the direct exploitation of workers (i.e. starvation wages, long hours of work, etc.). Workers were drained of energy and weakened by their long hours of physical toil. Workers could not afford nutritious food, adequate clothing or shelter. These factors, in conjunction with poor sanitation and water supplies, led to an increased susceptibility to acute diseases.

As workers began to organize to fight against their conditions of abject poverty in the nineteenth century, their working and living conditions were seen to improve (i.e. through favourable legislation, increased wages, etc.). These changes however reduced the capitalists' ability to extract surplus value. Chernomas explained:

> The 'traditional' means of supplying the growing needs for surplus value had been blocked by the movement below. Capitalists in competition had to turn to the kinds of cost-reducing production techniques that forced the system in a direction which, ... , created conditions for chronic disease. If surplus value was to continue to become available given shorter hours and rising real wages, surplus value had to grow all the faster by some other means (1982:110).

During the transition period to monopoly capitalism, in an attempt to reduce production costs and thereby increase surplus value, there was the increased utilization of machinery in the production process (i.e. rise in the technical composition of capital) and, along with the increased rationalization of labour, these resulted in the conditions for chronic diseases.

Work for both productive and nonproductive workers became more alienating. Chernomas asked:

> How does alienation affect the health of the worker? A by-product of the separation of control from execution in the work process is stress, an increasingly recognized component of modern society, and chronic disease (1982:41).

Work not only requires less thought and creativity but it also requires less physical exertion, workers also become sedentary. The reduction of need for a variety of physical activity is not accomplished with the comfort of the worker in mind, but are the exigencies of capitalist competition because any unnecessary movement of the body tends to diminish output by interrupting the smooth, uniform flow of labour (1982:68). Isolation of the workers and the speed-ups of work further contribute to their stress.

Chernomas also recognized factors in the labour market which may be stressful to the workers (i.e. redundancy and unemployment).

The workplace environment may be too hot, too cold, too noisy and/or poorly ventilated. There may even be toxic chemicals present in the office environment. As Makower pointed out "(t)he office environment threatens inhabitants with a variety of assaults from radiants, carcinogens, mutagens, allergens, noise, and other components of inadequate design - ... (1981:1)".

All of these factors contribute to the chronic occurrence of stress and the eventual development of disease.

The health problems of office workers did not erupt suddenly with the introduction of VDTs into modern offices. There is a long history of health problems among office workers. In the 1930s the ILO found in its investigations of office workers that "(c)lerical workers often complained of muscular fatigue, backache and other such ills as a result of the unaccustomed strain of operating machines (ILO, Part III, 1960:352)". There were also complaints about: nervous tension or stress, eyestrain, frustration and boredom.

Since these health complaints were not immediately life threatening, office workers' health complaints were largely ignored and were not taken too seriously. Further, because hazardous office problems do not have an immediate and dramatic effect but usually take years to surface, their problems were seen to be not work-related, but due to such things as aging (Makower, 1981).

The ILO related office workers' problems primarily to the combined effects of rationalization and mechanization. The ILO reported:

> The machines themselves cannot be held entirely responsible for the monotony of office jobs, since even before mechanisation many clerical workers had been obliged to perform routine and uninteresting tasks, but work of this type became more frequent as the machines took over more and more of the mental operations required by the clerks, leaving them purely routine jobs or auxiliary operations such as classifying and preparing the data for the machines to work on. The uniformity and excessive simplification of the work of many machine operators, the extreme subdivision of functions which further limits their area of activity can induce in employees the feeling of being simply an unimportant cog in the machine. This is a difficult situation for workers to accept, and may have serious psychological and even physiological consequences; ... (Part III,1960:354).

Computerization exacerbates potential health problems originally evidenced with earlier rationalization and mechanization. Managements are allowed even greater controls over work with computers. Individual contributions are more identifiable, worker productivity can be guaged and errors can be easily traced. There is a rapid work pace dictated by the computers (i.e. imposed by management). Jobs which are boring due to simplification and standardization are at the same time demanding of the workers full attention to detail.

Stress-related health problems became the bain of office workers. Stress symptoms such as: headaches, fatigue, dizziness, nausea, muscle fatigue, breathing difficulties,

depression, anxiety, anger, boredom, irritability, nervousness, insomnia, digestive and heart troubles became common among office workers. As the ILO explained, these "symptoms may lead to an increased tendency to ill health, sensitivity to infections, pronesness to accidents, and illness such as stomach ulcers or high blood pressure (Part III, 1960:355)".

2.4 SUMMARY

Political economy theorists (e.g. Braverman, 1974; Edwards, 1979; Chernomas, 1982) have provided historical explanations for: why there have been transformations in labour processes in capitalist societies (e.g. strategies to promote increased capital accumulation which focus on increased control over the labour processes and the labour force); the exact nature of these transformations (e.g. the feminization of office work forces, the degradation of work due to : rationalization, mechanization/ computerization, etc.) and; the subsequent results of these tranformations for the workers (e.g. work-related health problems, etc.). These theorists reveal why previous ahistorical researchers have fallen into the trap of blaming the equipment in use rather than those who control the equipment.

It is apparent that the elements of control, rather than characteristics of any equipment used, are central, according to the political economy framework, in explaining the occurrence of workers' health problems. In this thesis,

attempts were made to test these premises on a specific group of office workers: the VDT workers.

Chapter III

REVIEW OF THE LITERATURE

There is a dearth of Canadian and American studies and these studies were usually approached from an occupational health and safety perspective by governments and/or unions. Most of the researchers used surveys to gather their data on health complaints, although, some supplemented their findings with actual clinical testing of their subjects. Data related to the potential contributing factors to workers' health problems, were also gathered through surveys and/or direct observations and measurements, by the researchers, in the workplaces.

The three major areas of non-radiation health problems studied are: visual, musculoskeletal and stress. There is a general tendency in the literature to examine these health problems separately. For example, a researcher may study only visual problems and exclude musculoskeletal and stress problems from consideration. This research strategy seems to imply that workers' visual, musculoskeletal and stress problems are unrelated and they have different causes. However, as suggested in Chapter Two of this thesis, there may be an overall causal factor: the performance of alienated labour.

Visual and musculoskeletal health problems can be the direct result of specific physical stressors. For example, physical strain on certain muscles may result in muscular fatigue or damage, but it may also be manifested in a variety of non-specific stress symptoms such as general tiredness or fatigue. According to Seyle "(w)hat we actually see when something acts upon the living body is a combination of stress and the specific actions of the agent (1956:43)".

It is probable that stress symptoms will coexist with visual and musculoskeletal problems and this has been evidenced in some previous research studies (e.g. Dainoff, 1980; Smith et al., 1980; Murray et al., 1981; Smith et al., 1981; CLC-LESC, 1982). Elias et al. (1980) suggested these interrelationships between stress and other health problems are due to similiar sources such as job content.

In the empirical literature, it has been generally recognized that the type of work performed is the major causal factor related to stress and musculoskeletal problems. These findings lend partial support to the political economy framework which suggests that the performance of alienated labour will be the primary cause of workers' health problems. However, in the study of visual problems, ergonomic researchers have emphasized VDT design flaws.

The following discussion of workers' health complaints and their causes is divided into three major sections: 3.1) visual problems, 3.2) musculoskeletal problems, and 3.3) stress problems.

3.1 VISUAL PROBLEMS

It has been suggested that VDTs may have their greatest impact on workers' eyes (e.g. AFL-CIO, CLC, 1981; DeMatteo, 1981; Rosenbaum, 1981; Charbonneau, 1982). Recent empirical evidence has demonstrated that more VDT operators, than non-VDT workers, report symptoms of eyestrain (asthenopia) and/or visual fatigue (e.g. Cakir, 1978; Ghiringhelli, 1980; Laubli et al., 1980; Rey et al., 1980; Smith et al., 1980; Dainoff, 1981; Murray et al., 1981; Smith et al., 1981; CLC-LESC, 1982). However, there has been found to be variations between groups of VDT workers (e.g. Cakir, 1978; Elias et al., 1980l Laubli et al., 1980; Smith et al., 1980; Smith et al., 1981; CLC-LESC, 1982) and, as well, some groups of non-VDT workers have reported almost as great occurrences of visual problems as some groups of VDT workers (e.g. Laubli et al., 1980; CLC-LESC, 1982). These findings suggest that it is not only the VDT equipment which is contributing to VDT workers' visual problems.

Eyestrain, as defined by Heaton, is "the symptoms experienced by a person who strives to see (1968:251)". Some of the possible symptoms of eyestrain are: headache,

aching eyes, irritation and itching of the eyes, red or watery eyes, hot and dry eyes, difficulty in focussing the eyes, and blurred vision (e.g. Heaton, 1968). Further, it is not just the occurrence of eyestrain which is of concern, but also the frequency of that occurrence. As DeMatteo remarked " (w)hile occasional eyestrain may be a minor problem, its daily or chronic occurrence may cause deterioration of vision (1981:39)". Visual fatigue, due to tired eye muscles, is not essentially a symptom of eyestrain, although visual fatigue can lead to the development of eyestrain (e.g. Heaton, 1968).

Grandjean (1969) noted that with visual fatigue there have been evidenced decreased visual acuity, accommodation and convergence.

Dainoff (1981), in his review of the literature, found evidence of correlations between visual fatigue and objective clinical measures of visual acuity, accommodation and convergence. Visual acuity, or the ability to discern specific shapes or fine detail, is seen as related to the functioning of the eyes' lens and retina.

Convergence and accommodation are interrelated visual functions (e.g. Stewart, 1978 (2)). Heaton defined convergence as " (t)he coordinated movement of the two eyes towards fixation of the same near point (1968:313)". Accommodation, according to Heaton, is " (t)he adjustment of the

power of the lens of the eye necessary to see at varying distances (1968:311)". Convergence on an object by the eyes, uses the extrinsic eye muscles (e.g. Shephard, 1974). Accommodation (near or far) on an object requires the use of the intrinsic eye muscles (e.g. Shephard, 1974). Focussing into the distance is the postion of relaxation for the eyes, focussing on near objects stresses the eyes (e.g. Grandjean, 1969). Thus, as Shephard explained, "(f)atigue of the intrinsic and extrinsic eye muscles is thought responsible for the burning aching sensation of visual strain (1974:150)".

Researchers are not quite sure what eyestrain is, or what the physical mechanisms of it are, and thus, any discussion of this remains to be primarily theoretical speculation (e.g. Dainoff, 1981). Exactly how the eyes are affected is not well understood, and therefore, attempts at constructing objective medical tests for eyestrain have not been very successful (e.g. Bedwell, 1978; Cakir, 1978; Stewart, 1978(2); Stone, 1978; Dainoff, 1980, 1981; Kalsbeek et al., 1980; Ostberg, 1980).

The problem with most testing, according to Bedwell (1978), is that objective tests are usually taken under static conditions while VDT work requires frequent dynamic eye movements. There is constant refocussing on the VDT screen keyboard and source documents by the operators and this has been found to contribute to workers' visual problems (e.g. Elias et al., 1980). Cakir observed 40 individu-

als working on VDTs, through the use of video tapes, and found:

> Half the time they looked at the keyboard. Only one-third of the time, normally, did they look at the display; and if you count the number, it is about 10 to 30 thousand times per day that they try to look from one point to the other. If you try to find out how long each look takes it is between 0.8 seconds to 4 seconds maximum (1978:14).

Thus, subjective reporting of visual symptoms remains the best means of detecting visual problems related to VDT usage (e.g. Dainoff, 1981).

There are four major interrelated clusters of factors which have been found to potentially contribute to the occurrence and frequency of visual problems. The empirical findings and hypotheses related to these clusters of contributing factors will be summarized in the following four sections: 3.1.1) the type of work performed and the duration of VDT usage daily; 3.1.2) the characteristics of the VDT equipment; 3.1.3) environmental factors; and 3.1.4) personal characteristics of the workers. Stewart (1978(1)) suggested a possible fifth causal factor, that of posture. However, in his discussion, it is clear, that posture does not cause visual problems, but it causes general fatigue, which operators may wrongly interpret as related to visual fatigue.

3.1.1 The Type of Work Performed

A number of studies have found support for a length of VDT exposure hypothesis (i.e. either the time period per day behind a VDT or actual screen viewing time) (e.g. Dainoff, 1980; Ghiringhelli, 1980; Rey et al., 1980; Dainoff, 1981; Smith et al., 1981; CLC-LESC, 1982).

In the CLC-LESC study, five vision problems (e.g. burning eyes, aching eyes, difficulty focussing, blurred vision, loss of the ability to see clearly) were all found to be reported significantly more often, as occurring "almost daily" with increasing amounts of daily VDT usage (1982: Table 25). Also, the greater the amount of time actually viewing the VDT screen was significantly related to vision problems (1982: Table 37). Further, a general analysis of VDT workers' health problems, by hours of VDT work per day, revealed that the frequency of reporting problems, as occurring "almost daily", increased after four hours a day of VDT work. Under four hours a day, VDT workers did not differ significantly from the non-VDT workers.

The CLC-LESC (1982) labelled their time exposure findings the "dose- response relationship". This label appears to imply that the amount of mere exposure to a VDT will be directly related to the occurrence of visual problems. This use of terms again reveals the tendency in the literature for the blame to be placed on the VDT equipment

in use as opposed to how the equipment is being utilized in the work process.

Ghiringhelli (1980) found that operators who worked more than 3 hours a day on a VDT were significantly more likely to suffer with eyestrain problems.

Rey et al. (1980) found that VDT workers who worked six to nine hours a day behind a VDT had reported significantly more visual problems than those who worked four hours or less a day.

In the NIOSH study, Smith et al. (1981) correlated the time spent on a VDT with the total number of health complaints reported and found the relationship to be significant but strong (i.e. Pearson's r=.19, p.=.01).

Dainoff (1981) found evidence that full-time workers experienced visual problems more often than part-time workers. These findings suggest that the effects of VDTs are cumulative, and thus rest breaks may be of importance.

The VDT exposure findings spawned interest in the utility of restbreaks in alleviating the exposure effects. Some researchers have attempted to determine the optimal amount of time away from VDTs to recommend visual problems (e.g. Haider et al., 1980; Mourant et al., 1981).

The amount of daily VDT usage will be a function of the type of work performed. The more rationalized a job

is, the greater utility to management a VDT will be in performing it. The amount of daily VDT usage then is partially capturing the effects of standardized, routine and repetitive work which ties VDT operators to their terminals, this in turn, increases their exposure to such factors as VDT design flaws, increasing the probability of visual problems. So the length of VDT exposure is indirectly capturing a variety of effects. A multivariate analysis would help to control for these different effects.

The type of tasks performed by VDT workers (e.g. professional versus clerical) has been demonstrated to affect the occurrence and/or frequency of recurrence of visual problems (e.g. Cakir, 1978; Binaschi et al., 1980; Elias et al., 1980; Smith et al., 1981; CLC-LESC, 1982). According to Stewart "(t)he nature of the user's job and the characteristics of their work load are very important in determining the individual's susceptibility to or likelihood of experiencing visual fatigue (1978(1):6)".

In the CLC-LESC (1982) study, when workers were analyzed within their occupational categorizations, production line VDT and data entry workers (both intensive VDT users), reported the daily occurrence of visual symptoms more often than conversational clerks and professional/technical VDT workers. The non-VDT occupational control groups suffered the least from daily occurrences of visual problems. Only the professional/technical VDT groups' responses closely approached their control groups'.

In the professional/ technical categories, the majority of programmers (42%) used their VDTs for less than 2 hours a day, while most T.V. technicians (49%) reported VDT usage of 7 hours or more a day. So, the professional VDT workers lesser prevalence of visual problems can not be wholly attributed to their lesser amounts of VDT usage.

It is probable that professional workers have greater control over their use of VDTs. They can decide when and how the VDTs will be used. If professional workers are suffering from the symptoms of eyestrain it is likely they can turn their terminals off.

There were no significant differences between non-VDT workers reporting of visual problems when analyzed by job type. Intensive VDT users (production line and data entry VDT workers) reported significantly more often, frequent visual problems, than their non-VDT comparison groups. Conversational VDT clerks and professional/technical VDT workers did not differ significantly from their non-VDT comparison groups.

In the NIOSH study, Smith et al. (1981) reported that significantly more clerical VDT workers experienced the visual problems of : eyestrain, burning eyes, irritated eyes, blurred vision, and a change in color perception, than clerical non-VDT workers. Significantly more professional VDT workers experienced the visual problems of eyestrain and

burning eyes than the clerical non-VDT workers. There was no non-VDT professional control group. More clerical VDT workers reported visual problems than professional VDT workers.

Smith et al. concluded that "(t)he results indicate that job content factors and VDT use contribute to the problems observed in the VDT operators in an interactive way (1981:1)". However, as noted previously, the amount of daily VDT usage will be a function of the type of job performed. So job content factors and VDT usage are probably not interacting, but instead are intercorrelated. That is, VDT usage and job content factors are both components of alienated labour.

Cakir (1978) in his study, found computer programmers to suffer less from eyestrain than other VDT workers, and those who did piece work data entry VDT work suffered the most. Further, he noted, that the VDT piece workers had the "best" VDTs of all the VDT groups studied. He concluded the "if you have a bad job, it does not matter much what equipment you use...(1978:14)". However, poorly designed VDT equipment may add to the effects of extensive VDT usage. Operators who are "chained" to their terminals because of performing alienated labour will have greater exposure to any VDT design flaws.

3.1.2 The Characteristics of the VDT Equipment

There has been suggestive empirical evidence that the following factors may contribute to the occurrence of visual problems among VDT operators: flickering characters on VDT screen (e.g. Laubli et al., 1980; Dainoff, 1981; Stammerjohn et al., 1981; CLC-LESC, 1981), color of the screen and characters (e.g. Haider et al., 1980), blurred characters (e.g. CLC-LESC, 1982), characters which are too small (e.g. Dainoff, 1981), reflected glare on the screen (e.g. Laubli et al., 1980; Dainoff, 1981; Stammerjohn et al., 1981), reflected glare from keyboard keys (e.g. Cakir, 1978; Dainoff, 1981; CLC-LESC, 1982), lack of or inadequate brightness/contrast controls (e.g. Laubli et al., 1980; Stammerjohn et al., 1981), and inadequate maintenance of VDT equipment (e.g. CLC LESC, 1982).

Flickering characters on a VDT screen are frequently the result of inadequate phosphor refresh rates in the cathode ray tube (e.g. NYCOSH, 1980; Purdham, 1980; DeMatteo, 1981; Province of B.C., 1981; AFL-CIO, CLC, 1981; Laubli et al., 1980), although, in some VDTs, there is the intended use of pulsating cursors as reference points (e.g. Dainoff et al., 1981). Laubli et al. gave the following technical explanation for flickering characters:

> The light emission of the stimulated phosphor on a cathode ray tube screen is not steady. A periodic impulse response is caused by the repeated refreshment of the decaying light emission of the fluorescent phosphor. The impulse response is determined by the kind of phosphor (decay time), by

> the refreshment rate and by the luminance levels of characters and of the background (1980;86)."

Flicker is an inherent problem in fluorescent technology, however, some types of fluorescent phosphors have less flicker (i.e. usually the more expensive types) than others. The costs versus the benefits of various phosphors (e.g. the rate of decay and refreshment versus the costs of the phosphors) are assessed at the time the VDTs are being designed and built. Sometimes phosphors will be used with higher flicker rates simply because they are cheaper.

In a NIOSH study, Stammerjohn et al. (1981) found that none of their objective observers reported flickering on VDT screens when on-the-site observations were collected, yet sixty-eight per cent of the VDT workers in their sample indicated this as a problem on their questionnaires. These contradictory findings between the subjective reports and the objective observations may be partially explained by the greater exposure time of the VDT operators to the screens and thus, the workers would have a greater chance of detecting the flicker. Finally, not only do individuals vary in their sensitivity to flicker (e.g. Stone, 1978), but the flicker need not be obvious for it to have an irritating affect on the eyes (e.g. Grandjean, 1969).

The color of the characters and the screen are dependent upon the type of phosphor used and some colors have more problems with flicker than others. Further, as the AFL-CIO,CLC (1981) noted, the eye has greater sensitivity to certain colors and thus, color is important for legibility.

Haider et al . (1980) for example, found yellow characters to be more favourable than green ones as they had less "color-contingent after-effects" (i.e. they had less affect on subjects color perceptions) and they had less affect generally as "(y)ellow characters produce less reduction in visual ability than green ones (1980:57)". The CLC-LESC (1982) found however that the majority of their Canadian respondents had VDTs with green characters on green screen backgrounds.

Reflected glare from the VDT screen or from the VDT keyboards have been demonstrated to affect workers' vision, and quite high percentages of workers have reported this problem. Stammerjohn et al. (1981) found that eighty-five per cent of all the VDT workers in their study reported the problem of glare on their questionnaires. Further, the objective observers corroborated these subjective reports. Most of the workstations were found to have reflected glare problems and in seventeen (nine of out of fifty-three workstations) per cent of the cases, screen readability became difficult due to glare.

In Laubli et al.'s (1980) study forty-five per cent of the VDT operators reported glare and there was "a correlation between measured intensity of reflections and reported annoyance, but no relation between the measured luminance of reflections and eye impairments (1980:91)".

Reflected glare on the VDT may obscure screen characters. According to a recent AFL-CIO, CLC publication " (r)eflected glare is produced when light bounces off smooth glossy surfaces - walls, floors, furniture, paper or any other object with high reflectivity (1981:18)".

Various ergonomic solutions to contend with reflected glare have been proposed, such as: screen tiltability, detachable key-boards, hoods on screens, and antiglare screens which can be put on during, or after, manufacture of the VDT (AFL-CIO,CLC, 1981).

Dainoff (1981), in his review of the literature, did find evidence that these antiglare measures were effective in reducing glare and, thus, eyestrain.

The positioning of the VDT, in relation to the light sources in the office, can reduce glare problems. However, some solutions to glare may themselves cause problems, as they may reduce character legilbility (NYCOSH, 1980; AFL-CIO, CLC, 1981).

Contrast in the office brightness, between light and dark surfaces force the eye to continually adjust to different levels of brightness and this may be tiresome. Adequate brightness and contrast controls on the VDT can partially reduce this problem as the workers can adjust their screens in relation to the brightness in the office. Brightness and contrast controls allow the workers to sharpen their screen images which increases character legibility. Further, NYCOSH (1980) suggested that brightness can reduce the problems of flickering characters.

The lack of or inadequate brightness and/or contrast controls have been associated with workers' vision problems (e.g. Laubli et al., 1980). Stammerjohn et al. (1981) found screen and character brightness to be related to the professional VDT workers' visual problems in their sample and yet, most of the VDT operators were observed to have brightness and contrast controls on their terminals. It is probable that the VDT operators were either not properly trained to utilize these controls to their best advantage or the controls themselves were inadequate.

Blurred characters or characters which are too small have been found to contribute to workers' visual problems, again, due to legibility problems. According to Dainoff et al. (1981) blurred characters are due to the sometimes inadequate dot-matrix methods of creating the characters on the VDT. They noted that with blurred charac-

ters "the automatic focussing mechanisms of the operators' eyes tend to be continually operating in a futile attempt to produce a clear image (1981:422)".

Proper screen maintenance, inclusive of screen cleaning, has been recommended to reduce visual problems (e.g. NYCOSH, 1980; AFL-CIO,CLC, 1981; DeMatteo, 1981). The CLC-LESC study found that with proper machine maintenance, there were significantly less occurrences of eye problems among VDT operators (1982: Table 37).

Stewart (1978(1)) also emphasized the importance of the quality of images on the source documents. In Cakir's (1978) study, eighty per cent of the VDT workers reported the source documents as more problematic than the VDT images.

