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# A design for the management of industrial injury and worker impairment

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A Design for the Management

of Industrial Injury and Worker Impairment

by

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## ABSTRACT

Both medicine and management have made attempts to contain the costs of industrial injury. Medical approaches to the problem include a search for physical vulnerability through x-rays and medical tests of various kinds. Significant resources have been spent on the treatment of industrial injuries. Unfortunately, the increase in medical costs and frequency of treatment procedures do not produce significant reduction in overall costs due to days lost from work, wage replacement incomes, and medical bills. Industrial management has encouraged outpatient medical treatment, limited payment of medical bills by diagnosis or rewarded workers for keeping medical costs low.

Innovators in the treatment of soft tissue injuries have paved the way for a more direct and effective approach to the management of industrial injury. Trainers of professional athletes and studies of occupational biomechanics provide insights into effective treatment alternatives.

Crucial to the success of alternative approaches to the management of industrial injuries are quantifiable measures of physical capacity and strength demands of jobs. The author reviews these developments in recent years and establishes protocols for physical capacity evaluation (PCE) and ergonomic job analysis (EJA). Extrapolating from proven approaches to early treatment of soft tissue injuries, the author creates a rapid recovery protocol designed to effectively return an injured worker to maximum function expediently. A comprehensive design for the management of industrial injury and worker impairment is developed. The design includes pre-employment screening techniques for assignment of workers according to demonstrated strength and employee fitness and health education components, essential elements in prevention. Trauma management utilizes rapid recovery protocol, work hardening techniques, job injury profile, and job modifications to complete the rehabilitation efforts.

Psychological perspectives guide the implementation of the design and are inherent in each of the therapeutic interventions. The Millon Behavioral Health Inventory is used to objectify psychological attitudes of workers to determine appropriate management decisions. Implementation of the design at an electric utility illustrates its effectiveness.

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# Chapter 1

## INTRODUCTION

According to the National Institute of Handicapped Research (NIHR), every year in the United States 560,000 employees are injured while at work. Of those, half never return to gainful employment again. An additional quarter (140,000) continue to be dependent upon Worker's Compensation income for the next ten years. The combined cost of these injuries includes medical benefits, wage replacement incomes, and the cost of hiring replacement employees. The Menninger Rehabilitation Research and Training Center (Faimon, 1987) estimates that the present cost to the public and private sectors combined is well over $100 billion annually. This expense continues despite the fact that these injured workers are considered at some level to be employable. This is wasteful and an extreme cost to society not only economically, but in terms of wasted talent, unfulfilled lives, and needless loss of self-worth and productivity. The cost is so staggering that it is difficult to adequately conceive the magnitude of this problem. The seriousness, however, has more to do with the fact that this problem is growing rapidly everyday and is beginning to be of paramount importance to American industry.

Recent data indicates that overexertion is the leading cause of industrial injury today, leading all other types of injury both in numbers and cost (Bureau of Labor Statistics, 1980). The statistics also show that 68% of the overexertion incidents involve lifting. An estimated 28% of the United States industrial population will experience disabling low back pain at some time in their lives (Rowe, 1969), with 8% of the total working population being disabled during each year (Gyntelberg, 1974). Low back injuries account for one out of every five compensible injuries and are responsible for one third of all compensation costs according to Dr. Stover Snook of the Liberty Mutual Insurance Company (Snook, 1983). Musculosketetal injuries (usually to the low back) are less clear-cut and the extent of trauma is poorly defined.

Clinical evaluation and management of workers with musculoskeletal back pain is particularly difficult for several reasons. First, there seems to be a heavy reliance upon subjective reports without objective findings. Secondly, physical examination of the low back has been surprisingly unreliable (Nelson, et al., 1979). Finally, it has been difficult for clinicians to make specific recommendations as to physical capacity or allowable limits of exposure. While numerous contributing factors have been identified with substantial evidence, it seems misleading to select a single factor for the etiology of back pain.

Industries have been identified that have a high risk for back injuries. They are construction (1.6 claims per 100 workers per year), mining (1.5 claims per 100 workers per year), transportation (1.2 claims per 100 workers per year), and manufacturing (1.0 claims per 100 workers per year). Also, high risk occupations have been identified. They are general laborers (12.3 claims per 100 workers per year), garbage collectors (11.1 claims per 100 workers per year), warehousemen (9.3 claims per 100 workers per year), mechanics (5.6 claims per 100 workers per year), and nurse's aides (3.6 claims per 100 workers per year) (Klein, Jensen, & Sanderson, 1980). Finally, high risk activities have also been identified. They are lifting (associated with 49% of low back compensation), twisting (associated with 18% of low back compensation), bending (associated with 12% of low back compensation), and reaching (associated with high intradiscal pressures and bulky objects) (Snook, Campanelli, & Hart, 1978).

In the United States today the single most costly diagnosis is that of back pain. Ironically, the back injury which is so expensive and so common is also the most avoidable. Efforts to decrease the incidence of industrial injuries, however, have been poorly rewarded. Without an effective tool of pre-employment screening, many workers are assigned to positions that are physically more demanding than the workers are physically capable of performing.

Gulf Power Company (a local utility and a division of the Southern Company) is an industry experiencing many, if not all, of the above phenomena. The stimulation for this Project Demonstrating Excellence (PDE) is in response to a request from Gulf Power for assistance in managing their injured and otherwise impaired workers. Gulf Power has long had a policy that workers who are identified as incapable of performing their job responsibilities continue to receive full salary and benefits as long as they appear at the job site. Many times these workers are given odd jobs or other "light duty" tasks to perform, but frequently they sit on the sidelines "drinking coffee" or otherwise being unproductive.

With health care costs continuing to rise and profit margins continuing to shrink, the issue of injured and impaired workers becomes of increasing importance. As management seeks to increase efficiency, eliminate waste, and otherwise maximize production, line supervisors naturally begin to notice those workers that are less than maximally productive. Consequently, Gulf Power Company is seeking to revise their policy regarding injured and impaired workers. Although they wish to improve the economy of managing these workers, they also seek to continue an attitude of benevolence, equality, and fairness. It is within these parameters that a definitive, efficient, and effective design has been developed for the management of injury and workers.

In addition to the need for a management design, Gulf Power identified approximately 20 workers they wanted evaluated. These workers fell into two categories regarding the nature of their injuries. The first category was those suffering from work-related incidents and the second was those suffering from nonwork-related incidents. Both groups, however, have been identified by their managing physicians as incapable of continuing their job responsibilities from a physical standpoint.

From a psychological perspective the subspecialty behavioral medicine has been deeply involved in the treatment of industrial injury. Usually this has been in the form of teaching techniques for the prevention and management of physical injury, disease, or dysfunction. Psychologists work with groups and individuals in this effort and have contributed significantly to the understanding of how injuries affect the personality and subsequent coping skills. Additionally, psychologists have been involved in helping management make decisions about reducing stress at work, communicating effectively with employees and assigning workers to appropriate positions. Virtually every rehabilitation facility has psychologists on staff who consult with industry on issues related to prevention, health maintenance, and coping with injury.

The primary purpose of this study shall be to design a model for the prevention and management of industrial injury and impaired workers. The design will require the development of tools for measuring physical capacity of workers and strength demands of jobs. Along with these two basic tools a behavioral medicine perspective will provide a basis for the construction and implementation of the entire management system.

# Chapter 2

## THEORECTICAL PERSPECTIVES

### Causes of Injury

While overexertion has already been identified as the leading cause of injury in industry today, naming the problem behavior does little that leads to changing it. Related closely to the search for what causes injury, is the search for objective evidence. Recently, Frymoyer (1988) indicated that there are a number of findings that accompany industrial injuries to the back. These include, but are not exclusive to, degenerative spondylolisthesis, facet syndrome, disk disruption syndrome, segmental instability, idiopathic vertebral sclerosis, diffuse idiopathic skeletal hyperostosis, inflammatory spondyloarthropathy, fibrocytis, and fibromyalgia. However, many of these diagnostic findings occur in the population among many individuals who are asymptomatic. In studies with patients suffering industrial low back injuries, a structural diagnosis was found 50% of the time (Pope, Rosen, Wilder, & Frymoyer, 1980) or less (Nachemson, 1983). Fiorini and McCammond found "many damaged disks showing radiographic narrowing may not cause discogenic back pain at all if there is no disk herniation, but may cause facetogenic back pain by causing subluxation and malapposition of the interarticular joints" (Fiorini & McCammond, 1976, p. 354).

Consequently, so-called objective evidence is very difficult to use in any definitive manner, especially in the absence of comparative data. Most authorities now believe that low back pain is basically caused by changes in the spine as one gets older. It is thought that these changes lower the resistance of the spine to heavy workloads that merely trigger the occurrence or onset of low back symptoms (Rowe, 1983). Most important, the assigning of cause for low back pain cannot be based simply on the immediate circumstances at the time when pain first develops. Essentially, contemporary knowledge supports a "wear-and-tear" hypothesis of low back pain which requires that load handling activities be limited and carefully selected.

Appropriately the focus seems to be turning away from the narrow perspective of medical considerations to a broader scope that includes behavior, work style, job design, and psychological factors. The National Institute for Occupational Safety and Health (NIOSH) published in March 1981 a Work Practices Guide for Manual Lifting. This extensive document reviews significant studies that have attempted to understand and better manage industrial injuries. It examines the problem of industrial injury from six different approaches. They are: (a) Epidemiological Approach, (b) Biomechanical Approach, (c) Physiologial Approach, (d) Psychophysical Approach, (e) Administrative Controls, and (f) Engineering Controls. This reference shall be utilized extensively in the formulation of a design for the management of industrial injury and impaired workers since it summarizes the work of the leaders in this field.

## Attempted Solutions

In their attempts to find solutions, industrial management has attempted to deal with loss from a traditional industrial management point of view. A recent survey (Schechter, 1984) illustrates that major industry in the United States has undertaken efforts to address the problem of health care costs. Exxon Corporation has increased the deductible amount for any individual claim. Also, they have increased reimbursement for outpatient services, while decreasing reimbursement for inpatient services, thus encouraging employees to utilize less expensive health care systems.

They also have instituted a practice of reimbursing home health care.