Stammerjohn et al. (1981), in the analysis of their questionnaire data, compared the professional VDT versus the clerical VDT workers, as to the relationship between their reported visual complaints and VDT design features. Visual complaints were found to be significantly related to the following VDT characteristics, for both professional and clerical workers: screen angle, screen height, screen glare, and screen flicker. The following factors were significantly associated with visual problems, among professional workers only: screen brightness, character brightness, and readability. The differences between these two

VDT groups of workers were explained, partially, by the other differing factors, not controlled for in the analysis, such as: " sample size, differing task demands, differences in workstation design and equipment, and demographic differences (1981:9)".

The workstations were observed and objectively measured by the researchers, and most of their findings corresponded to the problems reported by the workers. Unfortunately, the researchers' observations could not be directly compared with the workers' reports, due to the anonymity of the questionnaires.

3.1.3 Environmental Factors

Various components of the office environment may also be contributing to workers' visual problems, particularly those related to office lighting and humidity. It has been suggested that office lighting which is too bright can cause problems of reflected glare from VDT screens and keyboards and/or problems of direct or contrast glare (e.g. NYCOSH, 1980; AFL-CIO, CLC, 1981; DeMatteo, 1981). Some empirical evidence does support the hypothesis that office lighting which is too bright may contribute to workers' visual problems.

In the NIOSH study, Stammerjohn et al. (1981) observed that there were direct sources of glare, or "discom-

fort" glare, in 46 of the 53 workstations. The majority of offices investigated had illumination levels within recommended levels, as 39 out of the 53 workstations were found to have levels between 501 and 700 lux. Further, most of the workers indicated that they found their general background lighting to be satisfactory (63 per cent). Luminance contrast ratios between the screen and workstation background ranged from 1:3 to 1:10, with the majority of workers falling in the 1:3 contrast category. Grandjean (1969) noted that contrasts in surface brightness should be 1:3 or less in the "central and middle parts of the visual field". Contrasts should be 1:10 or less in the "central and outer part" of the visual field. According to Ostberg "(e)xcessive differences of luminance in the field of vision produce what is termed contrast glare (1980:42)".

Laubli et al. (1980) found in their study that the greater the contrasts in lighting, the greater was the reporting of eye impairments by VDT workers.

Dainoff (1980) in his study found a significant relationship between reports of visual fatigue and VDT workers' complaints about their office lighting ($r=.39, p< .01$).

The overall level of office lighting required by VDT operators is not a resolved issue in the literature (Dainoff, 1981), although it is often recommended that the lighting should be more subdued for VDT operators (e.g. Cak-

ir, 1978; AFL,CIO, CLC, 1981). Some have suggested levels of between 300 to 500 lux (e.g. Stewart, 1978(1); Rosenbaum, 1981), while in Sweden , the government has suggested levels as low as 200 to 300 lux (Ostberg, 1980) with supplementary task lighting to be supplied if it is required. Lower levels of lighting, in an office, will serve to reduce problems of direct glare, reflected glare, as well as, light/dark surface brightness problems.

Notably, in traditional offices it was thought that the more light (e.g. 750-1600 lux, Stammerjohn et al.,1981), the greater was worker productivity (e.g. Grandjean,1969). Problems often arise then when VDTs are placed into traditional office environments without making adjustments to the office lighting.

Flickering may also be the result of overhead flourescent lights in the office. However, flourescent lights have less luminance (surface reflectability) than incandescent lights, and thus may help to reduce glare problems (Grandjean, 1969).

Flickering from, whatever the source may be a casual factor in the onset of epileptic attacks for those epileptics susceptible to visual stimulation (Shephard, 1974; Wilkins, 1978; Province of B.C.,1981).

Another aspect of the office environment which may be problematic is dry, hot air, which has a tendency to dry

the eyes out (Stewart, 1978(1)). The CLC-LESC (1982) study found significant relationships between the respondents' reporting of dry office air and the occurrence of visual complaints. This may also be related to the nature of the workers' tasks, as jobs which require lengthy periods of concentration and staring, with reduced rates of eye blinking, will dry the eyes (Province of B.C., 1981).

Mourant et al. (1981) found in their quasi-experiment that VDT operators blinked (i.e. X=4.94 blinks per minute) significantly more often than subjects who were working with hard copy documents (i.e. X=3.76 blinks per minute). However, they did find that the blink rate varied with subjects' ages. Young subjects (i.e. less than 35 years old) blinked significantly more often (i.e. X=6.78 blinks per minute) than the older subjects (i.e. 53 years of age and older, their average blink rate was 3.12 blinks per minute). This may indicate that the younger workers were adapting better to the visual drying problems of staring than the older workers.

The CLC-LESC (1982) suggested that the wearers of contact lens may be aggravated more than other VDT workers by a dry air environment.

The CLC-LESC (1982) study also investigated the environmental factors of: heat; cold; dust; smoke; and noise, but none of these were found to be significantly related to visual problems.

3.1.4 Personal Characteristics of the Workers

All of the aforementioned potentially causal factors of visual problems can be compounded by certain characteristics of the human operators. As Stewart remarked "PERSONAL FACTORS may result in more or less susceptibility to eyestrain (1978(1):1)".

Age has been suggested as a potential factor, particularly due to the deterioration of eyesight in the aging process (Province of B.C., 1981: Grandjean, 1969: Shephard, 1974). Older workers are expected to have decreased visual acuity related to a deteriorating lens structure (presbyopia). Near accommodation becomes more difficult with age and older workers are anticipated to have greater sensitivity to glare. The "range of accommmodation decreases constantly with advancing age (Krueger 1980:35-36)". The Province of B.C. (1981) suggested that visual problems will become more apparent after the age of 40.

Mourant et al. (1981) did not find significant differences in near and far focussing times between their young and older subjects. However, as noted previously, there was found significant variation in blink rates between older and younger subjects. They however, concluded that "age per se does not appear to be a factor in the occurrence of visual fatigue (1981:540)".

The CLC-LESC (1982) concluded that there appeared to be no consistent pattern between age and the occurrence of visual problems. However, although the relationships were not linear, there did appear to be curvilinear relationships, but the CLC-LESC did not comment on this. Generally, those workers over 45 years of age did complain, with greater frequency, of the "almost daily" occurrence of visual problems. However, workers between 25-44 years of age reported suffering, less frequently "almost daily" visual problems, than workers between 17-24 years of age. It may just be that workers between 17-24 years of age are less tolerant, and more willing to report problems.

Smith et al. (1981) did not find that age was significantly related to workers' experience of visual problems.

Ghiringhelli (1980) found the younger VDT workers in his sample (younger than 35) generally complained more about aspects of VDT work (e.g. headaches, mental discomfort, negative attitudes towards VDTs, etc.) than older workers. He attributed this to younger people's greater propensity to complain in general since they are "more sensitive and disposed to react (1980:231)".

Rey et al. (1980) in their study did not find a significant relationship between visual problems and age. They compared two groups of workers: those 18-35 years of

age and those 36-65 years old. Although workers between 36-65 did have more visual complaints than workers between 18-35, when age was held constant VDT workers still complained more of visual problems than non-VDT workers. Rey et al. did find that age was significantly related to visual defects. Older workers had more defects than young workers. They concluded that "it is clear that visual impairment in VDU operators is partly related to visual defects (1980:83)".

Previously undetected or improperly corrected visual impairments, whatever the workers' ages, may be aggravated by VDT usage. As Purdham noted "approximately 30% of the work force have uncorrected or insufficiently corrected visual defects which affect both visual and general discomfort (1980:15)". The viewing distance for VDT work is usually about 400-500 mm, however, most eyeglasses (for nearsighted persons), have been corrected for reading distances between 250-330 mm (Cakir, 1978).

Stammerjohn et. al. (1981) noted that most view-distances, in their sample, were between 450-700mm. This may have caused problems for the workers who wore glasses, although, this was not investigated in the study.

Reading glass prescriptions may have to be altered to accommodate the viewing demands of VDT work. This fact is already recognized in Sweden, and it is regulation (Ostberg, 1980).

Wearers of bifocals may also experience problems (Dainoff, 1981), due to similiar problems with inadequately corrected distances. However, bifocal wearers problems may be compounded by the awkward postures they often assume to view the VDT screen. However, as Mourant et al. noted , close range viewing of VDTs may be stressful to operators, regardless of their visual capacity, since it "requires convergence and accommodation of the eyes for sustained periods of time (1981:529)".

The CLC-LESC (1982) did collect information on their respondents' visual aids, however, these were not analyzed with the occurrence of visual problems. They did find evidence that there were significant relationships between VDT usage and the workers' need to get new prescriptions for their glasses. Also, a changing ability to see clearly was associated with visual problems. Further, more VDT workers had gone to a doctor for visual problems, and had sought more solutions for their eye problems (e.g. eye drops, tinted glasses, aspirin).

Cakir (1978) found that 50 per cent of VDT operators, who wore reading glasses, had consulted a physician about their eyesight, as compared to only 30 per cent of workers with "normal" vision.

The sex of an operator has been hypothesized as a potential factor. Stellman (1977) noted the health hazards

of work should not generally affect women workers any differently than male workers. However, she explained, for women there are certain extraneous factors, such as the dual roles many women perform in the home and the workplace.

Occupational segregation may force women into certain categories of work, which due to their low status, for example, may contribute to their experience of health problems. Labour force segregation and the dual roles, are factors which may confound the analysis of sex and VDT usage.

In the CLC-LESC (1982) study, it was found that women workers reported experiencing visual problems "almost daily" with greater frequency than the male respondents. However, the majority of women in the sample were found in the more intensive VDT usage occupations, while the men were generally found in the professional job categories. Thus, the job type may be the causal factor, and the sex variable was merely capturing the effects of labour force segregation.

The CLC-LESC found women reported experiencing all types of problems (muscular, visual and stress) more often than the male respondents. This was attributed to possibly women's greater propensity to report problems than men. As the CLC-LESC remarked "(m)en, ... , may be reluctant to identify and report health problems because they feel such behavior may be inconsistent with a 'macho' self-image (1982:149)".

Smith et al. (1981) did not find that any of the demographic factors (e.g age; sex; ethnic background; education; marital status) tested for in their study, significantly affected the overall experience fo workers' health problems (i.e. the dependent variable was the total number of health complaints).

Stewart (1978(1)) suggested that the extent of a worker's training on VDT usage may affect the prevalence of health problems. There is often a fear of the new forms of technologically advanced equipment. Proper training could serve to reduce many of these initial fears.

Dainoff (1980), in his study, did not find evidence that worker's attitudes towards computerization were related to the occurrence of visual problems.

Although, not directly related to training, the CLC-LESC (1982) did find that the amount of VDT work experience was related to the occurrence of visual problems among VDT users. Workers with relatively little work experience (e.g. less than one year, 1 - 2 years) reported more frequently, the "almost daily" occurrence of visual problems, than workers with more VDT experience (e.g. 3-4 years, over 5 years). However, this relationship was not consistent, or strong, for any of the visual problems.

3.1.5 Summary

Four major groupings of causal factors have been empirically investigated in relation to visual problems: 1) job characteristics and length of VDT exposure, 2) VDT equipment design features, 3) environmental factors and 4) personal characteristics of the workers. Most of the previous studies did bivariate analyses to assess the impact of these independent variables and the emphasis by these reseachers has been directed primarily towards VDT design features and office lighting problems.

Multivariate analysis, which would view the affects of all these variables simultaneously, would allow for a true assessment of each variable's impact on workers' visual problems. It is suspected, based on the political economy framework, that the root of these workers' visual problems is the performance of alienated labour and that the other causal factors (i.e. VDT design features, etc.) will merely add to this central problem.

3.2 MUSCULOSKELETAL PROBLEMS

The human body is "designed" for movement. Sedentary work which involves, for example, sitting for extended periods of time, can over stress the body's muscles (e.g. Makower, 1982). Thus, musculoskeletal problems can be inherent in all keyboarding tasks (VDT and non-VDT) and this

is often due to the incorrect constrained postures assumed and maintained by workers (e.g. Grandjean, 1969, 1980: Dainoff, 1980).

Various empirical studies have evidenced that more VDT workers, when contrasted with comparable control groups of non-VDT workers, experience musculoskeletal problems often with greater frequency, than non-VDT workers (e.g. Smith et al., 1981; Murray et al., 1981). Although, some groups of non-VDT workers can suffer with musculoskeletal problems almost as often as some groups of VDT workers (e.g. Elais et al., 1980; Hunting et al., 1980; Smith et al., 1980; CLC-LESC, 1982). The two major factors previously investigated in relation to musculskeletal problems are: 1) VDT and workstation design features , and 2) the type of work performed by the workers (e.g. Grieco et al., 1980; Laville, 1980).

Musculoskeletal problems are often found to coexist with visual problems. This points to the possibility that there are similiar sources responsible for the both visual and musculoskeletal problems. VDT operators, for example, may assume incorrect postures to overcome visual difficulties (e.g. reflected glare on the VDT screen; visual defects; poor screen images; etc.) (e.g. AFL-CIO, CLC, 1981). Laville (1980) saw one of the functions of posture as assisting the individual in their visual tasks.

The CLC-LESC (1982), in their study, found that VDT workers who experienced a musculoskeletal problem (e.g. lower back, neck upper back or shoulder problems) "almost daily" were significantly more likely also to report head/ neck or back postures as "very uncomfortable". Constrained postures can result in musculoskeletal problems in such areas as the: neck, shoulders, arms, wrists, hands, back and legs. Aches and pains in these areas are symptomatic of "localized fatigue" in the muscles (e.g. Grandjean, 1969: Hunting et al., 1980). According to Lambert (1980) muscle fatigue is due to the accumulation of lactic acid in stressed muscles.

If muscular aches and pains become chronic (e.g. everyday), this may lead to permanent damage or "injury" to the joints and tendons (e.g. Grandjean, 1980; Hunting et al., 1980). Laville (1980) suggested that damage occurs due to the lack of sufficient blood circulation in these areas and this is often the result of contrained postures.

Hunting et al. (1980), in their study, found that groups of workers who did extensive keyboarding tasks (both VDT and non-VDT) had lower skin temperatures on their hands than on their foreheads. These workers were also found to have a high incidence of musculoskeletal problems in their hands, arms, necks and shoulders. They suggested these lower temperatures were the result of constrained postures which would compress the neck arteries, and thus, reduce blood flow to these areas.

Objective medical tests for musculoskeletal problems involve primarily examination of the muscles, joints and tendons to discern "painful pressure points", and medical results have generally been found to coincide with subjective reporting of symptoms by workers (e.g. Hunting et al., 1980).

The following discussion on contributing factors is divided into two sections: 3.2.1) VDT and workstation design features and 3.2.2) the type of tasks performed. A model which is inclusive of these two major clusters of factors has previously been hypothesized explanatory of the majority of variation in the frequency of recurrence of musculoskeletal problems (e.g. Grieco et al., 1980; Laville, 1980).

3.2.1 VDT and Workstation Design Factors

Uncomfortable office chairs have been associated with the occurrence of workers' musculoskeletal problems (e.g. CLC-LESC, 1982). It has been recommended that office chairs should have adjustable height and backrests to allow workers of variable body sizes to assume proper typing postures (e.g. NYCOSH, 1980; AFL,CIO, CLC, 1981; DeMatteo, 1981). Although, there is some evidence to suggest that even if these features are available the workers may not be taking advantage of them (e.g. Dainoff, 1981). Finally, footrests may be required by short VDT operators such that

their chair heights may be adjusted for proper screen viewing angles (e.g. NYCOSH, 1980; AFL-CIO,CLC, 1981, DeMatteo, 1981).

The CLC-LESC (1982) found significantly more VDT workers, who experienced muscular aches and pains "almost daily" in the lower back, upper back, neck and shoulder, could only adjust their backrests and/or chair height "with difficulty".

Objective on-site observations by Stammerjohn et al. (1981) found most workers to have standard typist chairs. However, their VDT clerical workers reported significantly more often than the VDT professional workers that their chairs were uncomfortable. This variation between the two groups of VDT workers was attributed to the different tasks performed by these workers.

According to the AFL-CIO,CLC:

> Ideal typing posture,..., is with the upper arms perpendicular to the floor and the forearms and hands at right angles to the body. If the forearms or hands have to be raised appreciably to reach the keyboard, muscular pains or wrist injury may very well result (1981:8).

VDT keyboards which are too high above the office desk, or sunken into the desk and therefore, leave no place for the workers to rest their hands have also been associated with the occurrence of workers' musculoskeletal problems (e.g. Hunting et al., 1980). Also, a keyboard which can be sepa-

rated from its screen has been recommended to allow workers to assume proper typing postures (e.g. NYCOSH, 1980; AFL-CIO,CLC, 1981; DeMatteo, 1981).

Workers may assume incorrect postures in their attempts to avoid screen glare. Screens which are tiltable can serve to reduce glare problems. The CLC-LESC (1982) found that significantly more of the VDT workers who experienced muscular pains in their lower back, neck, upper back and shoulders "almost daily", also reported they could not adjust the angle of their VDT screens.

Stammerjohn et al. (1981) found that significantly more professional VDT operators, who reported their screen angle as "bothersome", experienced musculoskeletal problems. These same workers reported "bothersome" screen glares. These relationships however were not evidenced among the clerical VDT workers.

Screen heights which are too high or too low force the workers to hold their heads and necks in unnatural positions and this has been found to be related to the occurrence of professional VDT workers' musculoskeletal problems (e.g. Stammerjohn et al., 1981). Screen height is related to the height of the office desk on which the VDT sits.

Hunting et al. (1981) found in their study that high desks were associated with lower occurrences of postural problems in their VDT workers' shoulders, necks and

backs. They explained these anomalous findings as due to the fact that none of the VDT operators had document holders and therefore "the higher the desk, the closer the source documents are to the eyes (1980:180)".

The AFL-CIO,CLC(1981) suggested that the lack of document holders may contribute to some workers' musculoskeletal problems. Dainoff (1981) noted that the lack of a document holder forces workers to twist their upper trunks into uncomfortable positions in order that they can view their source documents. However, there was no direct empirical evidence available to support this hypothesis.

Workstation and VDT design problems are necessary but not sufficient for musculoskeletal problems to occur (e.g. Grieco et al., 1980; Laville, 1980). Grieco et al. noted "that every type of posture, including the so-called "ergonomically correct posture" causes discomfort if it has to be fixed or maintained for too long a time (1980:189)". The type of work performed and its duration has been noted as probably the major source of musculoskeletal problems (e.g. Grieco et al., 1980; Laville, 1980; Smith et al., 1981).

3.2.2 The Types of Tasks Performed

VDT workers continually must orient themselves to three major points of reference, in performing their tasks:

the VDT screen, the VDT keyboard and the source documents. According to Grandjean, constrained postures:

> are due to the fact that the operators are forced to keep the head as well as the hands more or less permanently in a fixed position. The position is determined by the appropriate visual distance to the screen or the source documents, and the position of the hands is given by the location of the keyboard or sometimes by the source documents (1980:7).

The number and frequncy of body movements, between these points of reference, will depend on the types of tasks performed and the productivity levels imposed by the employer.

The speed of the VDT work and the lack of control over the workpace have been found to contribute to the occurrence and/or frequency of musculoskeletal problems (e.g. Elias et al., 1980: Hunting et al., 1980; Laville, 1980; Smith et al., 1980; CLC-LESC, 1982). Laville (1980) noted that the speed of work is facilitated by the simplification of work (e.g. repetitive tasks).

The CLC-LESC (1982) found in their study that the occurrence of musculoskeletal problems was signifiantly related to: whether the workers worked shifts; job pressure; job satisfation; hours of work on a VDT; frequency and duration of restbreaks; and the amount of time daily actually spent sitting.

3.2.3 Summary

With musculoskeletal problems it has been recognized in the literature that the type of work performed is probably the major contributing factor. Performing alienated labour which chains VDT operators to their terminals and forces workers to maintain certain postures for extended periods of time, for example, probably have the greatest impact on workers' muscular problems. VDT and workstation design features merely add to these workers' health problems.

3.3 STRESS AND PSYCHOLOGICAL PROBLEMS

The common usage of the term stress in everyday language generally donotes "nervous tension" (e.g. Selye, 1956, 1974; Makower, 1982). However, stress is much more than simply psychological strain. Stress can be manifested in a variety of symptoms or responses. For example, Cox (1978) delineated between physiological, psychological, behavioral and cognitive stress effects.

3.3.1 VDT Stress Effects

Unfortunatley, many of the previous investigations related to VDTs and stress did not theoretically define stress, and often, their operational definitions are not fully explained, and thus, it is often difficult to assess their research findings. Generally, however, these re-

searchers used indirect measurements of stress (e.g. Scales) and this would have increased each study's reliability. This would have partially avoided the variation in respondents' frames of reference with regards to the meaning of the word stress.

Groups of VDT workers generally reported more occurrences of stress symptoms, often with greater frquencies of recurrence, than groups of non-VDT workers (e.g. Smith et al., 1980; Murray et al., 1981; Smith et al., 1981; CLC-LESC, 1982). Again, as with the visual and musculoskeletal health problems, there were variations in stress symptoms between groups of VDT workers (e.g. Elias et al., 1980; Smith et al., 1980; Murray et al., 1981; Smith et al., 1981; CLC-LESC, 1982). These findings suggest that the type of tasks these workers perform may be a major contributing factor in their occurrence and frequency of stress problems.

There has been empirical evidence which tends to support this hypothesis (e.g. Elias et al., 1980; Smith et al., 1980; Murray et al., 1981). Some researchers have concluded further that task requirements interact with VDT use to affect workers' stress levels and other health problems (e.g. Smith et al., 1980; Smith et al., 1981). It is probable that VDT use and task requirements are actually both components of alienated labour and therefore, they do not interact.

Often researchers who have investigated VDT stress effects proceeded by characterizing a number of jobs according to their task requirements, job content and workload. They then compared these different occupational groupings of workers to discern variations in the occurrences of health and stress problems. They assumed these initial differences were causal and usually then specific aspects of the jobs were not entered into the bivariate statistical analyses (e.g. Elias et al., 1980; Smith et al., 1981).

Elias et al. (1980) studied two groups of women VDT workers (n=160) who either performed "man-computer dialogue" jobs or "off-line data acquisition" jobs. They characterized the data acquistion jobs as: repetitive jobs with short work cycles, lacking in opportunities for worker freedom or decision making, and requiring few skills to perform the standardized tasks. Alternatively, they described the dialogue jobs as: non-repetitive with longer work cycles, having more allowances for worker freedom and decision making, and finally, as requiring more skills.

They then observed the variations between these two groups of women workers with regards to their levels of job satisfaction and their stress and health problems. They attributed any differences between these two groups to the initial differences in jobs (i.e. dialogue versus acquisition).

It was found that significantly more data acquisition workers reported that they were dissatisfied with their jobs than the dialogue workers (i.e. 70 per cent versus 38 per cent respectivley). Further, the data acquisition reported significantly more often, chronic occurrences of neuropsychical disturbances than the dialogue workers (i.e. psychosomatic disorders such as: swellings, constipation, palpitations and chest pains; nervous disturbances such as: anxiety, irritability and depression; and inadequate sleep patterns such as troubled sleep).

NIOSH conducted a survey among groups of VDT and non-VDT workers in the United States. Smith et al. (1980) reported on the psychosocial job stress and health complaints and compared the variation between VDT and non-VDT workers in three of the work sites studied. Smith et al. (1981) reported on the same study however, they aggregated the data from all the worksites and did a comparison between VDT clerical, VDT professional and non-VDT clerical (i.e. control group) workers. The same problem is observed in both of these analyses, their job stressors are virtually indistinguishable from their measures of job stress. These problems arise it is contended due to their lack of explicit definitions of their concepts initially. Fortunately, these researchers never attempted to statistical correlate or associate their job stress/ors with the reported health problems. However, there still are some interesting findings which can be salvaged from these studies.

Smith et al. (1980) stated that due to the variations between VDT workers, "job demands, in the form of task requirements, appear responsible for a significant portion of the job stress and health complaints of VDU operators independent of their use of VDUs (1980:208)". Although they noted that it is probable that VDT use actually interacts with task demands. VDT use is not seen as the primary cause of VDT workers stress and health problems, it is a secondary factor related to the tasks performed.

Smith et al., (1981) in their analysis a similiar pattern of results were seen to emerge in which clerical VDT workers reported more stress/ors than the professional VDT and the non-VDT clerical workers. They described the clerical VDT workers' jobs as "involving rigid work procedures and high production standards, constant pressure for performance, very little operator control over the job tasks, and little identification with and satisfaction from the end product of their work activity (1981:397)". In comparison the VDT professional workers "held jobs that allowed for flexibility, control over job tasks, utilization of their education, and a great deal of satisfaction and pride in their end product (1981:397)". They saw job content as the primary source of workers' stress problems, further, they suspected that, although this was not tested for, there is probably an interrelationship between stress and the other health problems.

The CLC-LESC (1982) studied the following stress-related symptom: general tiredness, irritability, headaches, sleeplessness, dizziness and loss of appetite. They found the following factors contributed significantly to the occurrence and frequency of these stress problems among VDT workers: amount of daily VDT usage, restbreaks, shift work, control over speed of work, job pressure and job dissatisfaction.

Ghiringhelli (1980) suggested that all of the negative attitudes towards VDTs and their potential health effects may be stressful to the workers. The CLC-LESC (1982) did find that more VDT workers, who reported "almost daily" occurrence of stress symptoms, also reported more frequently the negative effects of their: work environment, their work in general, and VDT work specifically, as contributing to their stress problems.

The frequency of stress problems is of importance as chronic stress symptoms may result in permanent physical damage and/or disease (e.g. heart disease, ulcers, etc.). Evidence to date, however, has not found more VDT workers suffering from diseases than non-VDT workers (e.g. Smith et al., 1980; Murray et al., 1981).

3.3.2 Occupational Stress Effects

There have been numerous empirical studies done by psychologists and epidemiologists in Europe which have looked at the stresses of work (e.g. lack of control, machine-paced as opposed to man- paced work, repetitive work, work which affords the workers little opportunity for mobility (physically constraining), etc.) and its physiological and psychological consequences (dependent variables) on manual workers (e.g. Johansson et al., 1978; Broadbent et al., 1979; MacKay et al., 1979), non-manual workers (e.g. Johansson, 1979; Payne, 1979) and manual versus non-manual workers (e.g. Jenner et al., 1979, Caplan et al., 1980; French et al., 1982).

Although the effects of computerized mechanized work on either manual or non-manual workers has been found to be quite similiar (e.g. Johansson, 1979), non-manual workers have been found to demonstrate more physiological symptoms of stress (e.g. adrenaline secretions) than manual workers (e.g. Jenner et al., 1979).

Generally, data were collected on the physiological changes related to stressful work (e.g. heart rate, blood pressure, catecholamine (adrenaline and noradrenaline) excretions, etc.) as well, the study participants answered questionnaires about their physical and mental health. The psychological and physiological effects were assumed, based

on previous research, to be correlated and often referred to as "psychophysiological" effects.

Catecholamine secretions and their changes in levels in the urine between work/rest situations is one indicator or measure of physiological stress used by the researchers.

Johansson et al. explained that adrenaline " is of great importance for the mobilisation of physical strength in emergency situations. Adrenaline facilitates adjustments to demands in the physical environment by stimulating the heart blood flow to the muscles, (1978:584)". Further, as Cox et al. (1979) pointed out adrenaline has been found to be related to coronary heart disease and neuroses.

Alternatively, noradrenaline, another type of catecholamine excretion, is related to the maintenance of blood pressure (homeostatis) and can be affected by body posture and workload (e.g. Johansson et al., 1978).

Johansson et al. (1978) found there were sex differences in catecholamine secretions, with women generally execreting less than men. This evidence could contribute to a hypothesis that women will report fewer problems than men. However, as noted in the previous discussions, where male/female VDT operators have been compared, women tend actually to report more health problems than men.

This evidence about catecholamine excretions tends to indicate that the differences in health problems among men and women VDT operators are more related to social factors such as labour force segregation and the dual roles of women rather than any inherent characteristics of the sexes.

Johansson (1979) did a study of twenty-one female white collar workers in a Swedish insurance company. Eleven of these workers spent fifty per cent or more of their working day on a VDT and ten were a control group of secretaries (controlling for age, family situation, education and length of employment). They noted that although ergonomic problems such as lighting and the positioning of VDTs, etc. had been suitably adjusted, the problems of mental fatigue and stress still persisted among these VDT operators.

The differences in catecholamine secretions between these two groups were attributed to "differences in controllability". The two major occupational stressors for the VDT workers were computer down times (e.g. unplanned interuptions") and computer response times (e.g variation in the speed of "information retrieval").

The source of stress is that, with deficiencies in the computer system, management expected the workers to compensate for these problems (make up for lost time), thus, the stress is not from the technology used, as Johansson infers, but from management ultimately.

Johansson et al (1978) among their sample of Swedish sawmill workers found the adrenaline and noradrenaline levels and the self-reported subjective stress symptoms (e.g. irritation, clamness, well-being, etc.) were significantly related to: the monotony of their jobs (e.g. variations between work cycles), variation in tasks performed (e.g. repetitive tasks), the duration of the work cycle and machine-paced work. That is, the more monotonuous, repetitive and machine paced work was related to higher levels of catecholamine excretions and negative subjective stress symptoms.

Higher levels of noradrenaline secretions were significantly related to physically constraining work (not the adrenaline secretions). Those sawmill workers whose jobs were repetitive, physically restraining and machine-paced (i.e. considered to be the "high risk" group) were also found, by a physician, to have more health problems than those sawmill workers whose jobs were considered to be more flexible (control group), although only the symptoms of headaches and nervous disturbances were found to significantly differ between the two groups. Significantly more control workers reported "no illness" in the last year than the high risk workers.

They concluded "that monotony, physical constraint and machine pacing tended to contribute to stress reactions in a more obvious way than other environmental conditions

(1978:595)", since all the sawmill workers were generally subjected to the same working conditions (e.g. noise levels, etc.).

MacKay et al. (1979) did a simulated laboratory study (i.e. they set up a button sorting assembly line in a laboratory) with twelve females in Nottingham, England. They collected data on the psychophysiological dependent variables such as: catecholamine secretions, saliva (sodium and potassium measured levels), heart rate and heart rate variability, work performance, and self-reported mood (arousal) levels. They did an analysis of variance with these dependent variables and their independent variables (e.g. job type (loading, sorting and machine monitoring), machine pacing and duration of work). They found that heart rate was significantly related to: type of job performed; duration of work; job type interacting with duration and pacing interacting with duration. Pacing and job type were significantly related to self-reported stress. Noradrenaline was more sensitive to machine pacing and pacing interacting with duration than adrenaline. They concluded that "the physical characteristics of the tasks studied were shown to be associated with changes in psychophysiological state, including mood (1979:137)".

3.4 SUMMARY

Particularly, for the stress and musculoskeletal problems investigated, the type of work performed by VDT workers was emphasized by the researchers as the most prominent set of explanatory variables. With the visual problems, the role work was not ignored but the VDT design features and office lighting factors tended to get more emphasis.

There does appear to be some initial empirical support for the political economy framework in the literature. However, since none of the previous researchers utilized multivariate statistical procedures in their analyses it is difficult to assess the relative importance of all the potentially contributing factors in the VDT work situation.

It is hypothesized that:

1. When all possible contributing factors are simultaneously considered (i.e. environmental factors, VDT design features, workstation design factors, personal characteristics of the workers, alienated labour), factors related to the performance of alienated labour will have the greatest relative affect on VDT workers' stress-related health problems.
2. When all possible contributing factors are simultaneously considered (i.e. environmental factors, VDT design features, workstation design factors, personal characteristics of the workers, alienated labour),

factors related to the performance of alienated labour will have the greatest relative impact on VDT workers' visual health problems.

3. When all possible contributing factors are simultaneously considered (i.e. environmental factors, VDT design features, workstation design factors, personal characteristics of the workers, alienated labour), factors related to the performance of alienated labour will have the greatest relative impact on VDT workers' musculoskeletal problems.

Chapter IV

METHODOLOGY

The Women's Bureau, Manitoba Department of Labour & Employment Services, during the summer of 1982, did an exploratory one-shot (i.e. cross-sectional) survey of 1000 VDT/non-VDT women keyboard workers in Winnipeg. The Women's Bureau consented to the use of their data for the analysis in this thesis.

The sample for the Women's Bureau's study was obtained by approaching a number of employers in the city of Winnipeg. The criteria for the selection of employers was that they were major employers of clerical/office staffs with their head offices in Winnipeg. The time constraints placed on the study required that there should be speedy consents for participation from employers. Since most agreements had to be obtained from the upper management levels, head offices situated in Winnipeg ensured rapid employer responses.

Small employers were necessarily excluded from the study due essentially to the manpower, budget and time constraints placed on the study. Further, it was assumed that the large employers would have been more likely to have implemented the advanced forms of office technology. Large em-

ployers would have the capital available to invest in the new forms of equipment. Three provincial crown corporations (all unionized) agreed to participate in the study.

An attempt was made to sample from the entire universe of female keyboarding workers in these three crown corporations. The employers were asked to distribute the questionnaires among all their women clerical keyboarding staffs. Men were excluded from the sample since it would have proved difficult to obtain a comparable sample of male clerical/office workers due to such factors as labour force segregation. Also, the main function of the Women's Bureau, as its name implies, is to address issues specifically related to women's labour.

Approximately forty per cent of the women returned their questionnaires (n=401), through the mail, in postage paid envelopes, to the Women's Bureau. The manner in which the questionnaires were distributed through the employers may have contributed to the relatively low response rate. Although the workers were assured of the confidentiality of their responses in a cover letter enclosed with the questionnaire, and even though the questionnaires were mailed directly back to the Women's Bureau, the workers still may have feared that their employers would be able to discern their individual responses, and thus, this could have reduced the response rate.

For those women who did respond to the questionnaire this could have introduced into the study response biases (i.e. internal validity problems) with the employees responding in a way which they think would be acceptable to their employers. However, the sincere responses by these workers to the open-ended questions tended to indicate that this was not a problem.

The distribution by management also prevented any follow-up, and this again, may have contributed to the low return rate. Also, the survey was conducted during the summer months and it is probable that many workers did not receive the questionnaire as they were away on holidays.

Finally, the questionnaire could have conceivably been considered too lengthy by some employees (i.e. it was ten pages long). The length of the questionnaire may have contributed further to a motivational bias in the study (i.e. Smith, 1975). Only workers, for example, who were experiencing difficulties at work and with their health may have been inclined to reply to the long questionnaire.

The Women's Bureau's response rate was very similiar to the response rate of the American office workers in the NIOSH studies (e.g. Murray et al., 1981; Smith et al., 1981; Stammerjohn et al., 1981). In the NIOSH studies the VDT workers did have a higher propensity to respond (i.e. 50 per cent as compared to the 38 per cent response rate of the

non-VDT workers). Since the total number of VDT and non-VDT workers which were originally given the questionnaire in the Women's Bureau's study was unknown, the possible variation in VDT versus non-VDT return rates could not be assessed. However, the Women's Bureau sample was composed of nearly two times more VDT workers than non-VDT workers. The sample was nonrandom. It is not representative of the population of women workers in Winnipeg and therefore, the results are not generalizable.

As mentioned previously, the Women's Bureau used the standardized survey method (see Appendix-A). They designed their extensive self-administered interview to collect data from both VDT and non-VDT workers about their: health; background characteristics; the types of equipment used and the percentage of their day they use them; characteristics of their jobs, workstations and VDTs; level of job satisfaction; and the general office environmental conditions. The questionnaire had been pretested on a small group of women workers not in the study, and as well, other government departments reviewed the questionnaire.

The questionnaire was essentially only a simple exploratory device. Most of their questions were conceptualized as unidimensional items (i.e. nominal level variables) (e.g. Smith, 1975). Some of their concepts were operationalized at the ordinal and interval level as well. In most instances, the qualitative operationalizations were ad-

equate as they were primarily attempting to do a descriptive study. However, some concepts (i.e. stress) are multidimensional, and scales should have been constructed. The failure to construct scales in these instances may have detracted from the validity of the results since, for example, it is probable that there would be variation in the respondents' frames of reference (i.e. definitions of these concepts will vary) (i.e. Smith, 1975). The Women's Bureau reported the preliminary results of their study in: The Effect of VDT Usage: A Study of Women Office Workers (1983).

4.1 WOMEN'S BUREAU'S RESULTS

The Women's Bureau aggregated the data from all three crown corporations for their data analysis. Thus, potential organizational variation between the three crown corporations was not controlled for in their analysis. However, this aggregating of datum was done by many of the previous studies (e.g. the NIOSH studies) and it was done usually to achieve large enough samples for the statistical analyses.

The sample consisted of women workers who ranged in age between 18 and 65, although, the majority of them were between the ages of 18 and 29 (i.e. 64.7%, with 35.3% of the sample between the ages of 30-65) (1983:Table 1). According to Statistics Canada (1983), in the Manitoba labour force approximately fifty-three per cent of the employed wo-

men workers are between the ages of 15-34, while about forty-five per cent are between 35-64 years of age. Despite the slight differences in categorizations between the labour force statistics and the Women's Bureaus', it would appear that the Women's Bureau's sample age distribution is skewed in favour of younger workers.

About sixty-eight per cent of those between 18-23 and approximately sixty-three per cent of those between the ages of 24-29 used VDTs in their jobs while about forty-six per cent between the 30-39 and only about twenty-three per cent between 40-65 used VDTs. This could possibly indicate a greater propensity for young VDT operators to respond to the questionnaire or simply that not many of the older workers actually use VDTs. Since it is workers over the age of 40 who can experience visual deterioration due to the natural process of aging, it can be assumed that this type of visual deterioration would not be a major causal factor in the Women's Bureau's sample.

As mentioned previously, most of the variables in the Women's Bureau's study were operationalized at the ordinal or nominal levels. The datum they collected on the percentage of daily VDT usage was however interval level, and therefore, to facilitate their bivariate analyses, they categorized this variable as follows: 1) 0% of daily VDT usage (control group of non-VDT workers) (n=148), 2) 1-20% of daily VDT usage (n=128) and, 3) 21% + of daily VDT usage

(n=125). There were two groups of VDT workers and one group of comparison of non-VDT workers.

Although finer delineations in the percentage of VDT work would have been preferable (i.e. 1-20%, 21-41%, 41-60%, 61-80%, 81-100%), they were restricted by their sample size and the distribution of their workers along this variable. Narrower categorizations would have resulted in statistical artifacts in their crosstabulations due to the large numbers of empty cells.

Their demarcation between VDT workers who work twenty per cent or less and VDT workers which work twenty-one percent or more was also partially based on previous findings which observed visual problems become bothersome after 90 minnutes of VDT work (i.e. Makower, 1982). A large number of the workers grouped into the category of 21% of daily VDT usage actually worked more than fifty percent of their day on a VDT.

The Women's Bureau studied the following twenty-five health problems: isolation, boredom, fatigue, stress, frustration, conflict, fear, anxiety, depression, irritability, nervousness, headache, eyestrain, burning eyes, blurred vision, loss of appetite, increased appetite, skin rash, insomnia, backache, sore neck, hand cramps, sore wrists, swelling feet and increased smoking. These health problems were operationalized as quantitative variables with the fol-

lowing values indicative of the frequency of occurrence: 1) every day, 2) often during a week, 3) occasionally during a month and 4) never. They found that twenty-five per cent or more of the sample suffered "every day" or "often during a week" from: boredom, stress, frustration, irritability, eyestrain, burning eyes, backache and sorenecks. These eight health problems were considered by the Women's Bureau to be the most potentially serious problems among its women workers sampled.

Less than twenty-five per cent of the women workers reported the "every day" or "often during the week" occurrences of: conflict, fear, anxiety, depression, nervousness, headache, blurred vision, insomnia and increased appetite. All of these health problems were found to be significantly related to the percentage of daily VDT usage (i.e. the significance of Kendall's Tau C, $p < .05$). Notably, they should have probably used a stricter level of significance (i.e. $p < .01$), since they had quite a large sample.

Approximately forty-two per cent of all of the workers reported the "every day" or "often during a week" occurrences of fatigue. Fatigue was not significantly related to the percentage of daily VDT usage and thus, fatigue was seen to be a problem for all workers.

Very few women reported the chronic occurrences of: isolation, skin rash, loss of appetite, increased smok-

ing, swelling of feet and hand cramps, and these were not significantly related to the percentage of daily VDT usage.

The Women's Bureau did further bivariate analyses between the eight potentially serious health problems and a variety of possible contributing factors such as: workplace design factors, VDT equipment design, environmental factors and the characteristics of their work (e.g. opportunities for movement in the office, indicative of the "chained" to the terminal phenomenon; relationship with supervisor, indicative of their social supports at work; opportunities to be creative on the job; independence to make decisions; opportunities for career advancement or promotions; level of job satisfaction; the challenge of their work; opportunities to acquire new skills on the job; and salary).

These bivariate analyses were done for the VDT workers only and many of these factors were found to be significantly related to the frequency of occurrence of the eight potentially serious health problems (1983: Tables 44 to 52). However, in these bivariate analyses the percentage of daily VDT usage was not controlled. It is probable that these bivariate results are confounded by this factor, and thus, do not give a true picture of the relationships between the variables in these VDT work situations.

It is impossible to distinguish from their analyses, for example, the most important contributing factors.

The problems inherent in the interpretation of findings, when all contributing factors are not simultaneously controlled, can be seen in some of their rather anomalous findings. For example, it was found that some of the VDT design features utilized to overcome various problems (i.e. screen tiltability and antiglare screens used to reduce glare problems) actually appeared to increase the frequency of occurrence of certain health problems. Generally, it was the workers who worked 21% or more of their days on VDTs which possessed these features, and therefore, it becomes apparent that the amount of daily VDT usage was probably the overriding factor.

It can be suspected that the bivariate relationships between the independent variables (i.e. screen tiltability and antiglare screens) and the various health problems were probably actually capturing the effects of the type of work they were performing. Aspects of VDT design problems (e.g. flickering characters, glare from screen and keyboard, etc.) will be more problematic for workers who use VDTs extensively, and it was demonstrated that it was these workers who suffer also from frequent occurrences of health problems.

The Women's Bureau recognized that their results can only be considered preliminary and that further analyses were necessary. As they concluded, " the VDT workplace is a complex situation in which numerous contributing factors must be considered simultaneously (1983:14)".

Another problem not specifically addressed in the Women's Bureau study was the possible interrelationships between their dependent variables. For example, it was found that offices which workers reported to be "too noisy" (i.e. an environmental factor) were significantly related to the frequency of occurrence of eyestrain. Intuitively, eyestrain would not be related to the noise levels in an office and therefore this would appear to be a spurious relationship.

Noise has been previously linked to stress among workers. As Cox & Mackay remarked, "noise can have what might be termed a stress effect. It may produce changes in mood, intellectual and motor performance, general behavior and general bodily state, all indicative of impaired psychological and physical well-being (1978:155)". The experience of eyestrain may be stressful to the worker. Thus, the relationship between noise and eyestrain may be capturing primarily the indirect effects of stress. This points to the possible interrelationships between the dependent variables in this sample.

The construction of health problem scales, which take into consideration these interrelationships, would probably have yielded more comprehensive results. As Makower explained, "(i)t's difficult to separate the psychological stress of working with VDTs from the physical stress - or even from the visual problems (1982:94)".

Alternatively, some researchers have found that visual problems can be unrelated to non-visual stressors in their studies (e.g. Dainoff, 1980; Dainoff et al., 1981). These researchers found that the amount of time working on a VDT and office lighting problems were significantly related to the occurrence of workers' visual fatigue. However, factors related to general physical stress and job pressure were not significantly associated with workers' visual fatigue. However, as noted in the literature review of this thesis, musculoskeletal, visual and stress problems are often found to coexist among groups of VDT workers. Its logical to therefore assume that these health problems probably have at least some similiar causal sources. Since none of the previous researchers used multivariate methods it is difficult generally to assess the interrelationships between variables.

4.2 SAMPLE USED FOR THIS THESIS

For this thesis, 243 VDT operators in the Women's Bureau's study were included in the analyses. None of the non-VDT workers' responses were used. There are numerous factors, as noted in the literature review of this thesis, which could potentially affect VDT workers' health. Many of these factors would not be relevant in the study of non-VDT workers' health problems, particularly those related to VDT design features. Many of the questions on the Women's Bu-

reau's questionnaire were not applicable to non-VDT workers and therefore would become missing values in any analysis that was to be done. Since the objective of this thesis was to assess the relative importance of various independent variables in relation to VDT workers' health, it was important that all potential variables could be entered simultaneously into a regression equation. The exclusion of non-VDT workers from the analysis allowed for a better measurement of health problems and their causes among the VDT workers.

VDT workers' visual problems were seen by previous researchers as due primarily to VDT design flaws as related to office lighting problems. The intent of this thesis was to test the alternative hypothesis that the predominant causal factor is the performance of alienated labour. The exclusion of non-VDT would limit the conclusions which could be drawn from the analyses in this thesis (e.g. any discussions generally about alienating office work), but it will allow for a more specific assessment of all the contributing factors and their relative importance for VDT workers.

The usage of VDTs in modern offices has become a major issue for: workers and their unions, governments and managements. It is of great interest than to examine the specific causal factors related to VDT workers' health problems. This narrowing of focus on only VDT workers will hopefully facilitate the determination of solutions to their health problems.

4.3 OPERATIONALIZATION OF THE DEPENDENT VARIABLES

VDT workers' health problems are the dependent variables to be explained in this thesis. The World Health Organization's (WHO) has a broad conceptualization of health in which ill-health is more than simply the actual occurrence of disease (i.e. cardivascular disease, peptic ulcers, etc.). According to WHO, as quoted by Labour Canada, "(h)ealth is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (1982:51)".

The twenty-five health problems investigated by the Women's Bureau were symptomatic of: musculoskeletal, visual or stress problems. A factor analysis was done to determine the exact patterns or clustering of these variables, as well as, to reduce the number of dependent variables to be handled in the multiple regressions. All of the health symptoms studied by the Women's Bureau were seen as leading potentially to disease, especially if they recurred often or were chronic problems.

All of the twenty-five health problems studied by the Women's Bureau were entered into a principal-component factor analysis with iterations (i.e. PA2) with orthogonal (i.e. VARIMAX) rotations by using the SPSS (1970) FACTOR procedure. The PA2 and VARIMAX solutions are the most commonly used factoring procedures (i.e. Kim, 1970). According

to Kim, "(t)he total variance of a variable accounted for by the combination of all common factors, ... , is usually referred to as the communality of the variable (author's italics) (1970:475)" and the iterations used with the SPSS principal-component factor extracting procedure serve to improve these communality estimates. The rotation of factors facilitates statistical analysis as the patterns of variables tend to be more "obvious" with this procedure (i.e. Kim, 1970). As well, statistical artifacts may result if factors are unrotated since unrotated factors depend on the number of variables entered into the factor analysis. The VARIMAX rotational procedure was chosen as it attempts to simplify the columns in the factor matrix. This is achieved by making the

TABLE 1

Estimated Communality of Health Problems

	Estimated Communality
ISOLATON	.28645
BOREDOM	.48278
FATIGUE	.40656
STRESS	.59551
FRUST	.58535
CONFLICT	.42533
FEAR	.48413
ANXIETY	.61533
DEPRESS	.68087
IRRITABL	.61436
NERVES	.60169
HEADACHE	.44206
EYESTR	.58865
BURNEYES	.49754
BLURVIS	.47431
INSOMNIA	.38696
BACKACHE	.61379
SORENECK	.64892
HANDCRMP	.36429
SOREWRST	.43765

column values as close to zero as possible (i.e. Kim, 1970).