Chrysler Corporation expected to spend $364 million in health insurance premiums for its 149,000 active and retired employees in 1984. That is $2,443 per employee. Following the Federal Government's example of diagnosis related groups (DRGs), Chrysler planned to enact preadmission screening and to limit reimbursement to the specific diagnosis, especially in terms of length of stay. They also planned to reward employees for identifying hospital overcharges, thereby raising the consciousness of the employees to the cost of health care. Chrysler expected a cost savings of $2 million, which amounts to only one half of 1% in terms of reduction.

Hewlett Packard spent $80 million for health care in 1983 for 52,000 employees. That is $1,538 per employee ($900 less than Chrysler). Like Exxon, they encourage outpatient treatment by offering 90% reimbursement for outpatient services, 80% reimbursement for inpatient services, and doubled the initial deductible amount. They went a step further in contracting with a "preferred provider" (a health care facility used exclusively and providing a special rate).

Long known as an innovator in employee relations, Quaker Oats set an allowance of $3,000 per employee in 1983, with a promise to reimburse the unused balance to employees. This per capita cost target allowed employees to become involved in the efforts to save money. As a result, at the end of that year each employee received $204 as a dividend derived from the unused portion of the allowance. Quaker Oats had expected their health care costs to rise 20% that year, but instead this effort reduced their expenses significantly and they experienced only a 5.6% increase.

This sampling of industry's efforts to reduce the financial outlay for health care does indicate how important containing costs is to industry, but is obviously an inadequate approach that only minimally affects overall costs.

## Rehabilitation

Once industrial injury occurs, it is to the advantage of industry, the injured employee, and society to rehabilitate the injured worker quickly, effectively, and efficiently to return him/her to work. While the above mentioned efforts at containing costs by industry can certainly save dollars, they do little to prevent injury or rehabilitate the injured employee.

Unfortunately, rehabilitation has taken on a connotation of treatment for catastrophic injury and illness with psychological, economic, and social overlay. While this impression of rehabilitation is true on an extreme end, rehabilitation also extends (if not begins) to the moment injury occurs. This is probably most clearly identified in the world of sports medicine. Large segments of the American population were exposed to the industrial management of injury regarding the National Football League in 1986. Joe Montana (quarterback for the San Francisco 49ers) suffered an injury related to his work that incapacitated him from his employment, resulted in surgery and an aggressive rehabilitation plan that returned him to his employment within a short period of time. Many marvelled at the "rapid recovery" and apparent physical viability of Joe Montana upon returning to his place of employment. Much can be learned from the field of sports medicine and rehabilitation and applied to the more common occurrence of industrial injury.

Rapid Recovery

Johnston and Blakney (1984, p. 19) indicate that "What's good for the athlete is good for the worker". Their observation is that "rapid and aggressive treatment of effusion and other physical responses to soft tissue injuries is very effective both in reducing the degree of injury and speeding the return of the athlete to the playing arena" (Johnston & Blakney, 1984, p. 19). They indicate that early and appropriate mobilization is the heart of this approach. They developed a "rapid response treatment phase" to an overall industrial management of injury. This innovative approach emphasizes a multidisciplinary team approach, rapid admission processing, and other expedient measures to ensure that the rapid response treatment is, indeed, rapid.

Numerous medical researchers have supported the idea of early aggressive intervention (Frymoyer, 1988; Nachemson, 1983; Morris & Randolph, 1984; Snook & Jensen, 1984). This intervention includes physical activity soon after injury as an important part of pain control and the development of confidence and mastery over symptoms (Nachemson, 1983). Rest and restricted activity is considered to be important only in the first days following acute injury. Beyond this period, however, inactivity begins to be detrimental. It leads to a loss of tissue flexibility and decreased muscular competence (Mayer, 1983). It has also been shown that stretching of bruised or torn soft tissues promotes an orderly alignment of collagen fibers, allowing for more rapid healing and improved flexibility of the healed tissue (Morris & Randolph, 1984; & Saal, 1987).

Crucial to the success of a rapid recovery program is structured and early intervention. While between 3% and 4% of these patients will ultimately require surgery (Mayer, 1983), the majority will be instructed to go home with a prescription to "take it easy for a few days." If the employees symptoms improve and they return to work, 50% of these employees will have a recurrence of symptoms (Nachemson, 1983). Since the need for surgical intervention can usually be determined quickly (Saal, 1987), and only a small number of these injuries improve as a result of surgical intervention, rapid recovery seems to be an appropriate alternative.

Work Hardening

Except in the field of sports medicine, rapid recovery approaches have not been implemented in industry. The closest approximation of this approach has been the implementation of "work hardening" programs that have cropped up throughout the United States in the last few years. One of the earlier and more prominent professionals to discuss work hardening is Leonard Matheson, in his book, Work Capacity Evaluation: An Interdisciplinary Approach to Industrial Rehabilitation,

1984. Matheson writes that through work hardening the injured worker is gradually conditioned to work through his involvement with work simulation tasks. There is obviously a psychological, as well as physiological, benefit from this simulation. Modifications can be made to both tools and techniques as the simulation proceeds. Matheson defines work hardening as

> a highly structured, productivity oriented treatment program that uses work simulation tasks to (1) decrease secondary impairment effects, (2) decrease functional limitations, (3) decrease disability, (4) improve vocational feasability, (5) improve employability, and (6) decrease vocational handicap (Matheson, 1984, p. 63-64).

Work hardening is a systematic program of gradually progressive work related activities performed with proper body mechanics. This activity reconditions the individual's musculoskeletal, cardiorespiratory, and psychomotor systems preparing that person for return to work. Work hardening is usually done in conjunction with work capacity and/or physical capacity evaluation and utilizes the same assessment devices and techniques as primary treatment tools. Clients are evaluated by utilizing standardized weights and containers to be lifted, carried, and maneuvered through a full range of physical function. Work habits, as well as postures, can be observed to identify areas of vulnerabilty to injury. Repetitions of a particular simulated work activity can indicate endurance and concentration factors, as well as deficits in function or strength.

The values obtained through testing can be used to determine a particular individual's capacity as defined by the U.S. Department of Labor (1972). After initial evaluation is completed, the therapist can structure supervised simulated work activities within the client's ability. During the work hardening phase, clients learn ergonomically proper work techniques, adaptive behaviors, safe work limits, pacing, and self-confidence. With constant supervision and verbal feedback regarding performance, clients develop healthy and productive habits that carry over to actual return to work. Upon reaching the work level required by available employment or upon reaching a plateau of performance, clients can be released to return to work. The release and any accompanying limitations are then based on actual performance that has been clinically documented over several days, as opposed to a subjectively projected expectation of ability. This method of quantification of disability and physical limitations is quite conducive to resolution of compensation cases and provides an objective basis for job placement.

The complex nature of soft tissue industrial injuries only serves to further complicate and prolong the process of diagnosis, treatment, and return to work. No doubt breakthroughs in the treatment of soft tissue injuries will continue to develop, but in the meantime millions of dollars are spent ineffectively. Work hardening can serve as a bridge in the reemployment of these injured workers.

Industry has made significant effort to provide training to its employees in an effort to prevent injury. Most controlled studies on training have shown it to be ineffective, however, in reducing accidents and injuries, particularly related to lifting (NIOSH, 1981). Back schools have also become popular as a method of rehabilitating and preventing further injury in those who suffered an initial back injury while working. Most often these schools involve films and slides, as well demonstration, about safe lifting practices. However, controlled studies are yet to appear that demonstrate significant impact. It does not seem to be enough to teach safe lifting practices. The individual must be practically involved where lifting techniques are both demonstrated and practiced repeatedly until they are learned at the somatic level (NIOSH, 1981).

Matheson reports that those who benefit most from work hardening programs are those who are seriously deconditioned subsequent to an impairment brought about by an injury or disease process. Often these are people who have discrepancies between their reported symptoms and objective findings. Compliance seems to be a major problem in the prevention of low back injuries (Morris, 1984). Work hardening programs can contribute to the rehabilitation process not only by providing a model for proper lifting and other work techniques but also through repeated simulation of the proper technique, much as an athlete experiences, until the behavior becomes automatic. Work hardening therapies seem to work most successfully when they involve client participation at a level similar to an expected work level. In other words, individuals should participate in work hardening therapies 40 hours a week if they expect to return to a full-time job. In this way, the individual becomes conditioned to an expected level of performance and the professional has a way of objectively measuring physical capacity and consistent performance through objective measures. When a specific job is identified that the individual anticipates returning to, work hardening therapies can simulate that job specifically. If, however, there is no specific job anticipated, then the worker participates in a generic work hardening program that still identifies his physical capacities.

## Physical Capacity Evaluation

One of the most significant challenges in the management of industrial injury is in determining physical capacity. Traditional medical training equips physicians to identify and treat pathology, however, physicians are not trained in quantifying physical capacity. Nevertheless, in the case of the medical management of industrial injury, it is the physician who is asked to determine what level of work an individual can perform upon reaching maximum medical improvement (MMI). This has become one of the most controversial areas in the process of managing industrial injury.

One of the most prominent researchers in the area of human performance is Don Chaffin (1984) at the University of Michigan, Center for Ergonomics, Ann Arbor, Michigan. Chaffin and his colleagues are widely published in the area of occupational biomechanics. His contributions have been very significant in helping professionals understand the biomechanical interactions of the body, and particularly the back, as it is involved in lifting activities. Chaffin and others have helped to focus the management of industrial injury away from evidence of tissue damage or tendency for injury from premorbid x-rays to a more functional analysis of physical capacity.

Another leader in this field is Keith Blankenship, associated with American Therapeutics in Atlanta, Georgia. Blankenship (1984), a physical therapist, has conducted numerous training workshops for physical therapists and occupational therapists in the systematic evaluation of physical capacity. Physical capacity evaluation is a combination of the sciences of biomechanics, anthropometry, and work physiology.

The Work Practices Guide For Manual Lifting (NIOSH, 1981) provides several criteria that should be applied when administering any physical capacity evaluation. Those principles are:

1. Is it safe to administer?
2. Does it give reliable quantitative values?
3. Is it relative to specific job requirements?
4. Is it practical?

5. Does it predict risk of future injury or illnesses? (NIOSH, 1981).

Chaffin suggests that physical capacity evaluation should be capable of achieving a coefficient of variation of less than 15% and frequently better (Chaffin, Herrin, Keyserling, & Foulke, 1977).