In the preliminary factor analysis done for this thesis the number of factors to be extracted were allowed to vary freely and this resulted in the emergence of six factors. However, upon examination of the rotated factor matrix it was observed that three of the health factors (i.e. loss of appetite, skin rash and swelling feet) had negligible correlations with all six of the factors (i.e. the correlation coefficients or loadings were all below .3000 with the majority of them approaching zero) and as well, the communality estimates for these health factors were quite low (i.e. swelling feet equal to .18802, skin rash equal to .13163 and loss of appetite equal to .26970). A second factor analysis was done excluding these three variables and five factors emerged. Again however, it was observed that two of the health factors had low correlations with the five extracted factors (i.e. smoking and increased appetite) and low communality estimates (i.e. smoking equal to .19801 and increased appetite equal to .14556). It was decided to eliminate these two health factors and a third factor analysis was done in which three factors emerged (see Table 2).

The only health factor which was retained even though it had a relatively low communality estimate (i.e. see Table 1) was the health factor related to isolation (i.e. ISOLATON) since it tended to load primarily on FACTOR 1 (i.e. its correlation coefficient with FACTOR 1 was .44061).

TABLE 2

Varimax Rotated Factor Matrix

	Factor 1	Factor 2	Factor 3
ISOLATON	.44061	.20621	-.02472
BOREDOM	.48633	.41204	-.03062
FATIGUE	.50796	.27459	.22173
STRESS	.70947	.20271	.17574
FRUST	.70059	.23626	.03616
CONFLICT	.58381	.10625	.21161
FEAR	.60086	.10283	.17924
ANXIETY	.75660	.14916	.21867
DEPRESS	.77937	.29267	.10768
IRRITABL	.69741	.31979	.11112
NERVES	.72018	.11478	.21694
HEADACHE	.34742	.52076	.11528
EYESTR	.22687	.76684	.06305
BURNEYES	.09397	.71841	.12724
BLURVIS	.26595	.64250	.11556
INSOMNIA	.46528	.30517	.14183
BACKACHE	.23432	.44994	.48207
SORENECK	.27814	.49916	.43398
HANDCRMP	.08820	-.00107	.66334
SOREWRST	.19060	.19709	.66741

The eigenvalues routinely calculated (i.e. the sum of the squared loadings or correlation coefficients in each factor) in the SPSS FACTOR procedure represent summary statistics of the total variation accounted for by each individual factor (e.g. Kim,1970). Generally it is accepted that factors with eigenvalues below 1.0 are not significant. In the first factor analysis done, in which six factors were statistically extracted only three of the six factors had eigenvalues over 1.0. This was similiarly seen to occur when five factors were extracted. In the final factor analysis two of the three factors' eigenvalues were over 1.0 and the third factor's eigenvalue closely approached significance with a value of .99889 (see Table 3).

TABLE 3

Eigenvalues of Health Factors One to Three

	Eignevalues
Factor One	7.48853
Factor Two	1.38000
Factor Three	.99889

Stress-related health symptoms tended to load predominantly on FACTOR 1, visual and visually-related musculoskeletal problems loaded on FACTOR 2 and musculoskeletal problems tended to load on FACTOR 3 (see Table 2). The three emergent factors were seen as representative of three specific clusters of health problems and therefore these health problems were combined to create three factor scales.

The complete estimation method (i.e. SPSS FACSCORE) was used to calculate the factor scores for each case. The resultant factor scales were labelled FAC1 (representative of predominantly stress-related health problems), FAC2 (representative of primarily visual and visually-related musculoskeletal problems) and FAC3 (representative of musculoskeletal problems). The newly created dependent variables FAC1,FAC2 and FAC3 were added to the original SPSS systems file (i.e. SPSS ADD VARIABLES procedure).

It is apparent upon examination of Table 2 that a number of the health variables loaded on more than one factor (i.e. BOREDOM, INSOMNIA, HEADACHE, BACKACHE and SORENECK). According to Kim, "(i)f a variable loads on more

than one factor,..., the 'meaning' of that variable is no longer simple. It measures more than one theoretical dimension (1970:470)". However, this was not considered to be problematic since these loadings were what could be intuitively expected.

For example, there are a variety of reasons a worker may experience a headache (i.e. tension headaches due to stress, headaches which are related to eyestrain, etc.) and therefore, it could be anticipated that the variable HEADACHE would load on more than one factor.

BACKACHE and SORENECK both load strongly on two factors (i.e. FACTOR 2 and FACTOR 3) and this would indicate that these musculoskeletal problems are related to the occurrence of workers' visual problems.

These intercorrelations were accounted for in the calculation of factor scales by using the complete estimation method in which all factor score coefficients (i.e. that is for all twenty variables) were entered into the calculation of all three factor scales (i.e. FAC1, FAC2 and FAC3).

4.4 OPERATIONALIZATION OF THE INDEPENDENT VARIABLES

4.4.1 Characteristics of the VDT Equipment

Descriptive data on many of the characteristics of VDTs previously investigated in the literature were available in the Women's Bureau's data. Data on some of the VDT characteristics (i.e. color of VDT screen and characters) were not available, however, the data were considered sufficient to assess the impact of VDT equipment on workers' health.

Data from questions one to twelve of the Women's Bureau questionnaire were used (see Appendix A - Section II, Part B). These questions obtained information on: whether the VDT was separable from its keyboard; whether there was reflected glare from the VDT screen or keyboard; whether the VDT screens were tiltable; whether there were hoods on the VDT screens; whether the VDTs were equipped with anti-glare screens; whether there were flickering characters on the VDT screen; if the screen contrast and/or brightness could be adjusted; the size of the characters on the VDT screen; and if there was a document holder available to the workers and whether it was adjustable.

The workers were originally requested to indicate the presence or absence of these VDT features and/or problems and thus, the data collected was qualitative. Since multiple regressions were to be done in this thesis, dummy

variables were created. The dummy variables related to ergonomic solutions to VDT problems: SP, can separate VDT keyboard from its screen; ALG1, unable to tilt VDT screen; HOOD, hood available on VDT screen; ATGR1, no antiglare screen on VDT; BRT1, no brightness controls and BRT2, inadequate brightness controls on the VDT; CON1, no contrast controls and CON2, inadequate contrast controls on the VDT; and DOC, document holder available to the worker and ADOC, the document holder is adjustable, were to be entered into subsequent regression analyses.

The dummy variables related to VDT problems: F, flickering characters on the VDT screen; GLK1, no glare from keyboard keys; GLS1, no glare from the VDT screen; and character sizes which are either too small (SZ1) or too large (SZ) were created.

4.4.2 Environmental Variables

Most of the environmental factors previously investigated in the literature were available in the Women's Bureau's data. These again were measured as qualitative variables and thus, dummy variables were constructed for use in the multivariate analyses.

The negative responses were to entered into the regression anlayzes. The categories to be used were: office temperatures which were too hot (TEMP1), too cold (TEMP) or

sometimes too hot and sometimes too cold (TEMP2) (see Appendix A - Section I, Question 11); office lighting which was either too bright (LGT) or not bright enough (LGT1) (see Appendix A - Section I, Question 8); noise levels which were either too quiet (NSE) or too noisy (NSE1) (see Appendix A - Section I, Question 13); and office air which was stuffy (AR) or was adequate (AR2) (see Appendix A - Section I, Question 12).

Unfortunately, data on the dryness of the office air, possibly a factor particulary for workers' visual discomfort was not collected.

4.4.3 Personal Characteristics of the Workers

Data was collected by the Women's Bureau on a variety of the personal attitudes and characteristics of the VDT workers such as their: ages, need for corrective lenses, length of training on a VDT, length of time in present position, attitudes towards computerization of our society, and whether they would work on a VDT during pregnancy.

The women's ages were collected (see Appendix A - Section I, Question 26) as interval level datum and this continuous variable (i.e. AGE) was to be entered into the subsequent multivariate analyses for this thesis without adjustment.

Whether a worker wore any corrective lenses (e.g. eyeglasses or contact lenses) (see Appendix A - Section II, Part C, Question 5) was information collected by the Women's Bureau. The "yes" response category was transformed into a dummy variable (WEYE) to represent the wearing of corrective lenses in future multivariate analyses.

The workers were asked where they had received their training for VDT operation (see Appendix A - Section II, Part A, Question 1) and how many days of training they had received. The number of days of VDT training was summed to create a continuous variable (TOTALTR) suitable for regression analyses.

The workers were asked as to how long they had held their present position (see Appendix A - Section I, Question 2) and the categories of responses for this variable (WKP) were interpreted as continuous for the subsequent regressions.

Datum on the workers' attitude towards the "computerization of our society" was collected in the Women's Bureau's questionnaire (see Appendix A - Section I, Question 1). The response categories which ranged from: very positive, positive, neutral, negative, very negative, were transformed into the dummy variables T0 to T4 respectively and T1 to T4 were to be entered into the regressions.

The workers were asked on the questionnaire as to whether they would consider working on a VDT if they were pregnant (see Appendix A - Section II, Part C, Question 9). The "yes" and "no" responses were transformed into dummy variables (P and P1 respectively) and P1 was used.

Finally, dummy variables were created to represent the specific organization in which each respondent worked to control for any organizational variation. The dummy variables O1 and O2 were to be entered into the multivariate analyses.

4.4.4 Characteristics of the VDT Workstations

Information on aspects of the VDT workers' workstation design was available in the Women's Bureau's data such as: the height adjustability of the office chair (see Appendix A - Section I, Question 15), the availability of space at the workstation (see Appendix A - Section I, Question 16) and the privacy at the VDT workers' desks (see Appendix A - Section I, Question 17). The following dummy variables were created: SPCE (lack of adequate space), SPCE1 (adequate space available); PRV (lack of adequate privacy), PRV2 (adequate privacy); and HGT (can adjust the height of office chair).

Unfortunately, the data available on the accessibility of a footrest had to be excluded from the analyses

for this thesis. This was due to the fact that the original question which had been used to obtain this information (see Appendix A -Section II, Part B, Question 13) was essentially a double-barreled question. The question actually contained two ideas: whether a footrest was available and whether a worker needed a footrest. Since a footrest is generally only required by short operators, the importance of the lack of this piece of office furniture to a worker's health is only meaningful if it is already established that a particular operator is in fact in need of a footrest.

As well, data were not available on the height of the office desk and the VDT keyboards. As noted previously these may be important factors especially related to the occurrence of musculoskeletal problems. The lack of these two factors in the analyses for this thesis may reduce the ability to explain these types of health problems.

4.4.5 Characteristics of Work Performed

The hypotheses to be tested in this thesis state that the performance of alienated labour (i.e. highly rationalized and computerized work and thus, highly controlled) will have the greatest impact on VDT workers' health. A number of questions in the Women's Bureau questionnaire could be considered indicators of controlled alienated work (see Appendix A - Section I, Question 22).

The following variables were explored as components of alienated labour: workers' opportunities for creativity in their work (CREATE), opportunities for challenging work assignments (CHALLENG), independence to make decisions on the job (INDEPEN), opportunities to learn new skills (SKILLS), and chances for promotions or advancement (ADVANCE) (see Appendix A - Section I, Question 22); quantity (QUANTITY) and quality (QUALITY) monitoring of VDT work (see Appendix A - Section II, Part D, Questions 2 and 3); the lack of opportunities for movement around the office indicative of the chained to the terminal phenomenon (MOVE) (see Appendix A - Section I, Question 18); the presence of an uncomfortable office chair (CHAIR) and finally, the workload pressure was captured in the variable related to the expectations of employers as to the completion times of work they submit to the workers (REAL) (see Appendix A - Section ii, Part D, Question 4). Dummy variables were created from the categories of these variables and the best solution for constructing an alienated labour scale were explored using the SPSS RELIABILITY (1970) program. The best solution found was inclusive of the following dummy variables summed: M1 (lack of movement in the office), C4 (very poor opportunities for creativity), I4 (very poor opportunities to make independent decisions), A4 (very poor opportunities for promotions), S4 (very poor opportunities for learning new skills), CG4 (very poor opportunities for challenging work assignments, QL (quality monitoring), QN (quantity monitor-

ing) and CHR (uncomfortable office chair). The newly created ALIEN scale, composed of summed dichotomous variables had a very high standardized alpha of .86844, suggesting that this is a reliable scale of alienated labour. The REAL variable actually reduced the reliability of the scale and it was therefore excluded from the scale and entered into the regressions as the dummy variables: R (employer does not have realistic expectations) and R1 (the employer is realistic in their expectations). The CHAIR was initially considered for inclusion in the ALIEN scale because its high correlations with the other indicators. This varaible is probably also capturing the chained phenomenon.

A worker who uses only one type of office equipment (i.e. a VDT), for the majority of their work day is assumed to probably perform standardized and routinized work. The amount of VDT usage daily will be a function of the type of work performed. The workers had been asked to indicate the percentage of their work day they used a VDT. The variable (VDTWP) was entered into the regressions for this thesis as one indicator of rationalized and computerized work. VDTWP therefore is probably capturing another dimension of alienated labour.

A similar measure, the amount of VDT usage, has been used in many previous studies, however, it is to be interpreted differently in this thesis. It is assumed that the more a worker utilizes a VDT daily, the more rational-

ized their job will be and therefore it will involve repetition of standardized tasks. Although this relationship will not always hold true, especially with regards to professional workers, it is probably not an unwarranted assumption with regards to office clerical workers. If clerical workers jobs were not highly rationalized the use of VDTs would not be a logical investment for management. All of the women workers in the sample used for this thesis were supposed to be clerical or secretarial keyboard staff, so it would appear that the amount of VDT usage could be used as one indicator of alienated labour.

Alienated labour is a multidimensional concept. Certain components of alienated labour were not available in the Women's Bureau's data, for example: machine pacing versus operator pacing, direct measures of repetitive work, length of work cycles, workload and the workers' ability to conceptualize the entire work process. VDTWP and ALIEN are both capturing certain aspects of alienated labour but they are not exhaustive.

The Women's Bureau collected salary datum (see Appendix A - Section I, Question 27). This interval level salary data was to be entered into subsequent statistical analyses without adjustments (SALARY).

Another possible measurement of management control was derived from the Women's Bureau's question related to

the quality of the workers' relationship with their supervisor (see Appendix A- Section I, Question 19). In the literature it is often commented upon that machine control eliminates the need for direct supervisory control. Supervisory control becomes redundant as the machines can function in the supervisory role. Therefore, it is uncertain how the relationship will affect workers' health problems. For example, it may depend on the managerial styles utilized. If the supervisor functions as a friendly advisor who attempts to alleviate for the workers some of the control effects of computerization, this then would serve to suppress some of the negative aspects of machine controlled work. Without this type of supervisory support the effects of machine control may have greater impact on the workers' health.

Dummy variables were created from the original response categories of: very good (RS), good (RS1), average (RS2), poor (RS3) and very poor (RS4) relationship with supervisor. The dummy variables RS1 to RS4 were to be subsequently entered into the multivariate analyses.

Another variable of use was related to the frequency of restbreaks (see Appendix A - Section II, Part B, Question 14). This variable indicated organizational awareness and policy towards VDT usage. The response category of "no special breaks" (BRK) was transformed into a dummy variable for the future multivariate analyses.

4.4.6 Summary

Approximately fifty predictor variables were to be entered into multiple regressions with the three dependent variables: FAC1 (stress-related health problems), FAC2 (visual health problems) and FAC3 (musculoskeletal health problems).

Chapter V

DATA ANALYSIS

5.1 INTRODUCTION

Multiple regression analyses were to be performed to assess the hypotheses presented in Chapter Three of this thesis. Prior to the multiple regressions, the data were examined to check that none of the four basic assumptions underlying multiple regression analysis were violated (Loether & McTavish, 1974). Various tests were done to look for any: 1) nonlinearity between the independent/dependent variable relationships, 2) multicollinearity and 3) interaction effects. The fourth assumption had already been met as all independent and dependent variables were interval level or dummy variables. The fact that the sample used was nonrandom did not pose any problems since a random sample is required only if a researcher wishes to make statistical inferences to a population (Kleinbaum & Kupper, 1978). It was understood that the sample used for this thesis was in no way representative of the population of women workers in Winnipeg.

To ensure that certain independent variables had linear relationships with the dependent variables the following tests were done:

1. Scatterplots were produced (SPSS SCATTERGRAM, 1970) and the relationships were visually assessed. Least-squares regression lines were drawn on the scatterplots using the standard equation: $Y' = a + b(x)$.
2. Dummy variables were created from the original independent variables and these dichotomous variables were entered into regressions with the three dependent variables (SPSS REGRESSION, 1970).

   If the R squared from the dummy variable regression was larger than the R squared from the original interval level variable regression, the dummy variables were kept for the subsequent multiple regression analyses and the continuous variable was discarded.

   If the dummy variables enhanced the explanation of the dependent variable it is probable that the nature of the association between these variables is nonlinear (ie. it does not follow a straight line).

At this stage of the analysis, it was also decided that if a variable, even after its transformation into dummy variables, still did not explain much of the variance in a dependent variable (i.e. the R squared closely approached zero), it was completely dropped from any subsequent analyses. It would be apparent, after examining the scatter dia-

grams and the dummy variable regressions, that the lack of strength in the association was not due to nonlinearity.

Variables which had been previously transformed into dummy variables due to their qualitative measurement were not tested for linearity since by definition these variables will have linear relationships with the dependent variables. After any linearity problems were solved initial multiple regressions were to be run in which all of the predictor variables were entered.

Multicollinearity problems arise when the independent variables are intercorrelated or are a linear function of each other (i.e. Kim & Kohout, 1970). Multicollinearity will affect the beta coefficients (i.e. the partial standardized regression coefficients which are indicative of the relative strength of the independent/dependent variable relationships) and thus, it will introduce statistical artifacts into a multiple regression analysis.

The major means of detecting potential multicollinearity problems used was the SAS (1982) collinearity diagnostics program. This procedure has the advantage of allowing a researcher the ability to detect collinearity between two or more variables. This program produces: condition indices, eigenvalues and the portion of variance explained for each independent variable within a component. The condition indices are the square roots of the ratio of the largest eigenvalue to each individual eigenvalue (SAS, 1982:55).

A collinearity problem occurs when a component associated with a high condition index contributes strongly to the variance of two or more variables (SAS, 1982:55). The general criteria used to determine the presence of collinearity was if a condition index attained a value of ten or higher and at least two variables had variances over .5000 within the same component, collinearity was suspected.

If collinearity was evident, the beta coefficients were inspected to see which of the independent variables had the strongest relationship with the dependent variable, the weaker independent variable was excluded from future multiple regressions since it was considered to be redundant.

In multiple regression analyses the effects of the independent variables are assumed to be additive (i.e. Loether & McTavish, 1974). If two independent variables operate jointly, or interact with one another, the predicted values of the dependent variable will then be incorrect (i.e. Kim & Kohout, 1970).

Where interaction was suspected the independent variables were multiplied by each other and the new interaction term was entered into a step-wise regression. The original independent variables were entered into the regression first and then the interaction term was added. The R squared, the beta coefficients and their significance were then examined to determine whether the interaction effects

were significantly adding to the explanation of the dependent variables.

The testing for interaction effects was of particular importance to the analyses since many of the contributing variables operating in the VDT work situation are seen to act synergistically.

5.2 LINEARITY

One of the fundamental assumptions underlying multiple regression analysis is that the nature of the association between any independent or predictor variable and the dependent variable is linear.

Most of the independent variables were dichotomous dummy variables and therefore, by definition, these variables had linear relationships with the dependent variables. Tests for linearity were performed on the following continuous interval level independent variables: AGE (the workers' age in years), SALARY (the workers' monthly gross salary), VDTWP (the workers' percent of daily VDT or WP usage) and ALIEN (the workers' score on the alienated labour scale).

5.2.1 AGE

The initial visual examination of the independent variable AGE and the dependent variables revealed a great deal of variation among the younger workers and their reported health problems, particularly FAC1 stress-related and FAC2 visual and visually-related musculoskeletal health problems (see Appendix B- Graphs 1 to 3). As the workers' ages increased, there was less variation in the reported health problems. However, there were few older workers in this sample in comparison to the number of younger workers (e.g. there were twenty-six workers forty years of age and older while there were 160 workers between the ages of 18 and 29). There may not be sufficient numbers of older workers in this sample to adequately assess the relationships between these variables. The heteroscedasticity, or the clustering of points on these graphs would be a function of this unequal distribution of workers along the age dimension. The deviations from linearity may be simply due to sampling error.

The relationship between AGE and the dependent variables could be confounded by the fact that the younger workers in this sample were known to use VDTs and WPS more extensively than the older workers. The nature of the associations were not readily apparent with the preliminary "eyeball" tests although AGE generally did not appear strongly related to FAC2 visual and visually-related muscu-

loskeletal problems or FAC3 musculoskeletal problems. The points on the graphs did not closely adhere to the regression lines and the simple r's approached zero.

The following dummy variables were created from the original AGE variable: AG1 (18 to 29 years of age), AG2 (30 to 39 years of age) and AG3 (40 years of age and older). AG1 and AG3 were entered into regressions with the dependent variables. For FAC1 stress-related and FAC2 visual and visually-related musculoskeletal health problems, the R squared actually declined with the dummy variable regression indicating that the interval level AGE variable explained more of the variance in these dependent variables than the dummy

TABLE 4

AG1 AG3 Versus AGE R Squared Comparisons

	Dummy R Squared	Interval R Squared
FAC1	.03279	.03403
FAC2	.00039	.00048
FAC3	.00639	.00378

Note: FAC1 represents stress-related health problems, FAC2 represents visual and visually-related musculoskeletal problems and, FAC3 represents musculoskeletal problems.

variables AG1 and AG3 (see Table 4).

The relationships between the workers' ages and the dependent variables FAC2 visual and FAC3 musculoskeletal problems were very weak and not statistically significant.

The AGE variable, as well as AG1 and AG3, were deleted from future regressions with these dependent variable.

The dummy variables did not improve the explanation of the FAC1 stress-related health problems over the original AGE variable and it was decided to retain the AGE variable for subsequent FAC1 regressions.

5.2.2 SALARY

The scatter diagrams of the variable SALARY (i.e. workers' monthly gross salary) and the dependent variables were viewed (see Appendix B - Graphs 4 to 6) and the points appeared to be randomly and widely scattered around the regression lines. The lack of an apparent pattern with these associations is probably due to the absence of any strong systematic relationships between these variables.

The following dummy variables were created from the original SALARY variable: SAL1 ($1000 per month or less), SAL2 ($1001.00 to $1350.00 per month), SAL3 ($1351.00 to $1700.00 per month) and SAL4 ($1701.00 and over per month). The dummy variables SAL1,SAL2 and SAL3 were entered into regressions with the dependent variables. The dummy variables slightly enhanced the explanation of all three dependent variables (see Table 5) indicating these relationships are probably nonlinear.

The dummy variables were retained only for the FAC1 stress and FAC2 visual health problem regressions since the association between FAC3 musculoskeletal problems and the workers' monthly gross salary (either SALARY or SAL1,SAL2 or SAL3) was virtually nonexistent. The workers' salary was excluded from any further FAC3 musculoskeletal

TABLE 5

SAL1 SAL2 SAL3 Versus SALARY R Squared Comparisons

	Dummy R Squared	Interval R Squared
FAC1	.04185	.02726
FAC2	.09289	.09162
FAC3	.00677	.00249

Note: FAC1 represents stress-related health problems, FAC2 represents visual and visually-related musculoskeletal health problems and, FAC3 represents musculoskeletal problems.

problems analyses.

5.2.3 VDTWP

The visual inspection of the scatterplots of the independent variable VDTWP (i.e. the percentage of daily VDT usage) and the dependent variables (see Appendix B- Graphs 7 to 9) tended to reveal that the patterns of these associations were possibly nonlinear. Workers who utilized VDTs or WPs for relatively moderate per cents of their working days tended to have more positive health scores than workers who

used this equipment very little or extensively. These deviations from linearity however may be a function of the distribution of workers along the VDTWP variable in this sample. Workers tended to use their VDTs or WPs for quite short or very long periods of time with few workers using them for intermediate lengths of time.

The following dummy variables were created: V1 (1% to 30% of working day spent operating a VDT or WP), V2 (31% to 79% of working day worker operated a VDT or WP) and V3 (80% to 100% of work day on a VDT or WP). V1 and V3 were entered into regressions with the dependent variables. The dummy variables explained more of the variance in FAC1 stress and FAC2 visual and visually-related musculoskeletal problems than the interval VDTWP variable (see Table 6). The dummy variables were retained for later multiple regression analyses with FAC1 stress and FAC2 visual and visually-related musculoskeletal problems.

TABLE 6

V1 V3 Versus VDTWP R Squared Comparisons

	Dummy R Squared	Interval R Squared
FAC1	.21409	.20185
FAC2	.09788	.09011
FAC3	.00164	.00194

Note: FAC1 represents stress-related health problems, FAC2 represents visual and visually-related musculoskeletal problems and, FAC3 represents musculoskeletal problems.

The variables VDTWP or V1 V3 had basically no effect on FAC3 musculoskeletal problems and therefore these were excluded from any further analyses with FAC3.

5.2.4 ALIEN

The initial visual examination of the independent variable ALIEN (i.e. the alienated labour scale) and the three dependent variables suggested that these relationships are probably nonlinear (see Appendix B - Graphs 10 to 12).

The following dummy variables were created from the original ALIEN variable for analysis with the FAC1 stress-related dependent variable: AL1 (scale scores of 0 to 3 inclusive), AL2 (scale scores of 4 and 5), AL3 (scale scores from 6 to 9). The AL2 and AL3 dummies were entered into a regression with the FAC1 stress-related dependent variable and the R square was seen to improve (see Table 7). The AL2, AL3 dummy variables were kept for subsequent analyses.

The dummy variables formed from ALIEN (i.e. the alienated labour scale) for analysis with the FAC2 dependent variable related to visual and visually-related musculoskeletal problems were: AL1 (scale scores from 0 to 2), AL2 (scale scores 3 to 5) and AL3 (scale scores ranging from 6 to 9). The AL2 and AL3 dummies were entered into a regression analysis with the FAC2 dependent variable and the R

square increased slightly relative to the original ALIEN regression. It was decided to retain the AL2 AL3 dummy vari-

TABLE 7

Dummy Variable Versus ALIEN R Squared Comparisons

	Dummy R Squared	Interval R Squared
FAC1	.24486	.20185
FAC2	.20026	.19265
FAC3	.00903	.00023

Note: FAC1 represents stress-related health problems, FAC2 represents visual and visually-related musculoskeletal problems and, FAC3 represents musculoskeletal health problems.

ables for further analyses with the FAC2 dependent variable.

For analysis with the FAC3 dependent variable related to workers' musculoskeletal problems, the following dummy variables were created: AL1 (scale score of 0), AL2 (scale scores of 1 to 3), AL3 (scale scores 4 and 5), AL4 (scale scores from 6 to 9 inclusive). The dummy variables AL2 to AL4 were regressed with this dependent variable and it was found that the R square was larger with the dummy variables. However, the relationship between the percentage of daily VDT or WP use and this dependent variable was very weak. The ALIEN variable and the ALIEN dummy variables were dropped from any further regressions with this dependent variable.

5.3 MULTICOLLINEARITY

Initially, three multiple regressions were run, one for each of the dependent variables, in which over fifty predictor variables were entered into the analyses. Since there were so many independent variables relative to the number of cases (n=243), it was deemed advisable to reduce the numbers of these variables wherever it was feasible. This did not pose a problem as many of the predictor variables had negligible correlations with the dependent variables. Generally, only the statistically significant variables had standardized beta coefficients of .1000 or better and it was decided to eliminate any predictor variables which had statistically nonsignificant relationships with a dependent variable. Notably, since the sample was nonrandom the tests for statistical significance were used only as heuristic devices.

The regression with the FAC3 musculoskeletal dependent variable was problematic since even with all the independent variables included in the analysis under thirty per cent of the variance in the FAC3 dependent variable related to muculoskeletal problems. For this reason, extensive analysis of this dependent variable was not attempted. The correlation matrix was examined and multicollinearity did not appear to be a problem. The low amount of variance explained in this dependent variable was not due to intercorrelations between the independent variables.

The SAS program for collinearity diagnostics was run on the remaining predictor variables in the FAC1 stress and the FAC2 visual and visually-related dependent variable regressions.

5.3.1 Stress- Related Health Problems

The following statistically significant predictor variables were kept for the FAC1 dependent variable regression analyses: AL2 (dummy variable of alienated labour scores of 4 or 5), AL3 (dummy variable of alienated labour scores from 6 to 9), RS2 (dummy variable representative of an adequate relationship with supervisor), RS3 (dummy variable representative of a poor working relationship with supervisor), T2 (dummy variable representative of a neutral attitude to computerization), T3 (dummy variable representative of a negative attitude towards computerization), V3 (80 to 100% of work day on a VDT or WP) and HGT (dummy variable which indicates they could not adjust the height of their office chair). The general criteria for assessing multicollinearity were applied and in no instance did the condition index acquire a value of ten or higher. There were however high portion variances reported on one component for AL3 (.7622) and V3 (.8138) although the condition index was only 4.837. The correlation matrix was referred to and the simple r for AL3 and V3 was equal to .63090. Since the beta coefficient for AL3 was much smaller than the beta coefficient

for V3 (+.22710 versus +.44470 respectively), the AL3 dummy variable was deleted from subsequent multiple regressions with this dependent variable. No other potential collinearity problems were in evidence.

5.3.2 Visual and Visually-Related Musculoskeletal Problems

The following independent variables were found to have statistically significant relationships with the FAC2 dependent variable: P1 (dummy variable representative of a worker's unwillingness to work on a VDT if she became pregnant), LGT (dummy variable representative of office lighting which is too bright), LGT1 (dummy variable representative of office lighting which is not bright enough), TEMP1 (dummy variable representative of office temperatures which are too hot), NSE (dummy variable representative of noise levels in the office which are too quiet), AL2 (dummy variable of alienated labour scores of 4 or 5), AL3 (dummy variable representative of alienated labour scores from 6 to 9), BRT1 (dummy variable representative of VDT brightness controls which are inadequate), F (dummy variable representative of flickering characters on the VDT screen) and SPCE (dummy variable representative of inadequate space at the VDT workstation). The SAS collinearity diagnostics program was run with these variables. The condition indices were all below 4.0 and there were no portion variances of .5000 or higher reported on any one component.

5.4 INTERACTION EFFECTS

It was often noted in the literature that in the VDT workplace numerous factors act jointly or synergistically to affect workers' health (e.g. Mackay et al., 1979; Smith et al., 1981). Mackay et al. (1979) did test for interaction effects among sawmill workers but among VDT workers these interactions have never actually been tested. Various multiplicative or interaction terms were introduced into the FAC1 stress and FAC2 visual and visually-related musculoskeletal dependent variable regressions and never were these terms found to be statistically significant. The joint effects of two predictor variables, in this sample, did not contribute any more to the explanation of the dependent variables over that which had already been accounted for by their separate effects. This suggests that the effects of the predictor variables are additive.

5.5 HYPOTHESIS ONE

In hypothesis one, it was proposed that, when all contributing factors were considered at the same time, the performance of alienated labour would have the greatest relative effect on VDT workers' stress problems. The FAC1 dependent variable representative of workers' stress problems was used for the assessment of hypothesis one. The following predictor variables: AL2 (alienated labour scores of 4 or 5), RS2 (adequate relationship with supervisor), RS3

(poor relationship with supervisor), T2 (neutral attitude towards computerization), T3 (negative attitude towards computerization), AGE, V3 (80 to 100 per cent of day on a VDT or WP) and HGT (cannot adjust height of office chair) were entered into a final regression with the dependent variable. The overall regression was statistically significant at the .01 level (i.e. the F equalled 17.63768 at 8,232 degrees of freedom). The R squared was equal to .37819 such that 37.8 per cent of the linear variance in FAC1 was explained by these eight predictor variables. The coefficient of nondetermination (i.e. 1 - R squared = K squared) was equal to .62181 which showed that approximately 62.2 per cent of the variance in FAC1 was unaccounted for.

Six of the variables were found to have statistically significant affects on FAC1: AL2, RS2, RS3, T3, AGE and V3. When the standardized partial beta coefficients were compared, V3 emerged as the variable with the greatest impact on FAC1 (see Table 8).

The more a worker operated a VDT or WP daily, the greater were their stress problems. V3 is another indicator of alienated work, albeit an imperfect and indirect measure, it represents the extent of rationalization of the office work. AL2 (alienated labour scores from 4 to 5) were quite strongly related to the FAC1 stress dependent variable. This indicated that the more alienating their work could be characterized, the greater were their stress problems. It is

TABLE 8

Significant Predictors in the FAC1 Regressions

	Beta	F Ratio	RSQ Change	r
V3	+.40435	47.374	.12697	+.46360
T3	+.19943	12.823	.07800	+.34174
AL2	+.18441	11.011	.00520	-.06024
RS3	+.15720	8.521	.07325	+.25413
RS2	+.15457	8.360	.04704	+.21611
AGE	-.11765	4.987	.01911	-.18447

Note: The significant predictors in the FAC1 stress-related health problems regression were: V3 (80 to 100 per cent of day on a VDT or WP), T3 (a negative attitude to computerization), AL2 (alienated labour score of 4 or 5), RS3 (poor relationship with supervisor), RS2 (adequate relationship with supervisor) and AGE (worker's age in years).

probable that part of the affects of AL2 were suppressed by V3. V3 is capturing aspects of alienated labour which were not captured in AL2. Both V3 and AL2 are probably not exhaustive since other potentially important aspects of alienated labour were not available in this data (i.e. machine pacing versus operator pacing, direct measures of repetitive work, length of work cycles, workload, the workers' ability to conceptualize the entire work process, etc.).

If there were problems in their relationship with their supervisor (i.e. they reported a poor relationship with their supervisor, RS3), the greater were their stress problems. However, even if they reported an adequate relationship with their supervisor (i.e. RS2), this did not reduce their stress problems.

The older the worker, the less were their stress problems. That is when all other variables are controlled, younger workers tended to report stress problems more often than older workers. This may be due to general life factors external to work not captured in this data (i.e. younger workers may be more likely to have young children, etc.). Job senority had been indirectly captured in the initial regression (i.e. WKP) and it was not found to have a strong or significant effect on the FAC1 stress-related health problems. However, job senority, if a better measure had been available, probably would be a contributing factor. Older women were less likely to be working on VDTs in this sample and it is often the lower level clerical workers who utilize this equipment the most.

The more negative was the workers' attitude (i.e. T3) towards computerization in our society generally, the greater were their stress problems. However, the interpretation of this variable is difficult as it is not certain which came first, the negative attitude or VDT usage.

V3 and AL2 are expected to both be capturing the effects of alienating work, so it would appear that there is at least partial support for hypothesis one, in this sample.

5.6 HYPOTHESIS TWO

In hypothesis two, it was suggested that, when all possible contributing factors were considered simultaneously, the performance of alienated labour would have the greatest impact on workers' visual problems. The FAC2 dependent variable representative of workers' visual and visually-related musculoskeletal problems was used to assess hypothesis two. The independent variables: P1 (would not work on VDT if pregnant), LGT1 (office lighting which is not bright enough), LGT (office lighting which is too bright), TEMP1 (office temperatures which are too hot), NSE (noise levels which are too quiet), AL2 (alienated labour scores of 3 to 5), AL3 (alienated labour scores from 6 to 9), BRT1 (VDT brightness controls which are inadequate), F (flickering characters on VDT screen) and, SPCE (inadequate space at workstation) were entered into a final regression with the FAC2 dependent variable.

The overall regression was statistically significant at the .01 level (i.e. the F ratio was equal to 14.11654 at 10,232 degrees of freedom). The R square equalled .37829 indicating that 37.8 per cent of the linear variance in workers' visual problems was explained by these ten predictor variables. The coefficient of nondetermination revealed that approximately 62.2 per cent of the variance in this dependent variable was still unexplained.

The relative strengths of each predictor were compared and the AL2, AL3 variables were found to have the

TABLE 9

Significant Predictors in the FAC2 Regression

	Beta	F Ratio	RSQ Change	r
AL3	+.28039	21.067	.11156	+.36997
AL2	+.21766	16.317	.02468	+.16383
P1	+.19973	13.368	.09468	+.30773
F	+.18605	11.715	.03139	+.23830
BRT1	+.17659	9.679	.03242	+.33374
SPCE	+.17097	10.439	.01313	+.11459
LGT1	+.15252	8.292	.02255	+.10433
TEMP1	-.13590	6.383	.00948	-.05591
LGT	+.13085	5.801	.03182	+.18551
NSE	+.10979	4.391	.00658	+.06182

Note: AL3 represents alienated labour scores from six to nine,
AL2 represents alienated labour scores from three to five,
P1 indicates the workers' refusal to work if pregnant on a VDT,
F represents flickering characters on VDT screen,
BRT1 represents inadequate VDT brightness controls,
SPCE represents inadequate space at VDT workstation,
LGT1 represents office lighting which is not bright enough,
TEMP1 represents office temperatures which are too hot,
LGT represents office lighting which is too bright,
and NSE represents noise levels in the office which are too quiet.

greatest impact on this dependent variable (see Table 9).

The more alienating a workers' work can be characterized as, the greater will be their visual problems. Thus, hypothesis two has some support in this sample of women workers. VDT characteristics such as flickering characters and inadequate brightness controls and, environmental problems related to improper office lighting may be contributing

to these workers' visual problems but, the type of work they are performing has the greatest impact when all variables are viewed simultaneously.

It was not surprising to find both inadequate brightness controls and flickering characters on the VDT significantly related to visual problems since brightness controls serve to reduce flicker problems.

Although over fifty per cent of the VDT workers reported glare on their VDT screens this variable was not found to be significantly related to the FAC2 dependent variable in the multivariate analyses. However, glare problems are often the result of office lighting which is too bright and this variable was found to be significant.

Notably, many of the VDT characteristics which were emphasized in the literature had virtually no affect on these workers' visual problems. Ergonomic solutions did not appear to resolve any of these VDT problems. Personal characteristics of the workers such as their age and whether they were in need of eyeglasses or contact lenses did not have any affect on their vision problems. These results suggest that much of the previous emphasis on such factors as VDT equipment design, ergonomic solutions and the personal characteristics of the workers, may have been misdirected.

The P1 dummy variable (representative of workers' unwillingness to work on a VDT during pregnancy) was strong-

ly related to FAC2 visual and visually-related musculoskeletal problems. This variable is probably capturing the workers concern about VDT radiation. There was a lot of attention by the popular press, especially during the summer of 1982, on the incidence of miscarriages among VDTs workers. The radiation emissions from VDT was suspected to be the cause of these birthing problems.

The TEMP1 (office temperatures which are too hot) and NSE (offices which are too quiet) were related to FAC2 visual and visually-related musculoskeletal problems. It is probable that these variables were capturing the general discomfort of the workers.

The variable SPCE (workstations which have inadequate space) was probably related to the musculoskeletal problems, as opposed to the visual problems, included in the FAC2 dependent variable.

5.7 HYPOTHESIS THREE

In hypothesis three, it was suggested that, when all possible contributing factors were considered simultaneously, the performance of alienated labour would have the greatest relative impact on workers' musculoskeletal problems. This hypothesis was partially supported with regards to workers' visually- related musculoskeletal problems (see the discussion in Section 5.6 of this thesis). Musculoskele-

tal problems which are unrelated to visual problems were captured in the FAC3 dependent variable and this dependent variable was used for further assessment of hypothesis three. However, the alienated labour variables were earlier eliminated from any FAC3 dependent variable regressions due to their very small correlations with this variable.

All independent variables which had betas of .1000 or better were entered into a multiple regression with the FAC3 dependent variable (representative of workers' musculoskeletal problems). The R square was equal to .22334 (the F ratio was equal to 4.68321 at 14,228 degrees of freedom) indicating that approximately twenty two per cent of the variance in workers' musculoskeletal problems were explained by these independent variables. Approximately seventy-eight per cent of the variance in this dependent variable was left unexplained and this tends to indicate that possibly some of the important variables related to workers' musculoskeletal problems were not included in this analysis.

As well, it is suspected that the calculation of this dependent variable may be partially to blame for the low amount of variance explained. This variable only closely approached statistical significance in the factor analyses (i.e. its eigenvalue was .99889). This indicates that there may have been insufficient variation in the FAC3 musculoskeletal health problems to begin with. This dependent variable was predominantly composed of the health problems:

hand cramps and sore wrists and, according to the Women's Bureau (1983), few of the women workers actually complained of the frequent occurrence of these musculoskeletal prob-

TABLE 10

Predictors in the FAC3 Regression

	Beta	F Ratio	RSQ Change	r
T4	+.20383	10.740	.03790	+.23881
02	+.18927	8.117	.02576	+.13328
RS1	+.17758	7.555	.01259	+.07187
HOOD	+.17090	7.767	.02077	+.08097
RS4	+.16559	6.959	.03604	+.18251
GLS1	-.14325	5.092	.01734	-.16251
LGT	+.13406	4.831	.01268	+.12433

Note: FAC3 represents workers' musculoskeletal problems, T4 is a dummy variable representative of a very negative attitude towards the computerization of our society, 02 is a dummy variable representative of one of the three crown corporations involved in this study, RS1 is a dummy variable representative of a good relationship with supervisor, HOOD is a dummy variable representative of the presence of a hood on their VDT, RS4 is a dummy variable representative of a very poor relationship with their supervisor, GLS1 is a dummy variable representative of no glare from the VDT screen and LGT is a dummy variable representative of office lighting which is too bright.

lems.

Of the predictor variables entered into the FAC3 musculoskeletal problems regression, T4, the dummy variable representative of a worker having a very negative attitude towards the computerization of our society, emerged as the strongest variable (see Table 10). It is difficult to interpret this variable as it is not clear whether this negative attitude came before or after the usage of VDTs.

The second strongest variable was O2, the dummy variable which indicated they worked in one of the three crown corporations. This variable was entered into the regressions to control for any organizational variation between the three crown corporations. It is apparent that, with regards to workers' musculoskeletal problems, the organization the workers were employed at had an affect on their musculoskeletal problems.

It would appear that regardless of whether the workers had a good working relationship with their supervisor or a poor relationship (i.e. RS1 and RS4) and, even if they had a hood (i.e. HOOD) on their VDT screen, these did not help to reduce their musculoskeletal problems. It is apparent that there is an overriding factor operating in these work situations. It is probable that those dimensions of alienated labour (i.e. machine pacing, the speed of their work, etc.) not captured in this analysis, are the intervening variables affecting workers' musculoskeletal problems.

Those workers who did not have a glare on their VDT screens (i.e. GLS1) had less musculoskeletal problems than those who had glare.

Office lighting which is too bright (i.e. LGT) increased workers' musculoskeletal problems.

5.8 SUMMARY

There was partial support in this sample for hypotheses one, two and three. Close to forty per cent of the variance was explained in the stress-related health problems (i.e. FAC1) and the visual and visually-related musculoskeletal problems (i.e. FAC2). These are important findings, especially when it is recognized that the alienated labour variables were probably not exhaustive measures. Improved measures of alienated labour which were inclusive of indicators for: machine pacing as opposed to operator pacing, the extent their work can be characterized as repetitive, the length of their work cycles, workload, and the worker's ability to conceptualize the entire work process, would probably further increase the explanation of these dependent variables. These findings dispute the claims of ergonomists who maintain that many of the problems of VDT usage can be overcome primarily with VDT design solutions.

Chapter VI

DISCUSSION

The major objective of this thesis was to construct and test multivariate models which attempted to explain the incidence of health complaints among VDT workers. Multivariate analysis was done for this thesis since none of the previous researchers attempted to control all the pertinent variables simultaneously and this may be necessary if a true understanding of the VDT work situation is to be reached. The use of multivariate techniques for the analyses in this thesis, improved upon the initial Women's Bureau's (1983) bivariate analyses of the data. A comparison of the Women's Bureau's original findings with those found here reveals the advantages of multivariate methods and generally points to possible problems with the conclusions of most of the previous researchers.

The Women's Bureau was faced with the analysis of twenty-five dependent variables. In order to simplify their analysis and to make it more manageable, they reduced the number of dependent variables for intensive study by choosing only those health problems which were found to occur chronically (i.e. "every day" or "often during a week") among at least twenty-five per cent of the women workers

(both VDT and non-VDT) in their sample. This served to delineate the more "serious" health problems of: boredom, stress, frustration, irritability, eyestrain, burning eyes, backache and sore neck, for their analyses. However, all of the twenty-five health problems were essentially symptoms of more general problems.

Blurred vision and burning eyes are known symptoms of eyestrain. Irritability, frustration, depression, boredom, insomnia, etc., are symptomatic of psychological stress. So the construction of scales of health problems, as was done in the preliminary analyses for this thesis, would have increased the validity of their health problems. Their approach to the problem of too many dependent variables ignored the possible interrelationships between these health problems. Their rather arbitrary means for determining the more serious health problems probably resulted in the exclusion of some important health variables.

The Women's Bureau proceeded to analyze the eight potentially serious health problems with various independent variables (i.e. crosstabulations). Most of the variables found significant at the multivariate level of analysis in this thesis were also found to be significant in the Women's Bureau's study at the bivariate level of analysis. Notably, since the sample used was nonrandom, the tests for statistical significance can only be seen as heuristic devices.

Generally, all the characteristics of work variables (i.e. lack of opportunities for: learning new skills, challenging work assignments, independence in decision-making, promotion and creativity; lack of movement around the office; uncomfortable office chairs; quality and quantity monitoring; relationship with their supervisors) were found to be significant at both levels of analysis.

Some of the significant independent variables at the bivariate level of analysis did not emerge as significant at the multivariate level of analysis. The differences in results between the multivariate and the bivariate analyses are probably due to the lack of control over the numerous independent variables related to VDT workers' health problems in the bivariate analyses.

In the Women's Bureau's analysis of eyestrain the following variables were found to be significant: inadequate brightness controls, glare from keyboard keys and VDT screen, inadequate contrast controls, flickering characters, lack of antiglare screen and lack of screen tiltability. Office lighting problems were not significantly related to eyestrain. In the multivariate analysis of the FAC2 dependent variable representative of workers' visual problems, only flickering characters and inadequate brightness controls were significant and the dummy variables related to office lighting emerged as significant variables.