Biomechanical Considerations

While the general concern of occupational biomechanics is focused on what an individual can mechanically perform, the concern is most practical when a specific job is considered. In an industrial setting, physical capacities need to be related to the physical demands of a prospective job. This will be further considered in the discussion of ergonomic job analysis. The biomechanical considerations, however, of physical capacity evaluation have much to do with the position the body is in, the structure of the tissues and their performance in a particular position, as well as the forces being exerted while in that position.

Probably one of the most important considerations regarding physical capacity evaluation has to do with compression forces generated at the L5-S1 disk space with lifting activity. Again, Chaffin is the most widely published researcher in this area. He makes a case for particular positions being utilized in any lifting activity and that the increasing forces required for lifting increase the emphasis upon proper lifting technique (Chaffin, 1974). One of the most significant studies, however, involved the use of lumbar intervertebral joints that were secured from cadavers and placed in varying positions in order to analyze their function under various forces. This research shows that without using proper body mechanics such as are emphasized in competitive weight lifting, that unacceptable shear forces are created in the lumbar spine causing disk damage and eventual rupture. However, when proper body mechanics are employed incorporating lumbar lordosis, under extreme pressures, the bony structures of the vertebrae will fail before the integrity of the intervertebral disk. This, indeed, is a significant finding that has been corroborated by numerous other researchers (Adams & Hutton, 1982).

Physiological Considerations

In addition to the physical structure of the body in determining physical capacity, the evaluator must also take into consideration the effect of dynamic exercise. Specifically, one must consider oxygen consumption, metabolic energy expenditure rate, and heart rate. When muscles become active, metabolism increases and the demand for increased oxygen and foodstuffs follows. Increased respiratory function and blood flow are significant factors as physical demand increases. Aerobic capacity is, therefore, a significant consideration in determining physical capacity. Fortunately, except in "heavy" industries, or where "continuous lifting" is required, the work seldom reaches or exceeds 50% VO2 max and then only intermittently. Usually, therefore, this consideration is rarely necessary (NIOSH, 1981).

Using proper body mechanics as opposed to free style when lifting can require greater energy demand (NIOSH, 1981). This may be one reason why workers are noncompliant in regard to proper lifting technique. In addition to high frequency exercise, one must consider the effect of sustained contractions as in isometric exercise or holding a particular weight. Sustained contractions readily induce local muscle fatigue from which recovery is quite slow (NIOSH, 1981). Many injuries occur to workers who do not routinely perform tasks that require sustained physical performance. Consequently, on a day that they must do high frequency lifting or hold objects exerting forces for prolonged periods of time, fatigue sets in and becomes a significant factor. Research indicates that this is the second most frequent cause of low back injuries behind voluntary overloading. Chaffin (1972) indicates that "probably 80% or more of American men are not physically fit as judged by their aerobic capacities being below a reasonable value of 16 kilocalories per minute". This subject will be addressed further under the topic of employee fitness.

Psychophysiological Considerations

The psychophysiological perspective may be the most overlooked and possibly the most difficult to objectively measure of all dimensions of physical capacity. Strength in this context is defined as the maximum voluntary force a person is willing to exert in a single attempt. Endurance is the force a person is willing to repeatedly exert for an extended period of time without feeling fatigued (NIOSH, 1981). Psychophysics is concerned with the relationship between human sensation and physical stimuli. It probably accounts for much of the discrepancy between physical findings in regard to industrial injury and presented symptoms. In any physical capacity assessment, the evaluator must rely on voluntary effort.

While anthropometry and biomechanics have contributed a great deal in terms of structural factors related to strength and performance, they do not appear to be satisfactory predictors of how a particular individual functions on a particular strength demanding task. Traditionally, physical capacity evaluation has been measured through static strength testing. Static strength testing has contributed a great deal to the body of knowledge regarding the influence of body position on strength capacity, intrasubject variability, and intersubject variation. Researchers, Harber and SooHoo, agree with Chaffin that an individual should perform within 15% consistently in an authentic effort (NIOSH, 1981).

In a psychophysiological approach to physical capacity evaluation, the subject is given control over one of the task variables. Usually that variable is the weight of the object being handled. Thus, performance is based on voluntary maximal effort. Taking into account that research shows workers frequently do not lift as much weight when required to maintain proper body mechanics as when they are allowed to use poor body mechanics (free style), close supervision is required. This seems quite closely related to the fact that, as indicated earlier, the single most frequent cause of lifting injuries is from "voluntary overloading". Combining this most frequent cause of lifting injuries with the fact that many individuals will prefer to use poor body mechanics (which also requires less demand of energy) it is not too difficult to understand how lifting injuries occur.

When one takes into account the biomechanical principles of the back, then evaluator intervention and controls of lifting postures become extremely important. Essentially, it is postulated that workers do not know their own limitations and will frequently choose to participate in an activity or not participate in it based on their own gut level feelings of whether the job is acceptable or not. According to epidemiological evidence, the majority of low back injuries were shown to occur on jobs that were not acceptable to more than 75% of the population (Snook, Campanelli, & Hart, 1978). Consequently, any attempt at physical capacity evaluation must take this perspective into account. A systematic physical capacity evaluation is testing both physical capacity and psychological expectations. One can readily see the implications here for an effective work hardening program.

## Psychological Considerations

An area of great concern to injured workers, physicians, medical psychologists, and industrial management is the poorly defined, but widely held concept of malingering. True malingerers represent a very small portion of injured workers, and yet many frustrated professionals will use the word when an individual seems to be demonstrating "excess disability". This is particularly common when objective findings are insufficient to warrant the apparent dysfunction. "Secondary gain" issues are often spoken about in regard to the compensation claimant as issues or motives that prolong and exaggerate dysfunction.

The Minnesota Multiphasic Personality Inventory (MMPI) has been utilized extensively in the diagnosis of "conversion reaction," particularly as it relates to health and impairment. Fordyce (1978) has commented extensively on this phenomona as it relates to the low back injury and Caldwell has contributed as well (Caldwell & Chase, 1977). While it seems very clear that a high percentage of low back pain patients demonstrate the "conversion V" profile on the MMPI, the diagnosis of conversion reaction does little to indicate treatment or to contribute insightfully in the efforts to resolve the industrial injury. Matheson has contributed to this cause in his definition of "symptom magnification" (Matheson, 1984). He defines three types of symptom magnification and discusses ways in which to identify these types and an appropriate treatment approach. While Matheson's contributions are of great clinical value, his writings do not include any objective measures that can be used definitively in a court of law.

Another approach which has received increasing interest of late is related to computer generated graphs connected with isokinetic strength testing machines. The first device to be successfully recognized in a court of law was produced by the Lumex Corporation, originator of the Cybex II (Simmons, 1984). This isokinetic device was developed to rehabilitate the extremities. It produced a computer generated curve that was found to be highly interpretive with indications of specific pathologies, but also of progress and malingering. Without explaining the complex biomechanics that contribute to the validity of this device, it is significant to note that in all the joints involved in the utilization of the Cybex II, each joint is a single hinged joint.

In the fall of 1984, Cybex began producing isokinetic instruments to be utilized for the back. One for flexion/extension, one for trunk rotation, and one to be utilized in measuring lifting tasks. Initially Cybex claimed that these devices would also be able to identify malingering, upon delivery they issued a disclaimer. The prospect of being able to utilize the Cybex back machines as an objective identification of malingering was very appealing. However, one of the many reasons it is not accurate for this purpose has to do with the structure of the back, involving multihinged joints functioning in unison.

Recently, Arthur Jones (1988), the founder and former chairman of Nautilus Sports/Medical Industries Inc., developed a new line of equipment to isokinetically test and rehabilitate the lumbar spine, in conjunction with the University of Florida Center for Exercise Science. While Mr. Jones claims that his machinery is able to identify malingering, as well as measure functional capacity, neither of these claims have been proven. His explanation for the ability to identify malingering is indeed enticing and may one day be successfully recognized as an objective measure. The database at this time is being collected. Isokinetics has been demonstrated to be an effective, if not the most effective, instrument for safely and rapidly rehabilitating musculoskeletal injuries. As a measure for physical capacity, however, his data falls short, specifically in that it does not convert to any meaningful measures regarding a real job. Although the isokinetic equipment is available, it is not chosen as a part of the industrial management of injury and impairment other than as a rehabilitative device.

## Preventive Considerations

Preventive considerations are of paramount importance. The epidemic occurrence of industrial injury and the growing economic burden, including the degree of human suffering, make prevention equally important as rehabilitation. The primary prevention measures used by injury have included education, pre-employment testing, and modifications of the work place. While these measures have not been implemented universally, in selected examples they have made significant differences. Controlled studies have shown that both training and pre-employment screenings have been conducted in a manner that has been ineffective in reducing accidents and injuries related to lifting (NIOSH, 1981). Still these two efforts seem to be of benefit, but must be conducted in a different manner than they have been traditionally.

Pre-employment Screening

Traditionally, pre-employment screening has taken the form of traditional medical measures such as heart rate, blood pressure, blood testing, screening for obesity, previous injury, and occasionally x-rays of the lumbar spine. These measures have shown to be quite ineffective in predicting industrial injury. While many workers do suffer from cardiovascular disease, diabetes, obesity, and others, most industrial injuries are related to musculoskeletel strength and conditioning and are not inferred from such measures. Consequently, some type of measurement of an employee's ability to perform the work task would seem to be much more relevant.

In 1984, the Institute for Loss Control Studies in Philadelphia, Pennsylvania, published an example in its Loss Control Bulletin (Institute for Loss Control Studies, 1984). This example of a large steel company with multiple plant locations indicated that many newly hired laborers were suffering job related accidents and injuries. Many of these were of a musculoskeletal nature. Although this company did have a lifting standard for applicants to be hired, it was apparently not effective. The company contracted with an independent firm specializing in developing and validating isometric strength testing systems which empirically measure maximum strength in the major muscle groups used in materials handling tasks. Their screening techniques were able to identify applicants with the strength and endurance to perform strenuous work. Significant reduction in industrial injuries resulted from this strength testing measure. This prelimary effort is an excellent example of learning from losses and solving problems related to work place incidents.

While a maximum of 8% of young workers susceptible to future low back problems can be identified with careful history and thorough examination, and the use of low back x-rays can raise that effectiveness to approximately 10% (Rowe, 1983), the effectiveness of medical selection procedures currently being used in industry has not been demonstrated (Snook, 1978). Since the probability of a musculoskeletal disorder is up to three times greater when job lifting requirements approach or exceed the worker's isometric strength capability (Chaffin, 1974), it would seem that a pre-employment screening focus is more effective when strength capacities are systematically measured.