It is apparent that in the bivariate analysis the effects of office lighting were hidden and confounded. It is probable that the effects of VDT screen and keyboard glare, the lack of antiglare screens and screen tiltability and, inadequate contrast controls are related to lighting problems. Thus the bivariate results masked the underlying variable of importance: office lighting. This suggests that if the lighting problems are recommended, many of the other problems related to VDT usage would disappear.

As reported by the Women's Bureau (1983), many of the VDT operators were equipped with: antiglare screens (49.5%), tiltable VDT screens (42.6%), acceptable contrast controls on their VDTs (47.5%), adequate brightness controls (77.9%) and separable screens from VDT keyboards (58.4%). The three employers surveyed by the Women's Bureau were very aware of VDT issues as around the time the survey was done, VDTs and their effects had become a bargaining issue in these workplaces. However, even with many workers possessing these features on their VDTs, 51 per cent still reported glare from their VDT screens. About thirty per cent reported flickering characters on their VDT screens, most reported their characters to be of good sizes (92%) and about twenty-eight per cent reported glare from their VDT keyboards.

Among the four psychological stress problems emphasized by the Women's Bureau (i.e. stress, frustration, boredom, and irritability) again, many of the VDT design

problems were found to be significant in the bivariate analyses, as well as, the office lighting problems. Yet, in the multivariate analyses, none of these variables were found to be significantly related to the FAC1 dependent variable representative of workers' stress problems. These different results suggest that once the variables related to alienated work are controlled for, the VDT design characteristics tend to disappear. The affects of VDT design problems are through the performance of alienating labour. It is probable, that central to any attempts to reduce workers' visual, stress and musculoskeletal problems would require a reorganization of work, which allowed workers greater control over their work tasks and less repetitive, standardized and routinized tasks.

The differences in findings between the Women's Bureaus' bivariate analyses and the multivariate analyzes done for this thesis, on the same set of data, reveal the importance of doing multivariate analyses. Since almost all of the previous researchers have used bivariate techniques, this leads one to question their conclusions. These bivariate analyses could not reveal the relative importance of all contributing factors operating in the VDT work situation. It is difficult to understand therefore how these researchers can assert that the VDT design features are of prime importance to VDT workers and their health.

Even with measures of alienated labour which were deficient, close to forty per cent of these workers' visual, visually-related musculoskeletal and stress problems were explained in this thesis. This is quite a high proportion of variance explained since other factors, not included in the analyses, such as: radiation effects and factors external to the workplace, may also be contributing to their health problems.

It was never anticipated in this thesis that a 100 per cent of the variance would be explained since not all known contributory variables were included in the analyses. Chernomas (1982), in his analysis of health in capitalist societies suggested that there are numerous factors which can affect health, aside from work, inclusive of the food we ingest to the air we breath. Other lifestlye factors, related to social class and even marital status may play a role in an individual's health status. All the workers in this sample were women and if they had young children (married or single parents) this could have added different stressors (i.e. dual job syndrome).

Finally, it may actually be impossible to separate nonradiation health problems from radiation health problems. Although VDT radiation emissions have been deemed to be virtually nonexistent (e.g. Winnipeg Free Press, 1983), the research in this area seems, to the present author, to be inconclusive. The implications of even miniscule doses of

radiation, over long periods of time are still unknown. The incidence of miscarriages and other birth defects in recent years, among VDT workers and the strong recommendations often by provincial and federal governments that pregnant women should not use this type of equipment, makes any claims that radiation effects are not to be of concern sound rather shallow.

One woman in the Women's Bureau's survey stated that she had had a number of miscarriages after she started working on a VDT. It is probable that before the press seized on this issue, many women experiencing miscarriages did not think to relate them to their work. Now that the issue of radiation has been downplayed by a recent federal government study (e.g. Winnipeg Free Press, 1983), it is hopeful that it doesn't become a nonissue and that years from now we won't be confronted with many ill office workers, suffering from the accumulated radiation effects of VDT usage.

The results of the analyses done for this thesis cast serious doubts as to the present ergonomic solutions proposed to reduce VDT workers' health problems. Too much emphasis has been placed on the VDT design characteristics and the patchwork solutions (e.g. hoods on screen, antiglare screens, etc.). Notably, it is not here suggested that these are unimportant but, to concentrate on these factors is to ignore or to avoid the central issue: the performance of alienated labour.

Further attempts at multivariate research will be required in the future if the VDT work situation is ever going to be clarified. Reliable and valid measures of alienated labour will have to be developed. Medical doctors, who specialize in occupational health, could be consulted to help construct better health scales. Factors external to the workplace could be included in future surveys such that the relative impact of work can be assessed.

Appendix A

WOMEN'S BUREAU'S QUESTIONNAIRE

WOMEN'S BUREAU - STUDY OF WOMEN OFFICE WORKERS

INSTRUCTIONS:

Section I is to be answered by everyone who fills in this questionnaire.

Section II is to be answered only by those women workers who presently operate a video display terminal (VDT or CRT) or a word processor in their present occupations. We are referring specifically to equipment which has television-like screens.

Place the correct number of your response in the box provided with each question.

Example:

What is your current marital status?

1. Single
2. Married
3. Divorced
4. Separated
5. Common-law
6. Widowed

[1]

If you are single, for example, you would place the number "1" in the box to the right of this question.

Note: you are not required to answer this question, it is only an example.

In some questions, we have provided extra space in which you may comment further if you so wish.

SECTION I: Job-Related Information

1. In recent years, in our society, the integration of computer technology has been rapid and widespread, affecting many areas of our lives. Generally, your response to this computerization of our society is:

   1. Very Positive
   2. Positive
   3. Neutral
   4. Negative
   5. Very Negative

   [ ] 6

   Please explain your response: _____

   _____

   _____

   _____

2. Approximately how long have you held your present position in the organization for which you are now employed?

   1. less than 3 months
   2. 3 months to 6 months
   3. over 6 months to 1 year
   4. over 1 year to 2 years
   5. over 2 years to 3 years
   6. over 3 years

   [ ] 7

3. Approximately how long have you worked for the organization for which you are now employed?

   1. same response as to question number 2
   2. less than 3 months
   3. 3 months to 6 months
   4. over 6 months to 1 year
   5. over 1 year to 2 years
   6. over 2 years to 3 years
   7. over 3 years

   [ ] 8

4. How many hours on an average day do you work? (i.e. 7¼ hours is equal to 7.25 hours)

   [.] 12

5. How many days a week do you work?

   [ ] 13

6. What percent of your average day are you actually involved in the operation of the following office equipment? (Estimate the percentage of time where applicable and place your response or responses in the boxes provided).

   Place a "0" (zero) in the box provided if you do not operate the indicated equipment.

Example:

If you estimate that ten percent of your average work day is spent operating an electronic mail terminal, then you would indicate 10% in the box provided:

electronic mail terminal → [1 0]

****

manual typewriter	[ ] [ ] [ ]	16
electric typewriter	[ ] [ ] [ ]	19
electronic typewriter	[ ] [ ] [ ]	22
video display terminal and/or word processor (with television-like screen)	[ ] [ ] [ ]	25
electronic mail terminal	[ ] [ ] [ ]	28
telex machine	[ ] [ ] [ ]	31
photocopier or telecopier	[ ] [ ] [ ]	34
keypunch	[ ] [ ] [ ]	37
magnetic card	[ ] [ ] [ ]	40
printers (various types)	[ ] [ ] [ ]	43
microfiche reader	[ ] [ ] [ ]	46
dictaphone	[ ] [ ] [ ]	49
calculator/adding machine	[ ] [ ] [ ]	52
other, specify: _____	[ ] [ ] [ ]	55

_____

7. Estimate the total percent of your average day which you spend performing other duties (non-equipment related tasks, i.e. file; answer the telephone; shorthand/dictation; read and direct in-coming mail; etc.) [ ] [ ] [ ] 58

Note: Questions 6 and 7 should total to one hundred percent.

The following lists characteristics of your present work environment. Please place the correct responses in the boxes provided with each question.

8. The light in your office is:

   1. too bright 2. sufficient 3. not bright enough [ ] 59

9. The source of most of the light in your office is from:

   1. windows 2. light fixtures 3. both [ ] 60

10. The type of lighting fixtures in your office:

    1. fluorescent 2. incandescent (light bulbs) 3. both 4. don't know [ ] 61

11. The temperature in your office is usually:

1. adequate 2. too hot 3. too cold
4. sometimes too hot/sometimes too cold

62

12. The air in your office is usually:

1. fresh (good circulation) 2. adequate 3. stuffy

63

13. The noise level in your office is usually:

1. too quiet 2. tolerable noise levels 3. too noisy

64

14. Your office chair is:

1. comfortable 2. adequate 3. not comfortable

65

15. Could you adjust the height of your chair if you so wished?

1. Yes 2. No 3. don't know

66

16. Is the space at your workstation?

1. more than adequate 2. adequate 3. inadequate

67

17. Is the privacy at your desk:

1. more than adequate 2. adequate 3. inadequate

68

18. Is your opportunity to move around the office:

1. more than adequate 2. adequate 3. inadequate

69

19. Is your working relationship with your supervisor:

1. very good 2. good 3. adequate
4. poor 5. very poor

70

20. How often do you experience any of the following work-related problems in your present job?

	Every day	Often during A week	Occasionally During A month	Never	
feeling of isolation	1	2	3	4	71
boredom	1	2	3	4	72
fatigue	1	2	3	4	73
stress	1	2	3	4	74
frustration	1	2	3	4	75
conflict	1	2	3	4	76
fear	1	2	3	4	77
anxiety	1	2	3	4	78
depression	1	2	3	4	79
irritability	1	2	3	4	80
					2
nervousness	1	2	3	4	6

21. Since you started your present position, have you begun to experience any of the following work-related problems?

	Every Day	Often During a week	Occasion-aally during a month	Never	
headaches	1	2	3	4	☐ 7
eyestrain	1	2	3	4	☐ 8
burning eyes	1	2	3	4	☐ 9
blurred vision	1	2	3	4	☐ 10
loss of appetite	1	2	3	4	☐ 11
increased appetite	1	2	3	4	☐ 12
skin rash	1	2	3	4	☐ 13
insomnia	1	2	3	4	☐ 14
backaches	1	2	3	4	☐ 15
stiff/sore neck & shoulders	1	2	3	4	☐ 16
hand cramps	1	2	3	4	☐ 17
stiff/sore wrists	1	2	3	4	☐ 18
swelling of feet	1	2	3	4	☐ 19
increased smoking of cigarettes	1	2	3	4	☐ 20

22. In your present job, how would you rate your opportunities for:

	Very Good	Good	Adequate	Poor	Very Poor	
creativity	1	2	3	4	5	☐ 21
independence to make decisions on the job	1	2	3	4	5	☐ 22
promotion or advancement	1	2	3	4	5	☐ 23
acquiring new skills	1	2	3	4	5	☐ 24
challenging work assignments	1	2	3	4	5	☐ 25

23. What advantages or benefits do you find in your present job?

_____

_____

24. Are you presently in a supervisory position?

1. Yes 2. No ☐ 26

25. Overall, what is your general level of satisfaction with your present job?

1. Very satisfied 3. Neutral 5. Very dissatisfied
2. Satisfied 4. Dissatisfied ☐ 27

26. What is your present age in years? [ ][ ] 29

27. What is your approximate salary per month, before deductions? (gross salary) $[ ][ ][ ][ ] 33

28. If you do not presently operate a video display terminal or a word processor, would you be willing to learn? [ ] 34

1. Yes 2. No 3. Not applicable

If yes, under what conditions would you be willing to learn?

_____

_____

Section II is to be answered only by those women workers who operate video display terminals or word processors in their present jobs. If you do not presently operate these types of equipment, you have now completed the part of this questionnaire relevant to you. Thank you for your co-operation.

If you do operate a video-display terminal or word processor please continue on to Section II. We are specifically referring to video display terminals or word processors which have television-like screens.

SECTION II: Working with Video Display Terminals or Word Processors.

PART A

1. Where did you receive your training to operate a video display terminal or word processor and how long was this training? In the box provided indicate how long your training was in days (approximately) at that particular place.

	Length of Formal Training (days)
High school business course	[ ][ ][ ] 37
Vendor training (seller of equipment, for example: I.B.M. Xerox, etc)	[ ][ ][ ] 40
On-the-job-training (Supervisor, co-worker, etc (This is an accumulated total within the various organizations you may have worked)	[ ][ ][ ] 43
Success/Angus Business College	[ ][ ][ ] 46
Red River Community College	[ ][ ][ ] 49
Falcon Word Processing	[ ][ ][ ] 52
Herzing Institute	[ ][ ][ ] 55
Word-Pro Services	[ ][ ][ ] 58
Other, Specify _____	[ ][ ][ ] 61

_____

_____

2. At any point in your training, were any of the following issues brought up by your instructor/s?

   Correct posture when sitting behind a video display terminal? (i.e. the positioning of hands and feet, etc.)

   1. Yes 2. No ☐ 62

   The correct sitting distance from the screen?

   1. Yes 2. No ☐ 63

   How to adjust your workstation to best suit your own individual needs?

   1. Yes 2. No ☐ 64

   How to avoid, if possible, straining or tiring your eyes?

   1. Yes 2. No ☐ 65

3. Are there any other comments you have about your training?

   _____

   _____

   _____

PART B

1. Can you separate the keyboard of your video display terminal or word processor from its screen?

   1. Yes 2. No 3. Don't Know ☐ 66

2. Is there a reflected (direct or indirect) glare from your keyboard keys?

   1. Yes 2. No 3. Haven't noticed one ☐ 67

3. Is there a reflected (direct or indirect) glare from your screen?

   1. Yes 2. No 3. Haven't noticed one ☐ 68

4. Can you adjust the tilt or angle of your screen if you want to?

   1. Yes 2. No 3. Don't know ☐ 69

5. Do you have a hood or a similar device on your screen to eliminate possible glare?

   1. Yes 2. No ☐ 70

6. Do you have a special anti-glare screen on your video display terminal or word processor?

   1. Yes 2. No 3. Don't Know ☐ 71

7. Can you adjust the brightness on your screen?

   1. Yes, adequate adjustment
   2. Yes, but inadequate
   3. No
   4. Don't know

   72

8. Can you adjust the contrast on your screen?

   1. Yes, adequate adjustment
   2. Yes, but inadequate
   3. No
   4. Don't know

   73

9. Do you notice a flickering of characters on your screen?

   1. Yes
   2. No
   3. Haven't noticed this

   74

10. The size of the characters on your screen are:

    1. Too large
    2. Good size
    3. Too small

    75

11. Do you have a copy or document holder to hold your hard copy while typing?

    1. Yes
    2. No

    76

12. Is your copy or document holder adjustable?

    1. Yes
    2. No

    77

13. Do you have a footrest available to you if you need one?

    1. Yes
    2. No

    78

14. If you are working at your video display terminal or word processor for extended periods of time, how often do you take a formal break aside from your lunch break?

    1. five to fifteen minutes after one hour
    2. five to fifteen minutes after two hours
    3. twenty to thirty minutes after two hours
    4. no special breaks aside from morning and afternoon coffee breaks
    5. Other, specify _____

    _____

    79

    80

PART C

3

1. Did you have an eye examination prior to starting work on a video display terminal or word processor in your present job?

   1. Yes
   2. No

   6

2. Was the eye examination required by your present employer?

   1. Yes
   2. No
   3. Not Applicable

   7

3. Are you required by your employer to have regular (i.e. annual) eye examinations?

   1. Yes
   2. No

   8

4. Who pays for your regular eye examinations?

   1. Manitoba Health Services Commission
   2. Manitoba Health Services Commission and yourself (extra billing)
   3. Manitoba Health Services Commission and employer
   4. Manitoba Health Services Commission, yourself and employer
   5. Not applicable

   9

5. Do you now wear any form of eye glasses or contact lenses at work?

   1. Yes 2. No [ ] 10

   Since you have started working with video display terminals or word processors in your present job, have you had to replace or get new prescription eye glasses or contact lenses?

   1. Yes 2. No 3. Not applicable [ ] 11

   If yes, who paid for your new eye glasses or contact lenses?

   1. Yourself 2. Employer 3. Not applicable [ ] 12

6. Are the issues involving your eyes and general health negotiated with your employer by your union?

   1. Yes 2. No 3. Don't know

   4. Not applicable [ ] 13

7. Are there any immediate health concerns you may have in working with video display terminals or word processors?

   1. Yes 2. No 3. Never thought about it [ ] 14

   If yes, what are they? _____ [ ] 15

   _____

8. Do you anticipate any health problems in the future due to using the equipment?

   1. Yes 2. No 3. Never thought about it [ ] 16

   If yes, what are they? _____ [ ] 17

   _____

9. Would you consider working with a video display terminal or word processor during pregnancy?

   1. Yes 2. No 3. Don't know [ ] 18

10. Does your employer provide you with the option to transfer to another department where video display terminals or word processors are not used if you do become pregnant?

    1. Yes 2. No 3. Don't know [ ] 19

11. If you were to encounter any problems in your job related to your work environment, who would you report to?

    1. Employer/Supervisor 2. Union

    3. Workplace, Health & Safety 4. Don't know [ ] 20

PART D

1. Do you find there are advantages to using a video display terminal or word processor over other types of keyboards?

   1. Yes 2. No 3. No opinion [ ] 21

2. Is the quality of your work (i.e. number of errors, etc.) monitored by your employer?

   1. Yes 2. No 3. Don't know [ ] 22

If yes, does this bother you?

1. Yes 2. No 3. Don't know
4. Not applicable

23

Please comment further: _____

_____

_____

3. Is the quantity of your work or your productivity monitored by your employer?

1. Yes 2. No 3. Don't know

24

If yes, does this bother you?

1. Yes 2. No 3. Don't know
4. Not applicable

25

Please comment further: _____

_____

_____

4. Does your employer/supervisor, and/or users (agents) have realistic expectations as to completion times of work submitted to you?

1. Yes 2. No 3. No opinion

26

5. Do you see a need for <u>employer</u> education in the area of video display terminals and word processors to familiarize management with the capabilities of this technology?

1 Yes 2. No 3. No opinion

27

6. Are there any other aspects of working with video display terminals or word processors which you would care to comment upon?

_____

_____

_____

If, when you started working in your current job, video display terminals or word processors were already present, you have now finished this questionnaire.

Thank you for your co-operation.

<u>Part E</u> is to be answered only by those women <u>workers</u> who <u>were working</u> for their present employer when the video display terminals or word processors were actually introduced into the office.

<u>PART E</u>

1. Were you given advance notice by your employer as to the coming introduction of video display terminals or word processors into your office?

1. Yes 2. No

28

2. Were you asked by your employer for your opinion on the type of equipment to buy prior to the purchase of either video display terminals or word processors?

   1. Yes 2. No

   29

3. Did your employer or supervisor discuss with you the implications of this new equipment as related to your own job?

   1. Yes 2. No

   30

4. Did you find the initial change in your job due to the introduction of video display terminals or word processors:

   1. Very stressful 2. stressful 3. not stressful

   31

   Explain: _____

   _____

5. When you began utilizing a video display terminal or word processor did you receive a:

   1. promotion 2. demotion 3. no change in status

   32

6. Was there a change in your remuneration due to the acquisition of these new skills of operating a video display terminal or word processor?

   1. yes, a raise in salary
   2. no change in salary
   3. no, a reduction in salary

   33

   Are there any other comments you would like to make on topics raised above?

   _____

   _____

   _____

THANK-YOU FOR YOUR CO-OPERATION IN COMPLETING THIS QUESTIONNAIRE.