The type of pre-employment strength screening needed, however, is dictated a great deal by the type of job task the worker is going to perform. Therefore, it would seem that pre-employment strength testing should be closely related to ergonomic job analysis. It may be concluded that pre-employment screening can be effectively conducted after initiating ergonomic job analysis and then constructing appropriate physical capacity evaluation to go with that job analysis.

Ergonomic Job Analysis

Job analysis has been an important part of industrial functions for many years. Ultimately, the Federal Government has set the standard in terms of defining jobs. However, the most recent publication issued by the Federal Government in this regard is the Handbook for Analyzing Jobs. Published in 1972 by the U.S. Department of Labor Manpower Administration, this is considered the standard. It was utilized in the compilation of the Dictionary of Occupational Titles (DOT) which lists over 12,000 individual occupations. More than 75,000 on-site analyses and extensive contacts with professional and trade associations, were conducted in order to compile this document. Indeed, the DOT has become "the Bible" for many vocational placement specialists and other rehabilitation professionals. In recent years some researchers, have exceeded the federal standards in calculating the physical demand characteristics and incorporating them in any job analysis, thus the term ergonomic job analysis. These researchers including Blankenship (1984), Snook (1983), Matheson (1984) have increasingly focused on the lifting task as the first and predominant priority in the analysis of any job, as this is the situation most likely to provoke an injury of signicant proportions. Many of these researchers have relied heavily on the Work Practices Guide for Manual Lifting (NIOSH, 1981) in providing guidance in the structure of any ergonomic job analysis. The guide does an excellent job of summarizing the findings of research related to work injuries and those factors which should be considered in any review of a particular job.

There are seven factors that are prioritized as potentially hazardous to a person's musculoskeletal system. These job risk factors are (a) weight - force required, (b) location/sight - position of the load center of gravity with respect to the worker,
(c) frequency/duration/pace - temporal aspects of the task in terms of repetitiveness of handling,
(d) stability - consistency in location of load center of gravity as in handling bulky or liquid materials,

(e) coupling - texture, handle size and location, shape, color, and so forth, (f) work place geometry - spatial aspects of the task in terms of movement, distance, direction, obstacles, postural constraints, and so on, (g) environment - factors such as temperature, humidity, illumination, noise, vibration, frictional stability of the foot, and the like (NIOSH, 1981).

In regard to lifting task variables, specifically, there are six factors to be taken into consideration: (a) object weight - measured in either kilograms or pounds, (b) horizontal location - of the hands at the origin of lift measured forward of the body center line or midpoint between ankles, (c) vertical location - of the hands at origin of lift measured from floor level, (d) vertical travel distance - from origin to destination of lift, (e) frequency of lift - average number of lifts per minute, (f) duration of period - assumed to be occasional or continuous. Continuous lifting is further defined as: (a) infrequent - either occasional or continuous lifting less than once per three minutes, (b) occasional high frequency - lifting one or more times per three minutes for a period of up to one hour, (c) continuous high frequency - lifting one or more times per three minutes continuously for eight hours. These factors become significant when considering evidence that for infrequent lifting a person's musculoskeletal strength and potential stress to the back are the primary limitations to ability. For occasional high frequency lifting, psychophysical stress and possible muscle fatigue are primary limitations, while for continuous high frequency lifting, the primary limitations are based on cardiovascular capacity and metabolic endurance.

It is concluded regardless of the approach taken to evaluate the physical stresses of lifting that a large individual variability in risk of injury and lifting performance capability exists in the population today. This realization requires that the resulting controls be of both an engineering and administrative nature. In other words, there are some lifting situations which are so hazardous that only a few people could be expected to be capable of safely performing them. These conditions need to be modified to reduce stresses through job redesign. On the other hand, some lifting conditions may be safely tolerated by some people, but others, particularly weaker individuals, must be protected by an aggressive selection and training program. To specifically define these conditions, two limits are provided based on epidemiological, biomechanical, physiological, and psychophysical criteria (NIOSH, 1981, p. 124).

The Work Practices Guide for Manual Lifting has, therefore, constructed two categories. They are "action limit" and "maximum permissible limit." A formula has been composed that allows one to take into account the various measurements of a job function and calculate the action limit. The formula is as follows: $AL = 90 \text{ lb} \times [(6/H) \times (1 - .01\,|V - 30|) \times (.7 + (3/D)) \times (1 - (F/F_{max}))]$.

H = Horizontal displacement of lift

V = Vertical location of hands at origin of lift

D = Vertical travel distance from origin to destination

F = Average number of lifts per minute

According to the NIOSH standards, the action limit (AL) is the load at which 99% of the American adult male population and 75% of the American adult female population should be able to perform without increased risk of injury. The maximum permissible limit (MPL) equals three times the action limit. The MPL is the point at which only 25% of the men and 1% of the women will not experience an increased risk of injury. Thus, properly analyzed, lifting tasks can be of three types: (a) those above the MPL should be viewed as unacceptable and require engineering controls, (b) those between the AL and MPL are unacceptable without administrative or engineering controls, and (c) those below the AL are believed to represent nominal risk to most industrial work forces. Any ergonomic job analysis should incorporate the criteria outlined above and calculate the action limit and maximum permissible limit for each lifting task (NIOSH, 1981). Blankenship (1984) essentially utilizes these guidelines in his training of ergonomic job analysis.

## Employee Fitness

While employee fitness is not a new idea, it has only recently seen implementation in many industries. Most applications involve aerobic exercise of some kind because it has been known to reduce heart rate and systolic blood pressures in numerous studies, approximately 10-15%. Some noted examples of application of employee fitness programs can demonstrate its effectiveness.

At Prudential Insurance Company of Houston, Texas, an aerobic employee fitness program was offered to its workers. Statistics were kept on absenteeism (sick days) for the year of 1984. Those who participated in the aerobics program were absent from work on the average of

1.6 days per year, whereas the nonparticipants were absent 8.0 days per year (Volski, 1984).

In the same year Canada Life Assurance Company, with its 1,400 employees, also offered an aerobic employee fitness program. Absenteeism dropped 22% with this fitness program, or an average of 2.5 days per employee. In a company with 1,400 employees, the result is 3,500 fewer sick days. The average salary per employee being $50 per day equals a savings of $175,000 (Volski, 1984). From the company's point of view, this more than offset the cost of the program. Although 50% of their employees participated in this fitness program on company time, there was no change in productivity. This counters the typical argument from administration about fitness programs, that they might interfere with work concentration and overall productivity.

In that Canada Life program, a survey of employees found that 47% of the participants subjectively felt more alert, better rapport with co-workers and supervisors, and enjoying their work more. Sixty-three percent said that they felt more relaxed and less tired. The employee turnover rate of participants was only 1.5% for that year, while the rest of the company experienced a 15% rate of turnover.

While the employee fitness approach is not specifically related to job task, it is obviously an effective way to significantly reduce lost time and susceptibility to industrial injury. One possible weakness of this approach, however, is that those employees who are most susceptible to industrial injury might be the least motivated to participate in a fitness program.

## Job Modification

Most employers and many rehabilitation professionals do not appreciate the potential of work site modification beyond the structural accessibility for disabled people. Job design modifications are anticipated to be complex from an engineering perspective in addition to high cost factors. Many disabled Americans are unnecessarily prevented from employment because of this prejudice. As Worker's Compensation laws change, the trend is to expect every capable injured worker to be assisted back to work. This requires employer involvement and professional expertise in work site modification.

Burkely Planning Associates (1982) studied accommodation practices among 2,000 employers who held government contracts requiring accommodations for hiring and promoting qualified disabled people. About 50% of the employers reported accommodations costing nothing, 30% of the modifications cost up to $500, and only 8% cost over $2,000. Adaptive accommodations like hours of work, work procedures, and task assignments were most common and lowest in cost. More expensive were accommodations including equipment and environmental modifications, but they were considered cost effective since they are usually made for highly skilled or specially trained individuals. All efforts should be made to use the action limit, referred to above, as a way of decreasing back injuries, but many researchers insist that job redesign and other modifications should be given first priority (Liles & Mahajan, 1985). The proper design of jobs can potentially reduce up to one third of low back compensation by reducing the onset of painful episodes allowing the worker to stay on the job longer and permitting him to return to the job sooner (Chaffin, 1974; Liles & Mahajan, 1985; & Snook, et al., 1978).

From the above review of recent efforts to resolve the problem of industrial injury some conclusions can be drawn. There is a great need for job relevant measures of physical capacity as well as the strength demands of jobs. With tools that can provide this information workers can be assigned to activities safely. While some of these components of measurement exist they have not been incorporated into an overall design that can comprehensively and systematically be applied. Therefore, a need exists for the design of a mechanism that protects as well as prepares workers physically and psychologically for their assigned activities.

# Chapter 3

## TOOL DEVELOPMENT

The purpose of this chapter is to review considerations and develop instruments to be utilized in the structure of a design model. The components to be devolped include a method of physical capacity evaluation, a measurement of the physical strength demands of a specific job, and a method of identifying psychological health behaviors and attitudes.

Gulf Power, a division of the Southern Company, is the local electric utility in the panhandle area of Northwest Florida. Gulf Power is unionized, employs 1,600 workers in 53 major job classifications. Although there are three different divisions, Western, Central, and Eastern, the job classifications are standardized throughout the system and involve three power plants, three general service facilities, and one administrative office building. The initial request from Gulf Power was to assist in the "management of partially disabled workers," by defining the strength demands of seven or eight jobs. Their intention was to take this information to the treating physicians and inquire whether or not their patient was capable of performing the job to which they were assigned. In addition, would this patient be capable of physically performing any of these seven or eight defined jobs. Although this may seem a very logical process to the layperson, it has been the author's experience that physicians accept the fact that they are neither trained nor equipped to measure physical work capacity.

For years physicians have been requested to complete forms identifying patients' physical limitations. However, in a litigious society a physician's educated guess can often be challenged because it is based on subjective opinion. Ability to generate activity or force is quite a different matter from identifying pathology in order to prescribe and administer treatment. In the process of defining disability, or impairment, physicians have been quite inconsistent in their criteria for assigning a particular value (Brand, 1983; Waylonis, 1987). Despite this inconsistency, their methods are based on objective calculation and no one has come forth challenging their ability to designate medical impairment.

Oftentimes, however, impairment is considered to be relative to function. Therefore, impairment rating often overlaps with functional capacity. Physical capacity evaluation is more clearly a measurement of an individual's ability to perform activities, particularly related to work, but also to exercise, participate in athletics, or activities of daily living. Therefore, a measurement of physical capacity was needed in order to determine what jobs an impaired individual could perform.

Gulf Power's request was for ergonomic job analysis. However, it was obvious that physical capacity measures would be needed as well, and that treating physicians would be incapable of responding to the question of whether a particular worker would be able to perform a particular job as defined ergonomically. Tools to be developed then included physical capacity evaluation, ergonomic job analysis, and adaptive health behaviors (psychosocial response to injury and treatment).

## Measuring Health Behavior

### Millon Behavioral Health Inventory

A major trend in the psychological literature is the isolation of psychologic factors that may predict response to treatment. Very few studies have been conducted to relate psychologic factors to the rehabilitation of low back pain patients. There does appear to be a relationship in certain studies between scales on the MMPI and successful treatment outcome

(Sternbach, 1973). These measures, however, have been limited to subjective ratings by physicians or patients.

The Millon Behavioral Health Inventory (MBHI), a 150-item self-report, was developed as an assessment device for use with individuals undergoing evaluation or treatment for physical disorders in medical settings (Millon, Green, & Meagher, 1976). Unlike the MMPI, originally designed for a psychiatric population, the MBHI was developed and standardized on a medical population. It provides information on the patient's style of relating to health care personnel and major psychosocial stresses, as well as probable response to illness and treatment interventions. It has been found to be a more significant predictor of surgical suitability and outcome with low back pain patients than the MMPI (Orme, Brown, & Richardson, 1985). Its utility in predicting physical function and response to treatment make it a tool of choice in this design for the management of industrial injury and worker impairment (Gathel, Mayer, Capra, & Barnett, 1986).

## Measuring Physical Function

### The Physical Capacity Evaluation (PCE)

Asked to design and develop a rehabilitation program for injured workers the author initiated a PCE tool.

After reviewing research and with significant input from a staff of physical therapists, occupational therapists, and a physiatrist, a protocol was developed. We relied heavily on training from American Therapeutics, a physical therapy education and training group, as well as other sources. The format of our two-hour physical capacity evaluation evolved over the next several months until it reached its present form.

The principles outlined in the Work Practices Guide For Manual Lifting serve as an orientation. Again they are:

1. Is it safe to administer?
2. Does it give reliable quantitative values?
3. Is it related to specific job requirements?
4. Is it practical?
5. Does it predict risk of future injury or illness?

Initially, boxes were constructed with an ability to add disk weights internally in order to alter the weight as a method of testing dynamic lifting capacity. Although this proved to be a very effective method, eventually the WEST comprehensive weight system numbers one, two, and four was chosen because it is compact and easy to use, but more importantly, has established norms that make it more recognizable. An illustration of this instrument can be seen in Appendix A.

In addition to dynamic lifting with both one and two hands, the WEST equipment also allows measurement of upper extremity strength and fatigue tolerance in tasks that require pronation/supination or internal/external rotation against resistance. Torc resistance values can be calibrated to range between 12-in lbs to 50-in lbs. Whole body range of motion, including reaches to full extension overhead and prolonged overhead work, can be calculated.

An isometric strength testing component was designed and constructed by the author. It consists of a lifting platform with convenient and adjustable handles attached to a dynamometer by an adjustable chain. Testing levels include eye level, shoulder level, waist level, and knee level. The isometric measures can be compared to the dynamic lifting performance and inconsistencies can be noted. The isometric component was included because traditionally strength testing has been done isometrically. Increasingly however, dynamic lifting and isokinetic strength are being included in research design models.

Using a model designed by Blankenship (1984), a sled was constructed in order to measure static and dyanimic pulling and pushing capacities. Again, a dynamometer is used in order to measure these forces. Grip strength is measured with a traditional hand dynamometer.

Endurance testing is included in the PCE. This is tested in the form of leg press (flexion/extension) bilaterally, continuous walking for a period of ten minutes with the measure of distance being recorded, and stair climbing with the number of flights (13 stairs) and time recorded. Repetitive bending and squatting with a maximum of 20 being allowed without any load is also measured in order to test body mechanics and endurance. Carrying is tested in a manner similar to two-handed lifting, by adding weight successively and measuring distance traveled.

All lifts are one repetition at varying heights according to the WEST protocol, with approximately five seconds between each lift. A minute break is given between weight changes. The criteria for successful lifts are (a) maintenance of correct posture during the lift, (b) stable and predictable pain and pain that returns to its original level, and (c) compliance of patient with correct lifting techniques. Subjects are given the opportunity to stop the test at any point they desire with an explanation recorded. Testing personnel will also stop the test procedure if at any point the individual uses incorrect body mechanics or participates in an unsafe manner. Guidelines for high risk work style have been clearly defined by the Employment and Rehabilitation Institute of California (Matheson, 1984). These are posted within the testing laboratory. A copy is included in Appendix B.

Scores are recorded from the PCE on a form titled Two-Hour Physical Capacity Evaluation, Maximum Voluntary Strength Measures. Appendix C is a copy of this form. From this record of test performance scores, the physician involved in the PCE consults with the physical therapist in completing the recommended maximum capacities for continuous work. This form can be seen in Appendix D. Testing is always conducted after a thorough review of medical records and a history taken from the subject by both the testing physical therapist and the physiatrist.

This tool has been used extensively over the last three and a half years under supervision of the author at the Work Performance Rehabilitation Center. Current utilization is approximately 20 to 25 times a month in the testing of individuals referred by physicians and industry in order to determine appropriate work expectations. There have been no injuries reported from the testing procedure and it has been utilized consistently in legal proceedings as an objective tool.

Measuring Work Demands - Ergonomic Job Analysis (EJA)

Only recently (January 1987) was the Ergonomic Job Analysis tool developed by the author. Recommendations proposed by Blankenship (1984) were used as a beginning point. As in the case for the PCE, job analysis has been at least legally defined by the U.S. Department of Labor (1972). Consequently, a thorough review of the Handbook for Analyzing Jobs by the U.S. Department of Labor 1972 was conducted. The Department of Labor handbook focuses on all aspects of job analysis, including skills and training. The goal of the EJA was to specifically quantify the physical demands characteristics of any particular job. Consequently, it does not include the aspect of nonphysical skills.

A job analysis worksheet was developed and can be seen in Appendix E. This worksheet is utilized in the actual job analysis for recording the various values that later can be calculated in a more comprehensive analysis of physical demands. The first step in job analysis includes an interview of a worker experienced in the particular job. In that interview the worker is asked to describe all of the tasks involved and demonstrate their function for the analyzer. Particular attention is focused on lifting activities. Each task is analyzed and measured in terms of the force required (by means of a strain guage or hand dynamometer), horizontal location (H), vertical location (V), vertical travel distance (D), frequency of lifting (F), and duration or period (T). In addition to lifting, activities of standing, walking, sitting, holding, carrying, pushing and pulling, and various other positional activities are measured with comments regarding the task difficulty. Work conditions and environment are also recorded consistent with the Handbook for Analyzing Jobs.

Lifting injuries are the most frequent and most problematic for industry. Consequently, lifting is a primary focus in job analysis. The more demanding lifts are calculated through use of the action limit (AL) and maximum permissible limit (MPL). Effective EJA requires the analyzer to spend time observing the worker in action. Depending upon the complexity, variety, and demands of the job, this can take anywhere from a couple of hours to two or more days. Once the job has been thoroughly evaluated, calculations take place in order to determine the more demanding aspects of the job. It would be extremely difficult and probably unnecessary to analyze every activity of a job. So focus is on the more demanding aspects. However, one must keep in mind that the cumulative effect of all the activities can significantly influence a worker's ability to perform the job as regards fatigue and stress.

Once the job has been calculated comprehensively, it is then placed in the format described as the job analysis. As can be observed by the example in Appendix F, in this format industrial personnel can quickly review the physical requirements of the evaluated job in more specific detail. Accompanying this, however, is a narrative description titled Summary of Job Analysis/Strength Demand. It summarizes the job by title, purpose, strength requirements, working conditions, and job classification. The job is classified according to the U.S. Department of Labor's Designations of sedentary, light, medium, heavy, and very heavy. The final form, therefore, of the EJA includes the summary of job analysis/strength demands, the job analysis data sheet and the job classification format as defined by the Department of Labor.

# Chapter 4

# A DESIGN FOR THE MANAGEMENT OF INDUSTRIAL INJURY AND WORKER IMPAIRMENT

The purpose of this chapter is to present a comprehensive design model for the management of industrial injury and impaired workers. A comprehensive design requires both concepts and structure. The following narrative will explain the various components of this design, revealing their significance to the overall management system and in some cases the detailed structure that provides for management control and a method for measuring effectiveness. Some of the components are yet to be fully developed specifically for Gulf Power, but actual examples exist in industry today. These components can be implemented in stages as prioritized by management. Figure 1 represents how these components interface in a fully developed management system as proposed by the author.

## Prevention

### Ergonomic Job Analysis (EJA)

The EJA becomes the basis for both worker assignment and the management of industrial health. The basic components of an EJA identify the various positions and physical forces required of a worker in that position.