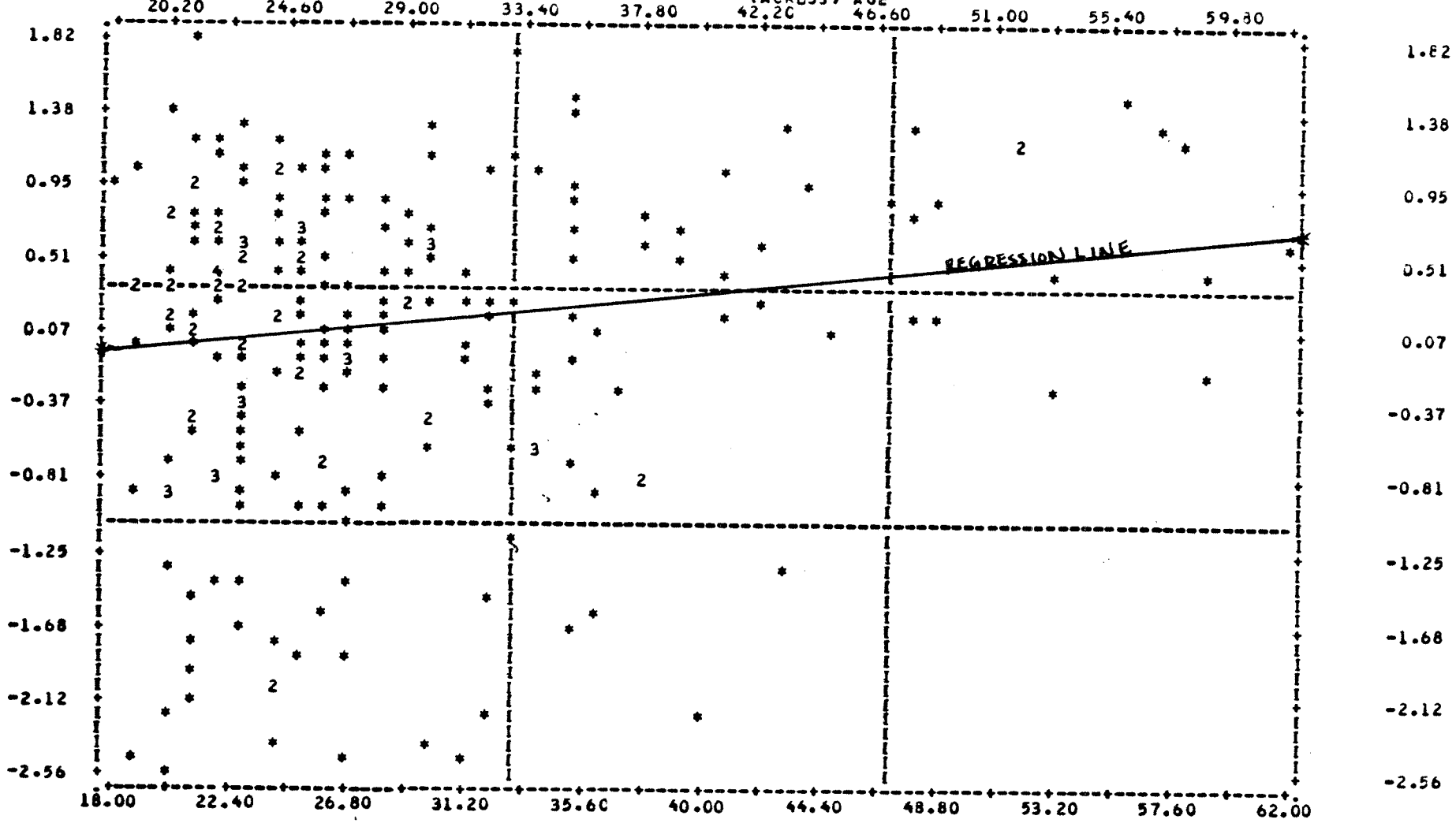
Appendix B

GRAPHS

STUDY OF WOMEN OFFICE WORKERS

GRAPH 1

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC1 (ACROSS) AGE



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 3

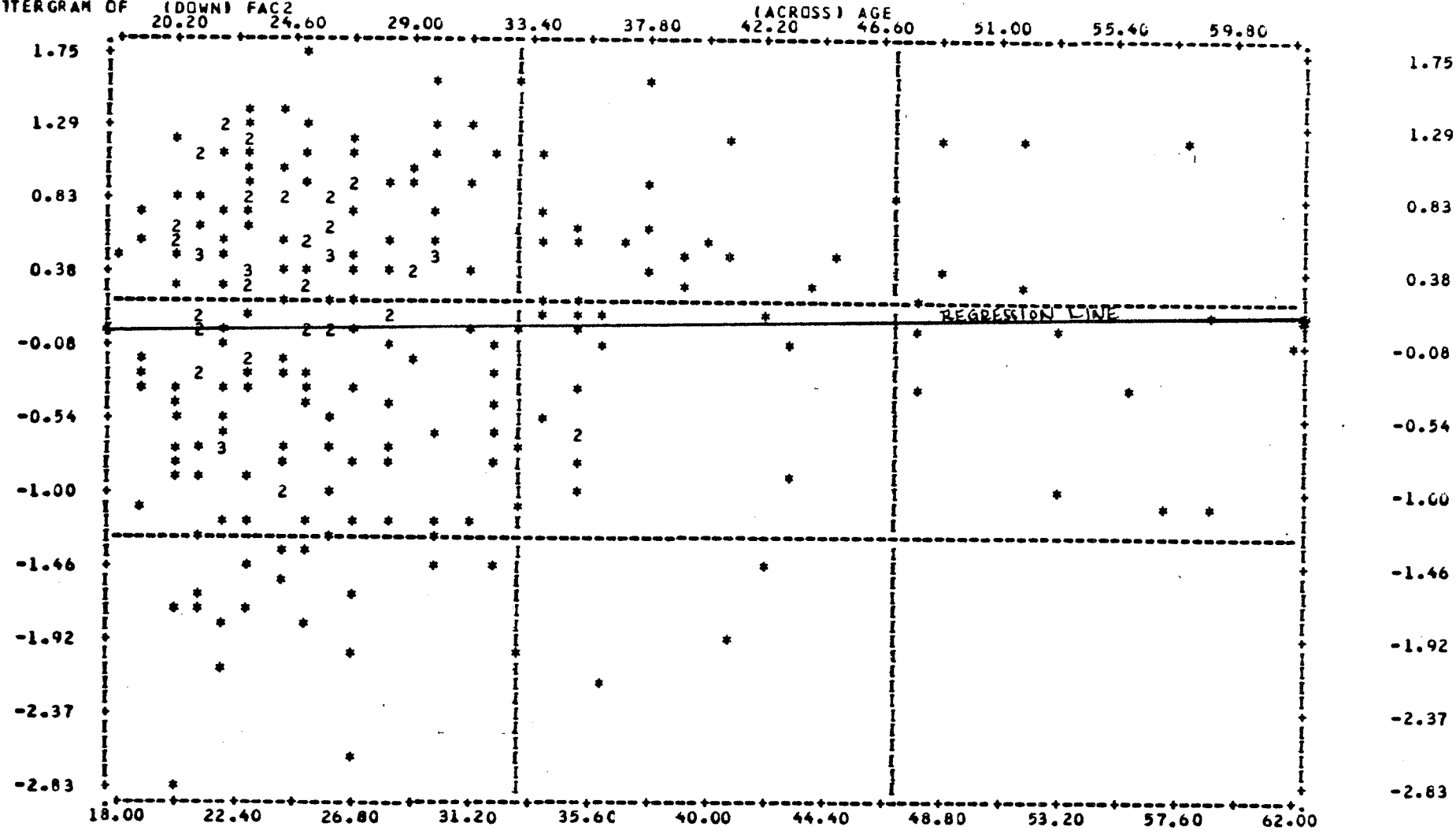
STATISTICS..

CORRELATION (R)-	0.18447	R SQUARED -	0.03403	SIGNIFICANCE -	0.00203
STD ERR OF EST -	0.92170	INTERCEPT (A) -	-0.55380	SLOPE (B) -	0.01961
PLOTTED VALUES -	241	EXCLUDED VALUES-	0	MISSING VALUES -	2

STUDY OF WOMEN OFFICE WORKERS

GRAPH 2

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC2 (ACROSS) AGE



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 11

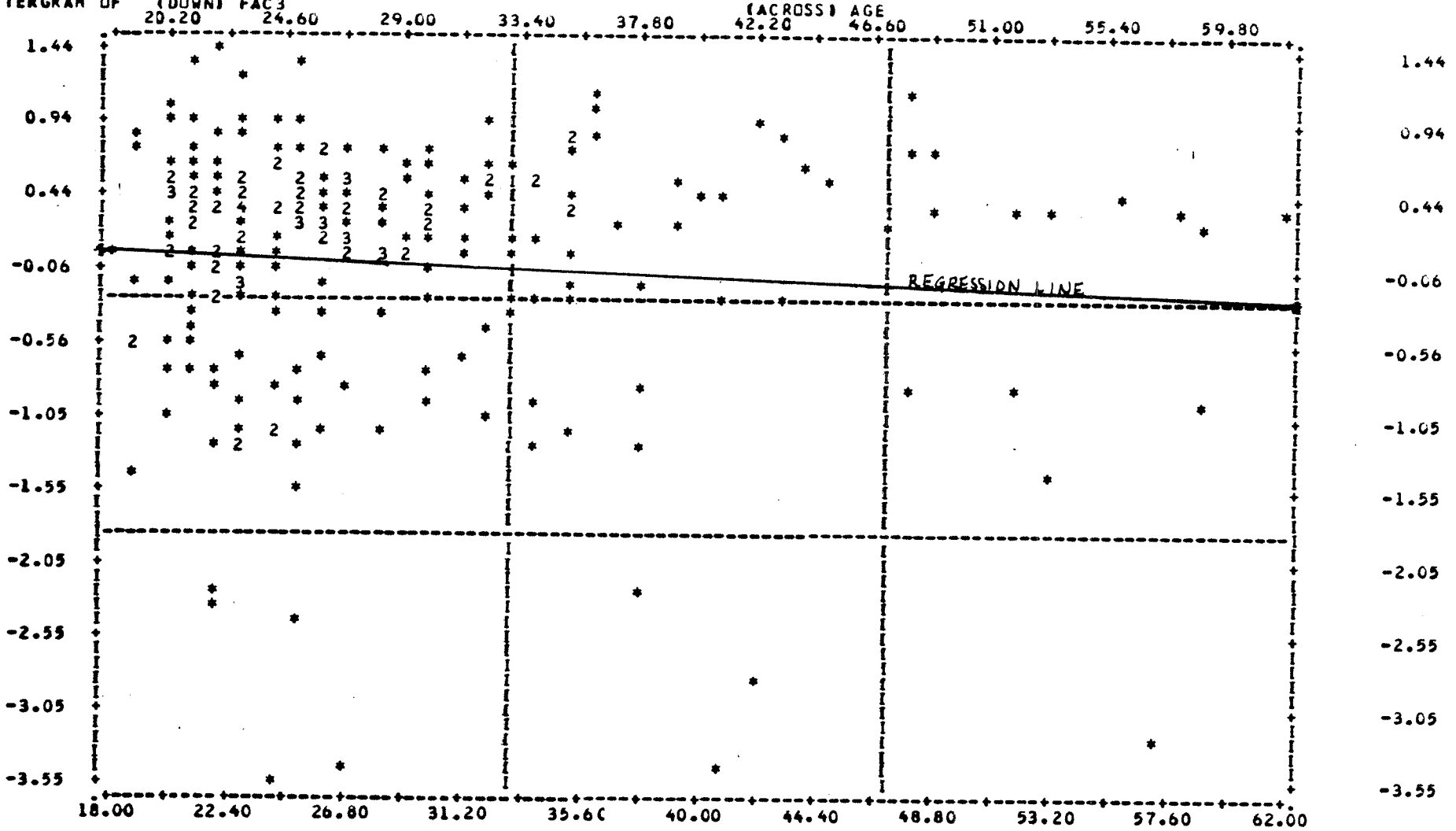
STATISTICS..

CORRELATION (R)-	0.02194	R SQUARED -	0.00048	SIGNIFICANCE -	0.36733
STD ERR OF EST -	0.89807	INTERCEPT (A) -	-0.06455	SLOPE (B) -	0.00223
PLOTTED VALUES -	241	EXCLUDED VALUES-	0	MISSING VALUES -	2

STUDY OF WOMEN OFFICE WORKERS

GRAPH 3

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC3 (ACROSS) AGE



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 19

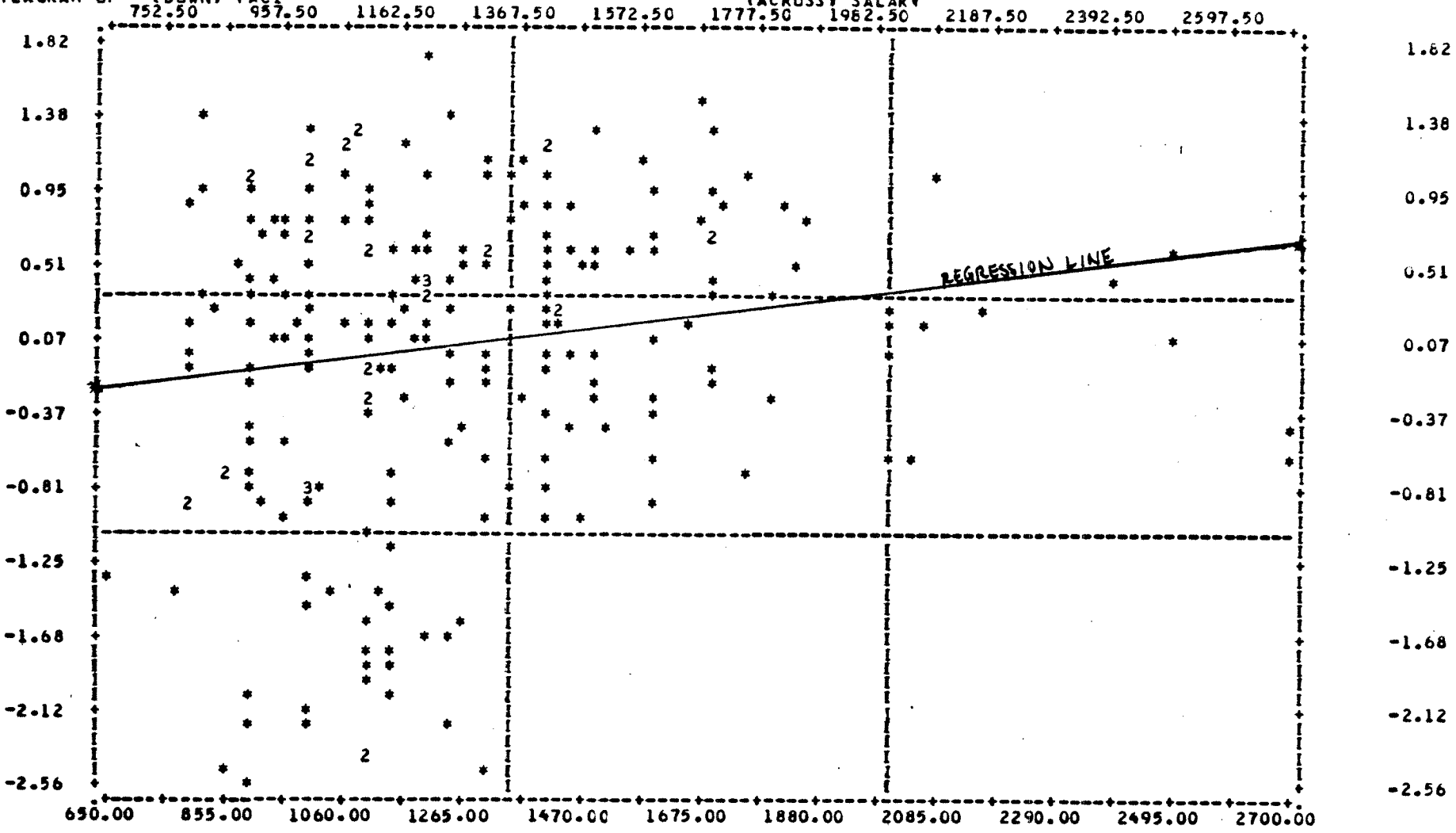
STATISTICS..

CORRELATION (R)-	-0.06145	R SQUARED -	0.00378	SIGNIFICANCE -	0.17110
STD ERR OF EST -	0.83257	INTERCEPT (A) -	0.17029	SLOPE (B) -	-0.00581
PLOTTED VALUES -	241	EXCLUDED VALUES-	0	MISSING VALUES -	2

GRAPH 4

STUDY OF WOMEN OFFICE WORKERS

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC1 (ACROSS) SALARY



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 5

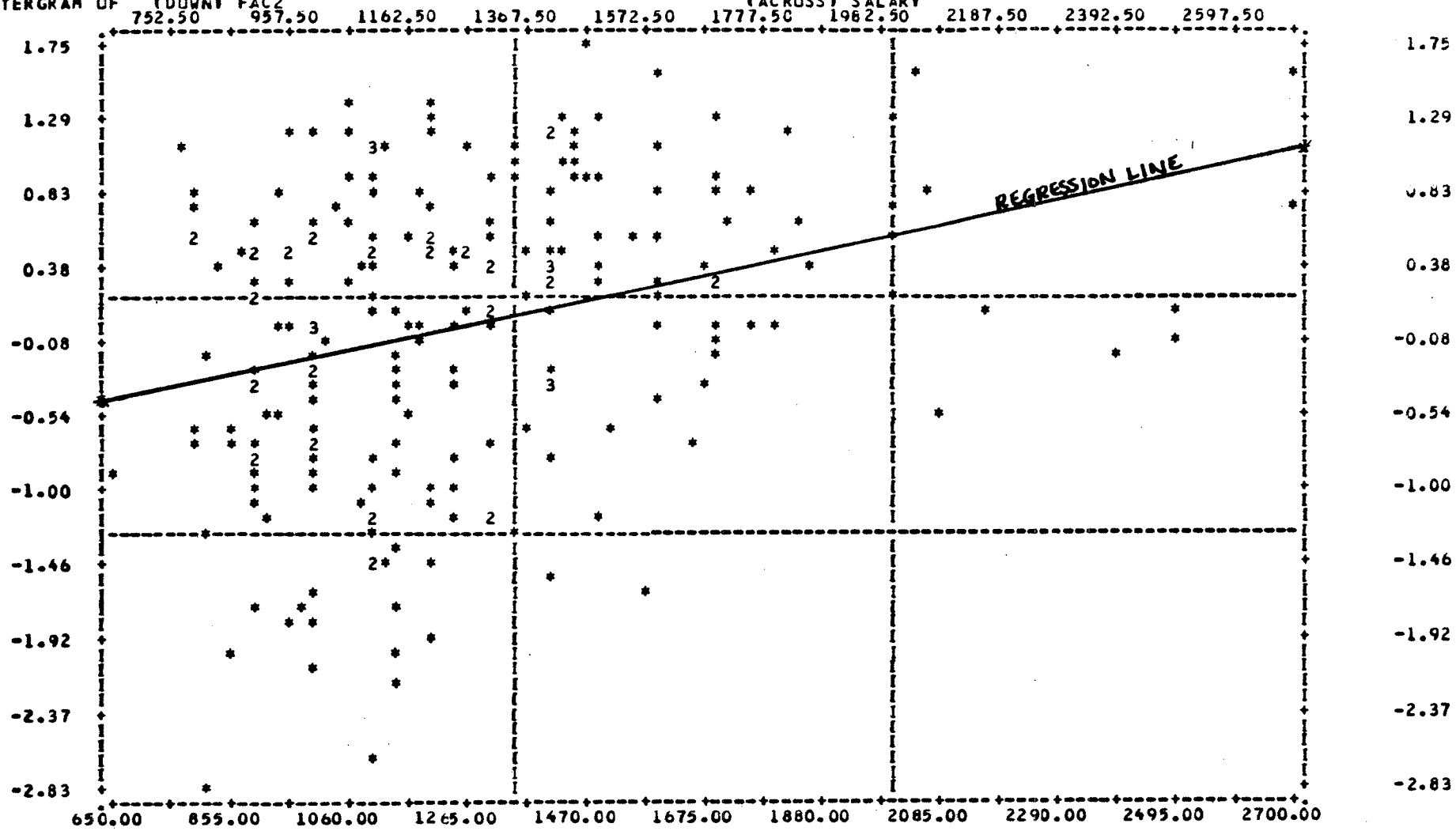
STATISTICS..

CORRELATION (R)=	0.16510	R SQUARED -	0.02726	SIGNIFICANCE -	0.00618
STD ERR OF EST -	0.91398	INTERCEPT (A) -	-0.54631	SLOPE (B) -	0.00043
PLOTTED VALUES -	229	EXCLUDED VALUES-	0	MISSING VALUES -	14

GRAPH 5

STUDY OF WOMEN OFFICE WORKERS

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC2 (ACROSS) SALARY



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 13

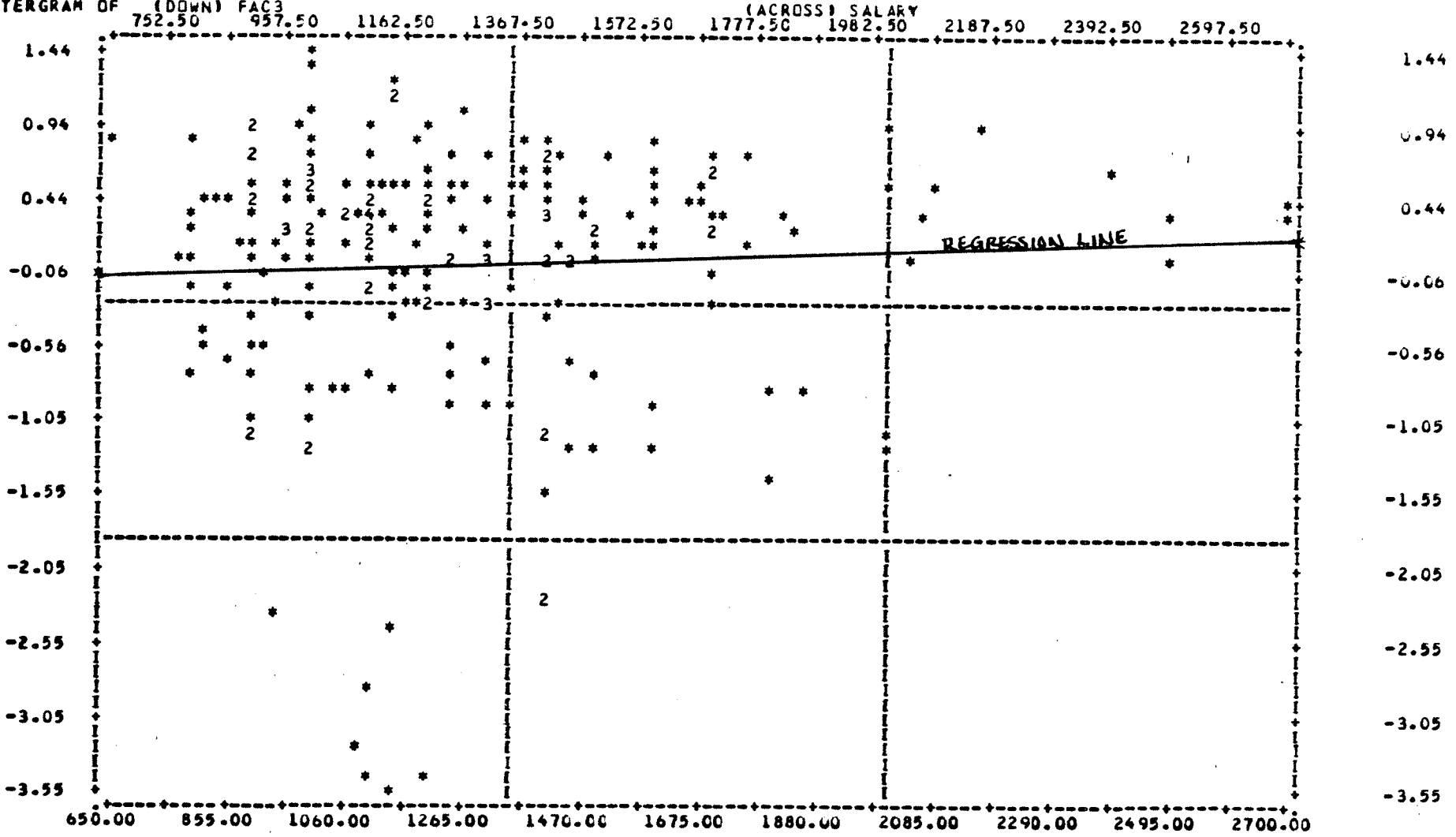
STATISTICS..

CORRELATION (R)-	0.30269	R SQUARED -	0.09162	SIGNIFICANCE -	0.00000
STD ERR OF EST -	0.86319	INTERCEPT (A) -	-0.96583	SLOPE (B) -	0.00076
PLOTTED VALUES -	229	EXCLUDED VALUES-	0	MISSING VALUES -	14

STUDY OF WOMEN OFFICE WORKERS

GRAPH 6

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC3 (ACROSS) SALARY



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 21

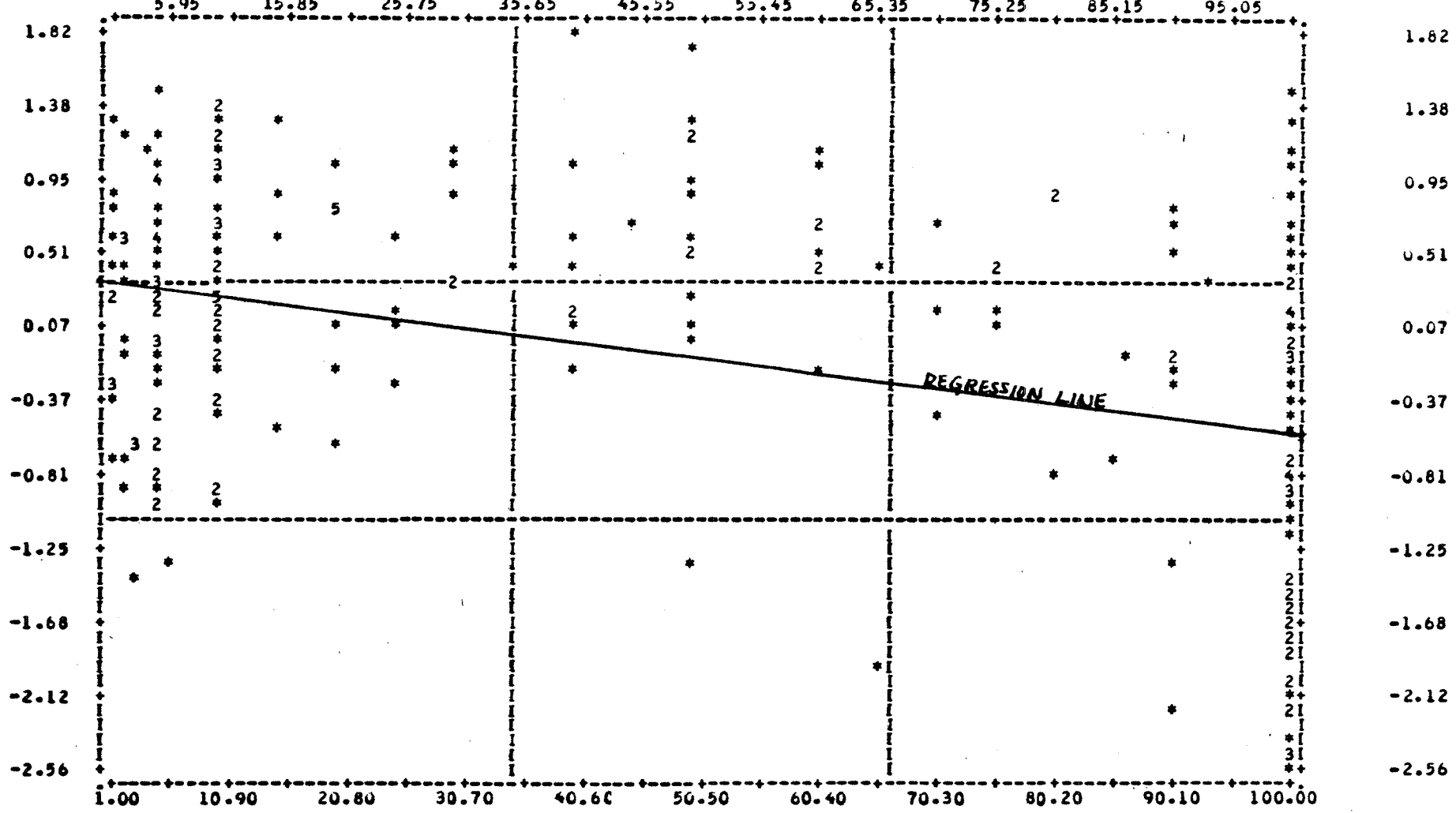
STATISTICS..