A DESIGN FOR THE MANAGEMENT OF INDUSTRIAL INJURY AND IMPAIRED WORKERS

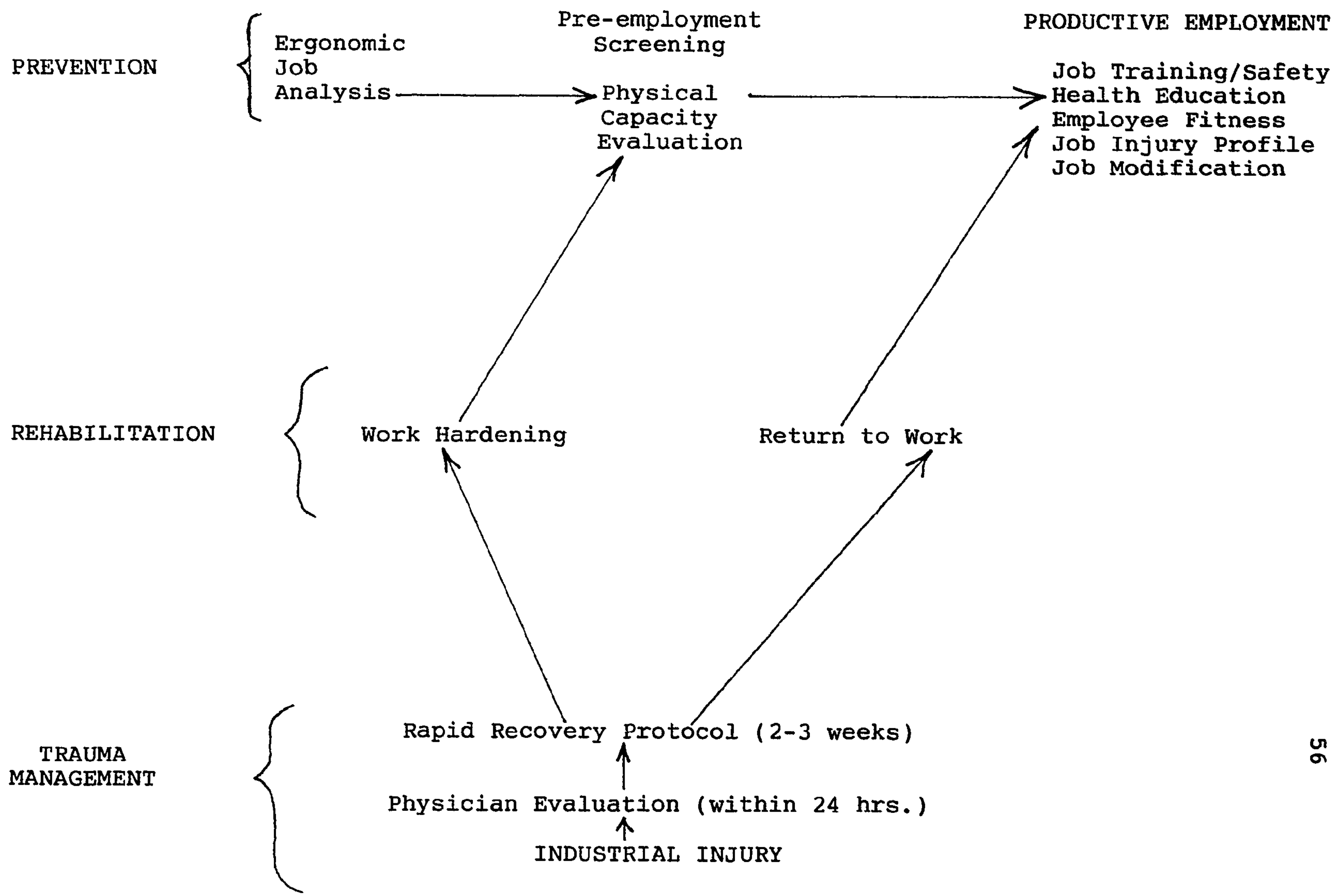



FIGURE 1

Focus is especially intense on the more demanding lifting tasks for most positions, as this is the area causing most industrial injuries today. However, for specific jobs that are unusual in that other hazards exist, the EJA can focus on whatever priorities exist.

Once a job has been defined by the EJA it provides input for preventive efforts and job modification. When injuries occur on a particular job, information received from the job injury profile (See page 73) should be filed along with the EJA records. With an unusually high incidence of injuries on a particular job or in a routine review of EJAs, ideas for modification will naturally arise. All this information is also very helpful in making a proper judgment regarding return to work.

Pre-employment Screening

Increasingly, industry has expressed interest in pre-employment screening. Many industries have company physicians and some have health nurses who screen individuals for conditions and situations predisposing health problems. Although this effort is well intentioned and quite sophisticated, it has not been effective in preventing on-the-job injuries. Many times healthy workers are hired to perform job tasks that they are simply not physically competent to perform without a high risk of injury. Consequently, the use of PCEs is strongly suggested for screening workers that are going to be assigned to jobs that fall with any one of the following categories: (a) jobs defined by the Department of Labor as "heavy", (b) jobs defined by the Department of Labor as "very heavy", (c) jobs that have a high incidence of injury, and (d) jobs that have an incidence of serious injury. By conducting a PCE prior to assignment to one of these job categories, management is utilizing a cost effective measure. This inexpensive screening tool can save thousands of dollars if just a few expensive-to-treat injuries are prevented, not to mention the cost of wage replacement should a worker be unable to return to work.

The traditional information gathered in pre-employment screening can provide valuable input regarding other vulnerable areas of health for workers. Information about lifestyle and health measures can be helpful in the planning of health education programs that might be planned for workers in general. While certain health measures might identify an employee as vulnerable, it would not necessarily prevent him from being hired. It might alert administration, however, to something to be monitored through annual health screening.

Health Education Program

Industrial health awareness and education programs are receiving increased attention. They teach employees to use proper posture and methods for increasing strength and flexibility, as well as general health enhancement. The purpose of a health education program is to aid workers in properly managing their own physical health and well being.

Information gathered from pre-employment screening or annual health screens can lead to the development of prevention and health enhancement programs. These programs can be offered in-house or out, with incentives for attending. These incentives could be in the form of subsidized tuition, bonuses for attending, bonuses for acquiring certain goals (weight loss, smoking cessation, etc.), or may be tied to health insurance coverage or retention of certain positions.

While there is an increasing number of individuals who are employed and do not have health coverage, many industries still provide group health insurance through employment. If workers maintain a certain level of health, health claims are reduced and costs go down. Often employers provide co-payments for health insurance to reduce the cost to workers. Through annual health screenings, health professionals can identify those areas where a person's health is vulnerable. Programs can be developed that would help reduce the vulnerability. Participation in these programs and achievement of goals could be tied to incentives for participation. While workers cannot be held responsible for inherited tendencies, they can be encouraged to participate in behaviors and lifestyle that reduce their vulnerability to the development of disease. In this case, what's good for the industry is also good for the employee. Numerous health enhancement programs are offered throughout the community and simply need to be advertised to workers, or on occasion can be offered within the facility to make them more accessible.

Another important part of any health education program is specific training for a job. While most developed industries have on-the-job training and ongoing safety and education programs, these efforts should continue to be upgraded and evaluated in terms of effectiveness. Annual health screenings, plus a history of injury incidents provide important information into this overall health education program.

Employee Fitness

The economic value of employee fitness programs has been documented in Chapter 2. While many people are interested in body building or strengthening programs, otherwise known as "pumping iron," the employee fitness programs that are of most benefit are those that involve aerobic exercise. These improve the cardiovascular system and circulation, as well as provide increased stamina, maintenance of ideal weight, and mental stimulation. Some equipment is recommended, but a beginning employee fitness program simply needs available space. Again, this can be provided either within the facility or, through some incentive program, can be provided within the community. While the direct relationship to the prevention of industrial injury is more related to ergonomic job analysis and physical capacity evaluation, an employee fitness program is an indirect way of effectively reducing absenteeism and secondary causes of low productivity. Employee fitness programs are only effective when employees participate. Therefore, they should be made available, accessible, and affordable. There should be controls on employee participation, as some individuals tend to have very poor concepts of their own level of fitness and overexert initially, creating physical problems. Any well established fitness program will include inexpensive prescreenings and instruction, as well as monitoring while they participate.

## Trauma Management

### Rapid Recovery

Once the design for managing industrial injury is well implemented, most efforts will be focused upon prevention. However, in the initial phase of implementation trauma management is extremely important and can provide significant economic savings if focus is placed on the effective management of the industrial injury when it occurs. Borrowing from the field of sports medicine, aggressive and prescribed treatment protocol of effusion and other physical injuries to soft tissue is very effective in reducing the degree of injury and speeding the return of the athlete to the playing arena.

Applying this concept to the industrial injury can mean large savings for industry and a return to productivity for the injured employee. In order to do this, a more defined approach to the management of injury must be initiated. The entire design suggested in this PDE is the author's effort to standardize protocol in terms of time, as well as organic evidence of injury and response to treatment. It is significant to point out here an example of this approach reported by the George Washington University Medical Center in Washington, DC. This study presented at the 51st annual meeting of the American Academy of Orthopedic Surgeons (Wiesel, Feffer, & Rothman, 1984) was titled "Industrial Low Back Pain: A Prospective Evaluation of a Standarized Diagnostic and Treatment Protocol". The protocol was specifically focused on managing low back injuries in industry. With the implementation of this protocol Dr. Wiesel reported that "cost savings were striking and the number of actual low back injuries dropped significantly."

This study was based on the evidence that inappropriate medical care was being given to industrial low back patients. Typically, when industrial injuries occur a company physician will be consulted. Although he is interested in saving industry money, he may fail to provide direction that successfully returns the individual to work. Once the injured worker gets beyond the company physician (this may take weeks of wage loss), a haphazard pattern may follow which includes weeks and months of time before a decision about surgery and other therapeutic treatments is made.

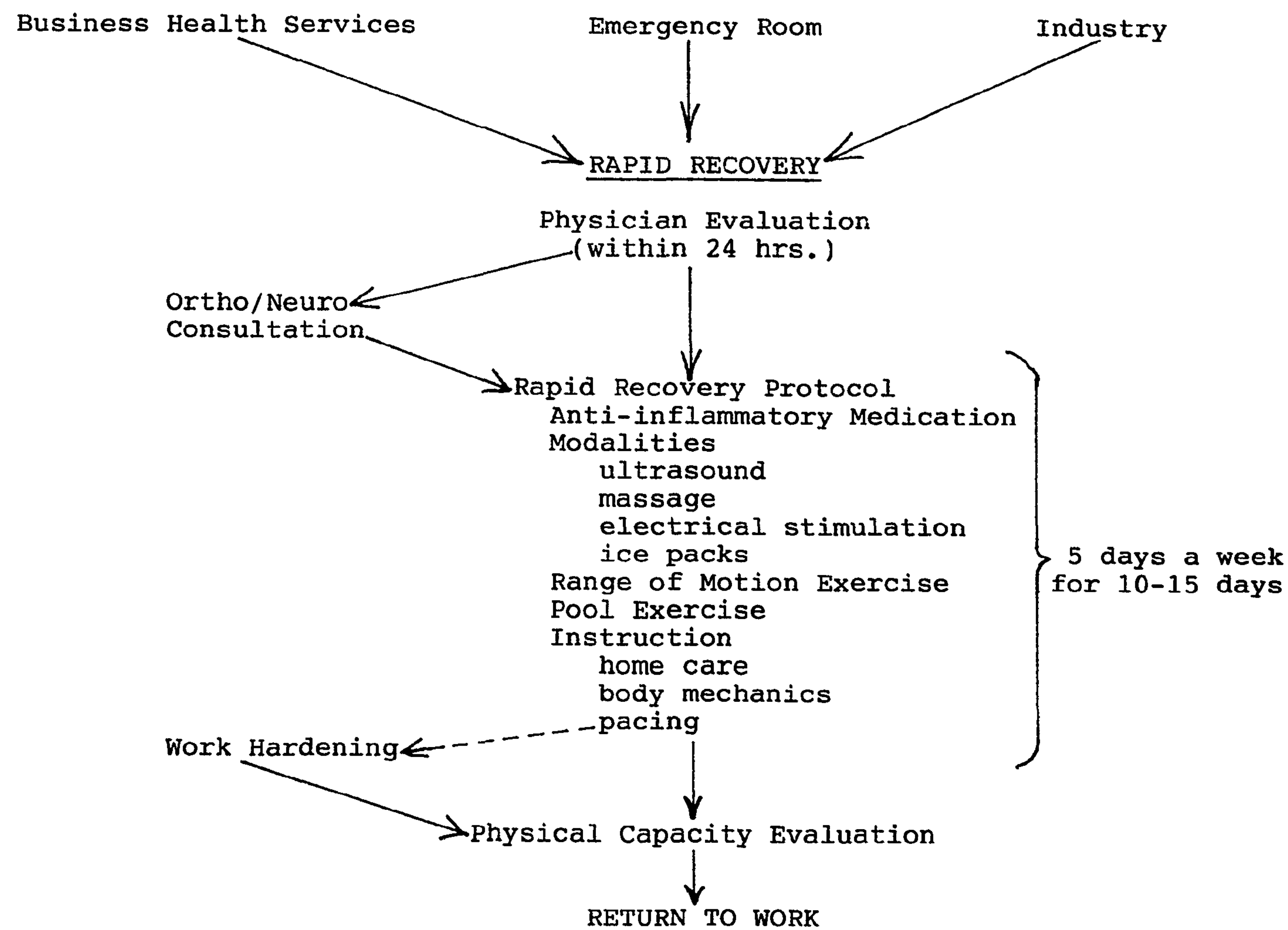
The study that Dr. Wiesel conducted was implemented at two industrial sites. The first was the Potomic Electric Power Company (PEPCO) with 5,380 employees. Between July 1981 and July 1983 any low back pain complaint was directed to the special clinic utilizing a prescribed protocol. The year before implementing this protocol, nine workers underwent surgery for back injuries. Only five returned to work. Medical costs alone exceeded $325,000. They then began their rapid recovery program and saw 98 low back injuries in the first year. However, only one of them underwent surgery and he returned to work. His medical costs were $29,000. The second year there were only 55 low back injuries. Two had surgery. Both returned to work and the total medical cost was $77,621. More significantly, however, in terms of economic savings were the time lost costs. The first year of implementation of the rapid recovery program, they saw a reduction of time lost costs in the amount of $201,000 over the previous year. The second year the reduction was even greater, $302,000.

The second example cited in the study was with the U.S. Postal Service involving 14,000 employees. Their system of rapid recovery was more passive than the first example and less than we are recommending in this design model. Between January of 1982 and January 1983 any new low back injury missing more than seven days from work was seen by a team. The team made a prediction about return to work and if the individual was more than five days late in returning to work he had to see the team again. This passive approach resulted in a reduction of low back pain injuries by 41% over the previous year, 1981. Days lost due to injury were reduced by 60%, health care costs overall were reduced 55%, and the rate of return to work increased 12%.

Needless to say, this rapid recovery protocol can have great economic impact. Dr. Wiesel's protocol can be observed in Appendix J. From Dr. Wiesel's design, a rapid recovery protocol was established by the author in conjuction with Dr. Buffington, Director of Emergency Services, and Dr. VerVoort, Medical Director of the Work Performance Rehabilitation Center. Figure 2 is a representation of the established protocol.

Job Injury Profile

The purpose of a job injury profile is to pinpoint the specific jobs producing the greatest economic impact to industry in terms of the number of injuries and work



Business Health Services
Emergency Room
Industry
RAPID RECOVERY
Physician Evaluation
(within 24 hrs.)
Ortho/Neuro
Consultation
Rapid Recovery Protocol
Anti-inflammatory Medication
Modalities
ultrasound
massage
electrical stimulation
ice packs
Range of Motion Exercise
Pool Exercise
Instruction
home care
body mechanics
pacing
5 days a week
for 10-15 days
Work Hardening
Physical Capacity Evaluation
RETURN TO WORK


FIGURE 2

days lost due to injury. An incident report of every injury describes the manner in which the injury occurred. This could include hazardous work style information or poor job design. Oftentimes, information may seem to be of little value until several incidents have occurred. Information from the job injury profile and the EJA can have significant impact on job modification and job training procedures. A specific format for collecting the job injury profile can be utilized to conduct research and to the effectiveness of pre-employment screening, job placement, and other preventive measures.

## Rehabilitation

### Work Hardening

Work hardening is a developing treatment intervention for injured workers who have not successfully been returned to work. Nachempson (1983) strongly emphasizes that it is the 20% of injured workers who do not return to work that need "specific medical and socio-political resources" directed to them. He goes on to say

> If after six to eight weeks patients have not recovered sufficiently to return to work, and if at this time a thorough examination by an orthopedic surgeon or another specialist has failed to

> demonstrate any signs of a more severe disease or a back problem for which a cause-related treatment exists, they should not continue to miss work or be declared disabled in the vain hope that nature will eventually heal the 'injury'. This latter group contains the largest proportion of patients in whom severe disabling and chronic back pain will develop (Nachemson, 1983).

Work hardening therapies provide just such structured treatment for these identified individuals.

In a work hardening program an individual is engaged in a prescribed protocol of reconditioning and instruction. Typically, work hardening programs are 40 hours a week and last from two to six weeks. Treatment duration is based on progress and cooperation. When treatment ends the employee is in much better condition for returning to work and employers know his specific work capacity. When a designated job has been identified, the EJA provides input into the therapeutic goals for the individual. Often the individual can be conditioned to a level where he is able to return to his former position. If he does not reach that level of physical competence, at least specific information is available as to job demand levels that he can perform competently. Occasionally work hardening provides information to employers and other health care professionals regarding poor effort and motivation, hazardous work style, and on occasion, malingering.

The work hardening program designed by the author for the Work Performance Rehabilitation Center continues to grow and evolve. Many individuals have been returned to productive employment as a result of participation in this program. It is increasingly utilized by both physicians and rehabilitation professionals.

Job Modification

In the past the last thing employers wanted to do was to redesign or modify jobs. Focus, instead, was placed on finding workers who could do the job as it was designed. As injuries increased the cost increased as well. However, attention is being placed on modifying job designs. Snook's procedure (Snook, 1978) is both systematic and pragmatic. Analgorhythmic representation can be seen in Appendix K. With input from the EJA and the job injury profile, priorities for modification can be identified.

Psychological Testing and Management

There are many times in the course of the management of industrial injury that psychological perspectives need to be considered. Test instruments such as the MBHI and the MMPI are quite helpful in determining the appropriate intervention. At certain times use of the MBHI or MMPI may be crucial in determining effective alternatives. Such occasions may be one of the following:

1. When an injured worker fails to return to work following rapid recovery protocols
2. When a PCE indicates a worker's ability to perform a certain job, but the worker fails to be productive
3. When there are gross inconsistencies in work performance within the PCE or subjective descriptions of discomfort
4. When a worker demonstrates dangerous work style and refuses to reform
5. When a worker is suspected of malingering.

Vocational Rehabilitation

In several states the Worker's Compensation law includes a clause requiring "mandatory rehabilitation". Essentially, this clause means that when a physician recommends rehabilitation therapies, the compensation carrier is required to provide the identified therapeutic interventions. In Florida this has resulted in a rapid growth in private vocational rehabilitation companies.

Rehabilitation specialists have traditionally been hired to assist carriers in the effective planning of rehabilitative efforts. Rehabilitation specialists can save carriers money by expediently rehabilitating injured workers and effectively returning them to employment. Many employers have quickly terminated injured workers following injury, thinking that by doing so they would be rid of all the problems that go with the injury. Ignorantly these employers have higher premiums as a result for continued compensation coverage. As increasing numbers of employers are becoming self-insured, their eyes are being opened to the wisdom of returning injured employees to work. Modifying jobs and redefining employee responsibilities have helped these self-insured employers save significant amounts of money by terminating lost days and wage replacement incomes, as well as occasional unnecessary surgeries and settlement claims.

There are times even in the most diverse industry that some injured workers cannot successfully be returned to employment within the system. It is at these times that an effective vocational specialist can find employment for injured workers outside the system in which he was injured. These vocational specialists are adept at understanding the meaning of a PCE and can utilize it in expediently identifying jobs in the community that are appropriate for the injured worker. While it is most desirable for an injured worker to be returned to his former employer, if it is not possible the injured employee will be best served by some type of return to productivity. Experience indicates that initially these injured workers resist employment outside of their previous work site. However, within time they adjust more successfully to work at the new job site than they do to being declared permanently disabled or otherwise unemployed. Vocational specialists should be utilized with workers who cannot fit into existing positions, who will not fit into existing positions, or who should not fit into existing positions.

## Initiation of Design and Preliminary Findings

The initiation of a design for responding to Gulf Power's request mandated an evaluation of (a) voluntary effort (health behaviors), (b) physical capacity, and (c) physical strength demands of a particular job. The MBHI, PCE, and EJA were selected and developed respectively for this evaluation process. The subjects were identified by Gulf Power and notified of the date for both the PCE and the MBHI test. Simultaneously, EJA procedures began as Gulf Power identified the priority jobs. The first phase of implementation, therefore, will be to complete the EJA's and to reassign workers to jobs they are physically competent to perform.