CORRELATION (R)-	0.04993	R SQUARED -	0.00249	SIGNIFICANCE -	0.22604
STD ERR OF EST -	0.83612	INTERCEPT (A) -	-0.13828	SLOPE (B) -	0.00012
PLOTTED VALUES -	229	EXCLUDED VALUES-	0	MISSING VALUES -	14

STUDY OF WOMEN OFFICE WORKERS

GRAPH 7

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC1 (ACROSS) VDTWP VDT OR WP



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 7

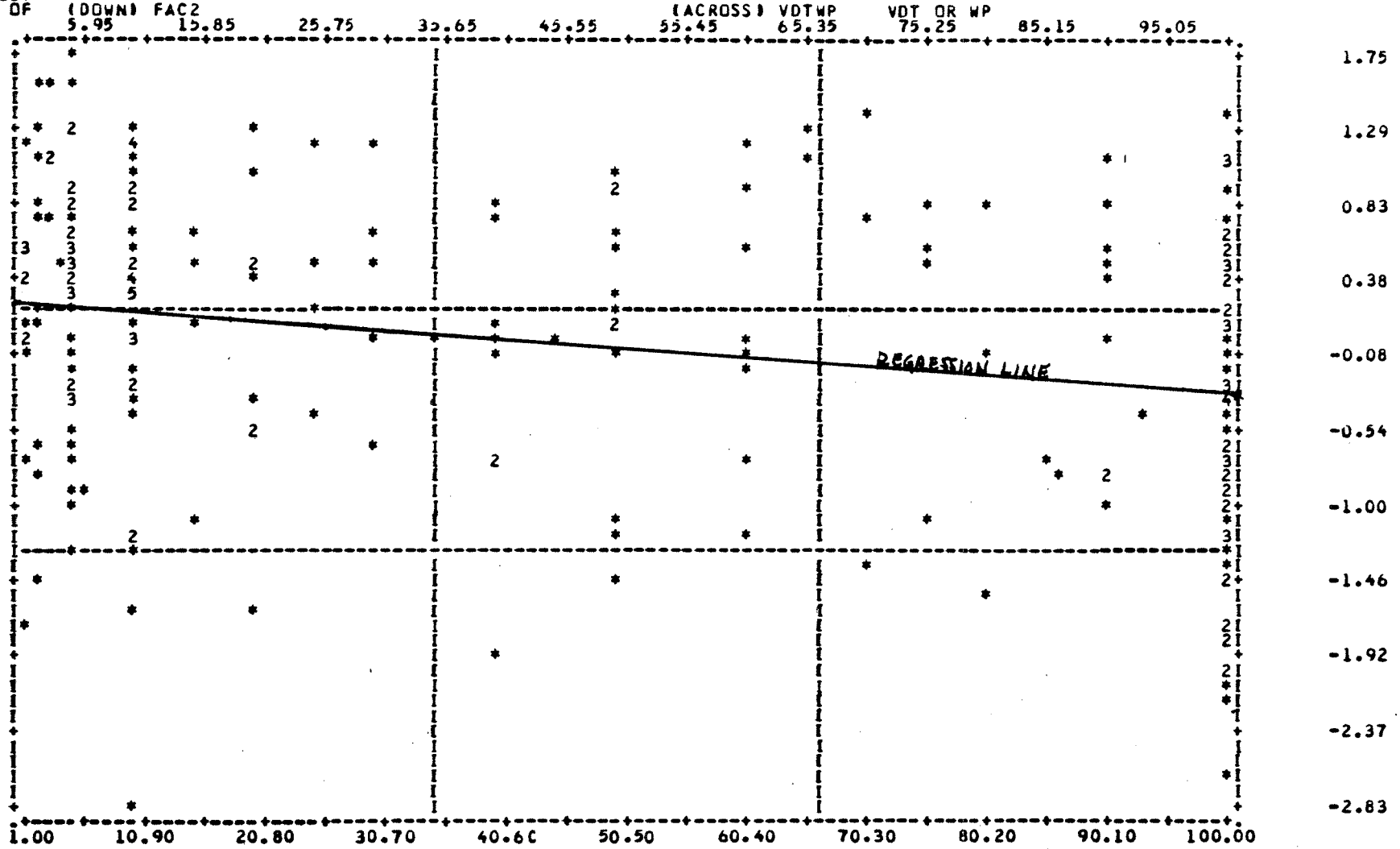
STATISTICS..

CORRELATION (R)-	-0.40001	R SQUARED -	0.16001	SIGNIFICANCE -	0.00000
STD ERR OF EST -	0.85256	INTERCEPT (A) -	0.41698	SLOPE (B) -	-0.00923
PLOTTED VALUES -	240	EXCLUDED VALUES-	0	MISSING VALUES -	3

GRAPH 8

STUDY OF WOMEN OFFICE WORKERS

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC2 (ACROSS) VDTWP VDT OR WP



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 15

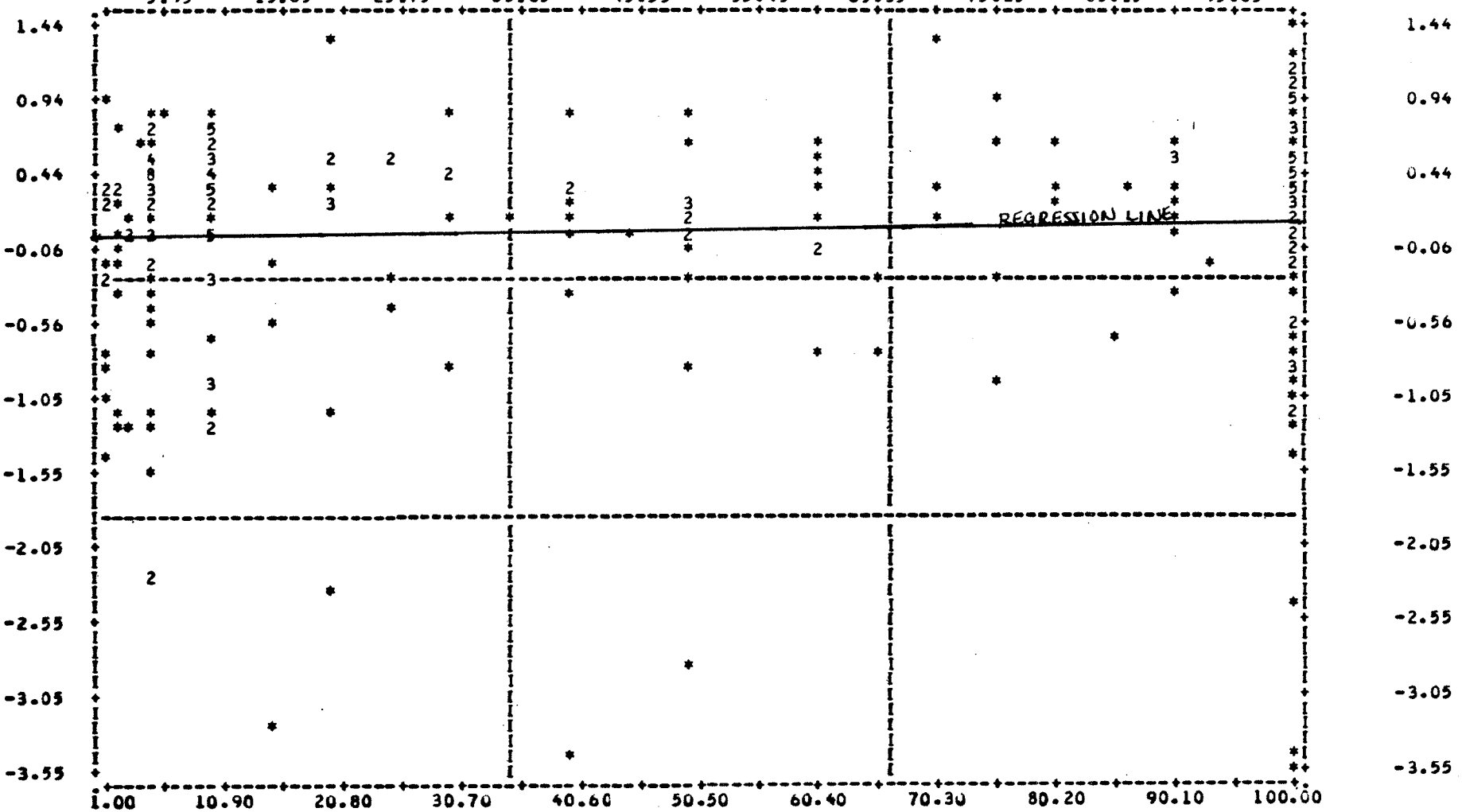
STATISTICS..

CORRELATION (R)-	-0.30018	R SQUARED -	0.09011	SIGNIFICANCE -	0.00000
STD ERR OF EST -	0.85615	INTERCEPT (A) -	0.29866	SLOPE (B) -	-0.00668
PLOTTED VALUES -	240	EXCLUDED VALUES-	0	MISSING VALUES -	3

GRAPH 9

STUDY OF WOMEN OFFICE WORKERS

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC3 (ACROSS) VDTWP VDT OR WP



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 23

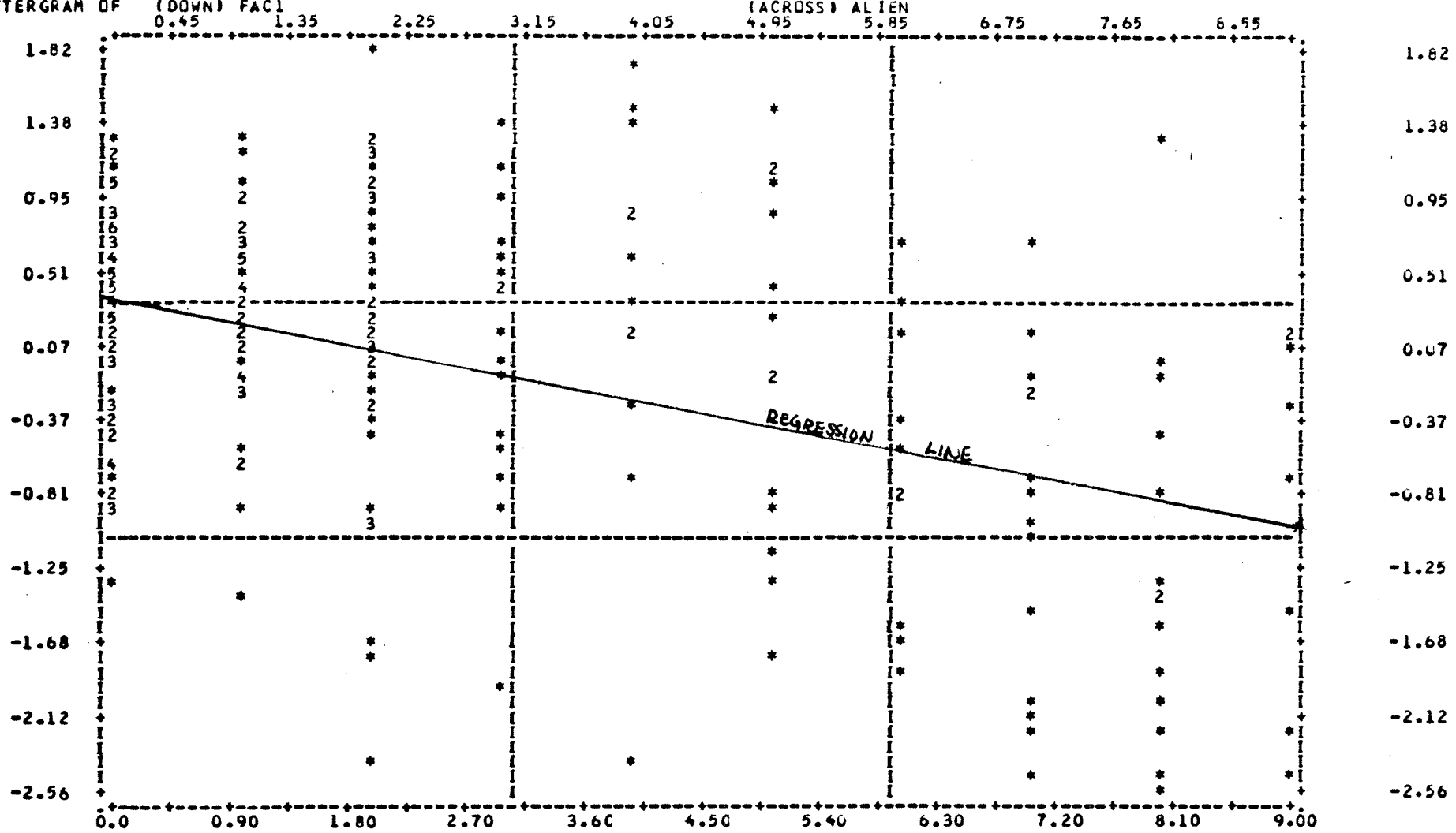
STATISTICS..

CORRELATION (R)-	0.04407	R SQUARED -	0.00194	SIGNIFICANCE -	0.24841
STD ERR OF EST -	0.83371	INTERCEPT (A) -	-0.03865	SLOPE (B) -	0.00091
PLOTTED VALUES -	240	EXCLUDED VALUES-	0	MISSING VALUES -	3

STUDY OF WOMEN OFFICE WORKERS

GRAPH 10

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC1 (ACROSS) ALIEN



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 9

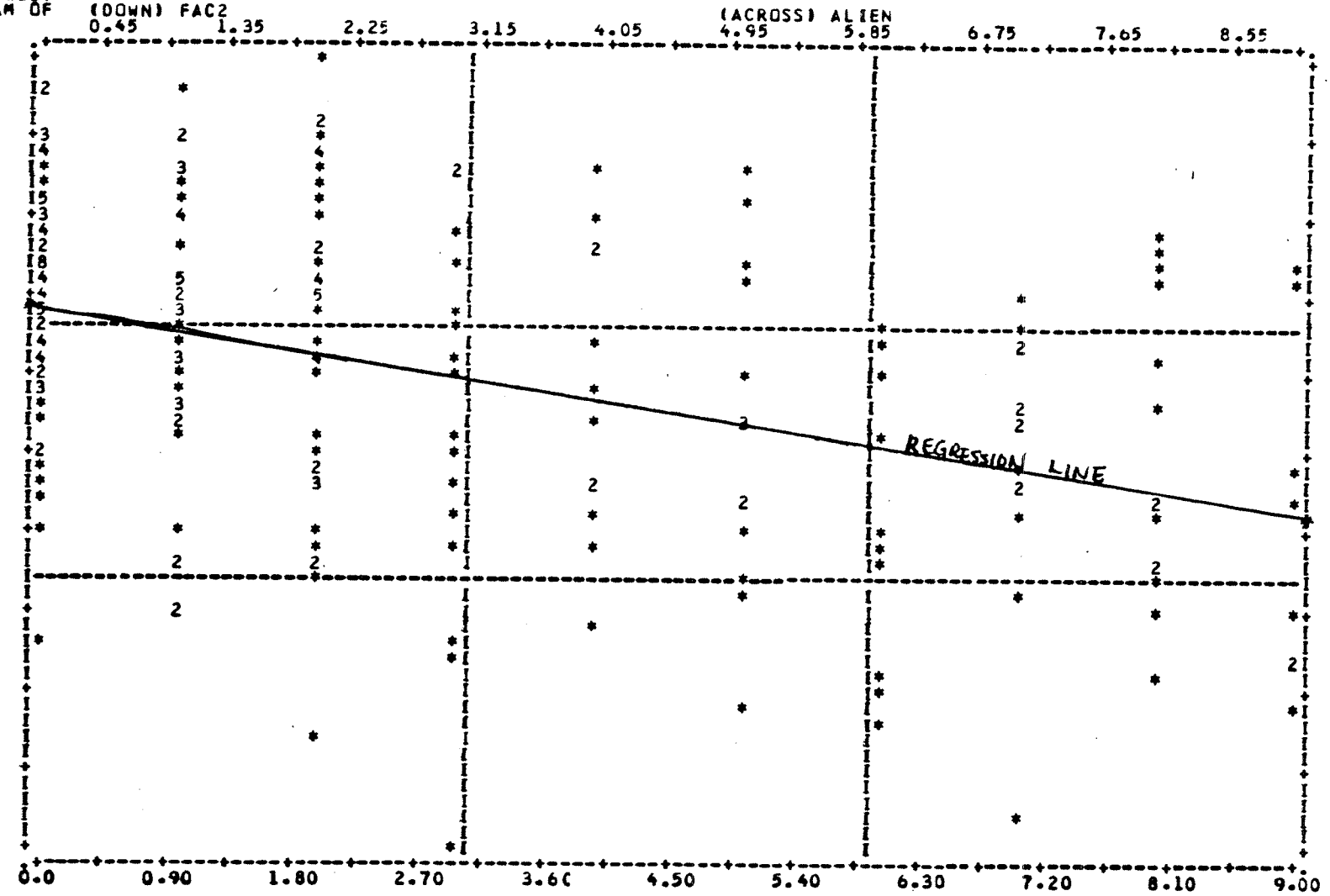
STATISTICS..

CORRELATION (R)-	-0.44928	R SQUARED -	0.20185	SIGNIFICANCE -	0.00000
STD ERR OF EST -	0.83805	INTERCEPT (A) -	0.40168	SLOPE (B) -	-0.15323
PLOTTED VALUES -	243	EXCLUDED VALUES-	0	MISSING VALUES -	0

STUDY OF WOMEN OFFICE WORKERS

GRAPH 11

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC2 (ACROSS) ALIEN



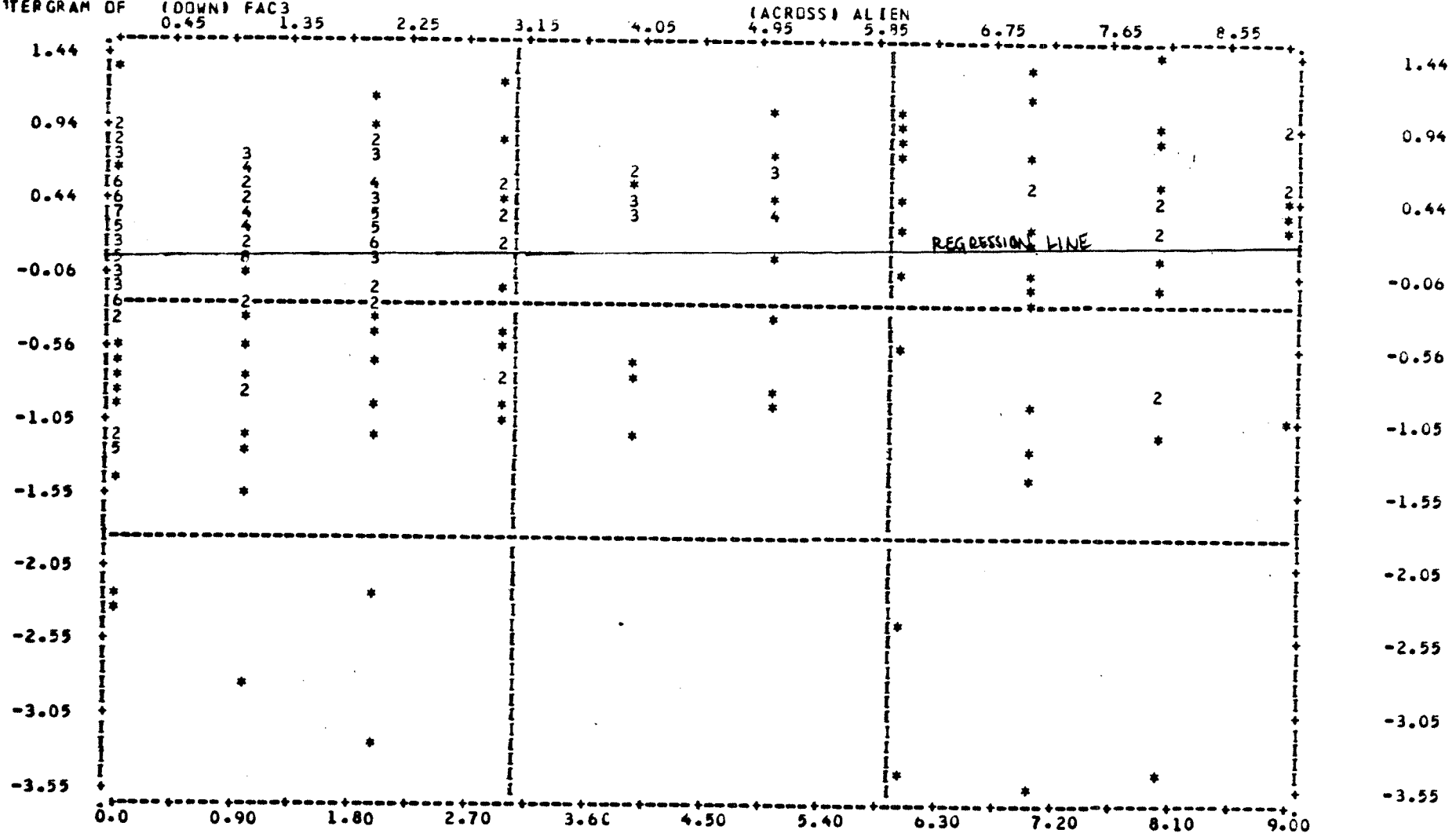
STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 17

STATISTICS..

CORRELATION (R)-	-0.43891	R SQUARED -	0.19265	SIGNIFICANCE -	0.00000
STD ERR OF EST -	0.80396	INTERCEPT (A) -	0.37429	SLOPE (B) -	-0.14278
PLOTTED VALUES -	243	EXCLUDED VALUES-	0	MISSING VALUES -	0

STUDY OF WOMEN OFFICE WORKERS

FILE WOST2 (CREATION DATE = 08/12/83)
SUBFILE WOST
SCATTERGRAM OF (DOWN) FAC3 (ACROSS) ALIEN



STUDY OF WOMEN OFFICE WORKERS 07/25/84 PAGE 25

STATISTICS..

CORRELATION (R)-	0.01501	R SQUARED -	0.00023	SIGNIFICANCE -	0.40796
STD ERR OF EST -	0.83449	INTERCEPT (A) -	-0.01194	SLOPE (B) -	0.00455
PLOTTED VALUES -	243	EXCLUDED VALUES-	0	MISSING VALUES -	0

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