## Identification of Subjects

Fourteen subjects have participated in physical capacity testing. The subjects were all males, ranging in age from 34-62 as shown in Table 1. Disabilities are identified as to whether or not they are job related. Each subject has been declared incapable of performing his assigned job duties by his attending physician.

Table 1

Identification of Subjects by

Age, Disability, and Job Related Nature of Injury

| Subject | Age | Disability | Job Related? |
|---|---|---|---|
| 160089 | 58 | Hypertension | No |
| 160932 | 54 | Cardiorespiratory disease | No |
| 159507 | 57 | Post MI, coronary bypass | No |
| 130157 | 34 | Light headedness | No |
| 160063 | 62 | Hypothyroidism | No |
| 159534 | 60 | Degenerated hip | No |
| 160931 | 60 | Hip replacement | No |
| 160080 | 60 | Hypertension | No |
| 144711 | 44 | Diabetes | No |
| 147204 | 57 | Ankle fusion | Yes |
| 160102 | 39 | Knee injury | Yes |
| 160103 | 34 | Knee injury | Yes |
| 153598 | 36 | Back injury | Yes |
| 165113 | 47 | Back injury | Yes |

Note: Job related injuries are predominantly back related although not represented proportionately in this sample.

MBHI Results

Ten subjects completed the MBHI. Three were uncooperative. One of the test protocols was invalid because none of the subject's scores on the coping style scales exceeded the minimum for a valid profile. The remaining nine protocols have been summarized in Table 2 in order to observe initial findings. "For the MBHI, raw scores are transformed into base rate scores" (BR), a conversion predicated on estimated style or class prevalence data, and by utilizing cutting lines which maximize correct classifications; that is, calculated in terms of optional valid positive to false positive ratios" (Millon, Green, & Meagher, 1976, p. 9). The frequency distribution is indicated according to the scales of the MBHI and the base rate.

Table 2

Millon Behavioral Health Inventory

Distribution of Tested Subjects on MBHI Scales

as Compared to Normative Population (N=9)

| | % of Base Rate Scores > 75 | |
|---|---|---|
| Coping Style | Subjects | Normative Population |
| Introversive | 66 | 17.8 |
| Inhibited | 11 | 25.9 |
| Cooperative | 33 | 25.9 |
| Sociable | 22 | 19.5 |
| Confident | 22 | 15.7 |
| Forceful | 22 | 16.8 |
| Respectful | 22 | 27.6 |
| Sensitive | 22 | 22.2 |
| Psychogenic Attitude | | |
| Chronic Tension | 11 | 17.8 |
| Recent Stress | 11 | 13.0 |
| Premorbid Pessimism | 11 | 17.8 |
| Future Despair | 0 | 16.2 |
| Social Alienation | 11 | 16.2 |
| Somatic Anxiety | 11 | 16.8 |

Table 2 (continued)

| Psychosomatic Correlate | % of Base Rate Scores >75 Subjects | Normative Population |
|---|---|---|
| Allergic Inclination | 44 | 43 |
| Gastrointestinal Susceptibility | 22 | 37 |
| Cardiovascular Tendency | 11 | 29 |
| Prognostic Index | | |
| Pain Treatment Responsivity | 11 | 30 |
| Life Threat Reactivity | 22 | 29 |
| Emotional Vulnerability | 0 | 12 |

Note: The Introversive Coping Style is significantly predominant in this sample.

PCE Results

Of the fourteen subjects who have undergone PCEs, three were found to be physically capable of continuing their former job assignment and have resumed full-time work in that assignment. Two of the subjects have removed themselves from the work force as is noted in Table 3. The remaining nine subjects will be reassigned to jobs they have demonstrated physical capacity to perform. (A sample PCE is included in Appendix G.)

Table 3

Physical Capacity Category and Disposition

| Subject | Age | Category* | Disposition |
|---|---|---|---|
| 160089 | 58 | Heavy | Returned to former job |
| 160932 | 54 | Medium | Retired |
| 159507 | 57 | Medium | Reassigned |
| 130157 | 34 | Heavy | Reassigned |
| 160063 | 62 | Heavy | Reassigned |
| 159534 | 60 | Light | Reassigned |
| 160931 | 60 | Heavy | Reassigned |
| 160080 | 60 | Medium | Reassigned |
| 144711 | 44 | Medium | Applied for LTD |
| 147204 | 37 | Very Heavy | Returned to former job |
| 160102 | 39 | Heavy | Reassigned |
| 160103 | 34 | Heavy | Reassigned |
| 153598 | 36 | Heavy | Returned to former job |
| 165113 | 47 | Medium | Reassigned |

* Categories are according to Department of Labor definitions.

## EJA Results

Ten jobs have been analyzed for Gulf Power Company. While it would be prohibitive to measure and record every physical aspect of a job, great care was given to identifying the range of physical activity and very specifically quantifying the physical strength demands of each job by utilizing the developed tool. Emphasis was placed on quantifying those activities and conditions that were most demanding. Table 4 indicates the classification of the analyzed jobs according to Department of Labor definitions. A sample EJA can be observed in Appendix H. Forty-five additional jobs remain to be analyzed. A listing of the 53 total positions and their job name is included in Appendix I.

Table 4

Analyzed Jobs According to

Title and Physical Demands Classification

| Job Title | Classification |
| --- | --- |
| Materialsman Timekeeper | Light |
| Radio and Telephone Clerk A | Sedentary |
| Mechanic-Plant | Very Heavy |
| Journeyman Lineman | Very heavy |
| Journeyman Meterman | Medium |
| Connect and Disconnect | Light |
| Apprentice Distribution System Operator | Light |
| Warehouseman | Heavy |
| Repairman-Shops | Heavy |
| Mechanic-Garage | Heavy |

Note: Detailed measurements of each job are recorded for in-depth reference at the time of worker assignment.

# Chapter 5

## Discussion and Recommendations

This project has accomplished its purposes. Through the development of the PCE and EJA tools, workers are being returned to productive employment. A mechanism has been established that leads to rapid management of industrial injuries and, more importantly, prevention of injuries through job specific strength screening. Health and attitude enhancement programs outlined in this project provide even greater benefits to industries that rely on the physical strength of their work force.

Increasing costs of health care and shrinking capital in modern industry demand that leaders seek new solutions to old problems. There is a proliferation of wellness programs, stress management programs, and a reorganization of the health care industry to include Health Maintenance Organizations (HMOs), Preferred Provider Organizations (PPOs), and other new structures. The process of remediation points to more effective means of prevention. This project has taken some of the same tools used in the treatment of industrial injury and applied them toward prevention. If these measures are utilized systematically the benefits to industry and workers can be significant.

The social impact includes an individualized approach to the solutions to many of the problems of industry by looking at job requirements, physical capacities of individuals, and voluntary effort. As demonstrated in this project, returning injured workers to full employment results in more efficiency for personnel, industry, and society. In addition, the economic costs to industry are potentially reduced, ultimately resulting in improvement in the quality of life for consumers of industry's products and services.

Further research is required before the MBHI can be fully utilized. It is recommended that a significant number of test protocols be accumulated along with follow up data focused on outcome from job reassignment. A factor analysis of the variables can indicate which scales predict success or failure. It may also identify additional treatment interventions of a more psychological nature.

# REFERENCES

Adams, M. A., & Hutton, W. C. (1982). Prolapsed intervertebral disk. Spine, 7(3), 184.

Berkely Planning Associates. (1982). A study of accomodations provided to handicapped employees by federal contracts. Employment Standards Administration, U.S. Department of Labor.

Blankenship, K. L. (1984). Occupational physical therapy. Macon, GA: American Therapeutics.

Brand, R. A. (1983). Low back impairment rating practices of orthopedic surgeons. Spine, 8(1), 75-78.

Bureau of Labor Statistics. (1980). Occupational injuries and illnesses in the United States by industry. (Bulletin 2130). U.S. Department of Labor.

Caldwell, A. B., & Chase, C. (1977). Diagnosis and treatment of personality factors in chronic low back pain. Clinical Orthopedics and Related Research.

Chaffin, D. B. (1972). Some effects of physical exertion. Unpublished manuscript. Department of Industrial Engineering, University of Michigan.

Chaffin, D. & Anderson, G. (1984). Occupational biomechanics. New York: John Wiley & Sons, Inc.

Chaffin, D. B. (1974). Human strength capacity and low back pain. Journal of Occupational Medicine, 16, 248-254.

Chaffin, D. B., Herrin, G. D., Keyserling, W. M., & Foulke, J. A. (1977). Pre-employment strength testing. NIOSH Technical Report, DHEW (NIOSH) Publication No. 77-163.

Faimon, G. R. (1987). Research in the area of preventing disability dependence. In Rehab Brief (Vol. IX, No. 3, ISSN: 0732-2623). Washington, D.C.: National Institute of Handicapped Research.

Fiorini, G. T. & McCammond, D. (1976). Forces on the lumbovertebral facets. Annals of Biomedical Engineering, 4, 354-363.

Fordyce, W. E. (1978). Relationship of patient semantic pain description to physician diagnostic judgments, activity levels and MMPI. Pain, 5, 293.

Frymoyer, J. W. (1988). Medical progess: Back pain and sciatica. The New England Journal of Medicine, 318, 291-300.

Gatchel, R. J., Mayer, T. G., Capra, P., & Barnett, J. (1986). MBHI: Its utility in predicting physical

Gyntelberg, F. (1974). One year incidence of low back pain among male residents in the city of Copenhagen, aged 40-59. Danish Medical Bulletin, 21, 30-36.

Harber, P., & Soo Hoo, K. (1984). Static ergonomic strength testing in evaluating occupational back pain. Journal of Occupational Medicine, 26(12), 877-884.

Hathaway, S. R. & McKinley, J. C. (1943). Minnesota Multiphasic Personality Inventory. Minneapolis: National Computer Systems, Inc.

Institute for Loss Control Studies (1984). I.S.A. Safety and Loss Control Bulletin. Philadelphia, PA.

Johnston, B., & Blakney, M. G. (1984). Industrial health program: Alternative or Obligation? Clinical Management, 2, 18-22.

Jones, A. (1988). Safe, specific testing and rehabilitation exercise for the muscles of the lumbar spine. Santa Barbara: Sequoia Communications.

Klein, B. P., Jensen, R. C., & Sanderson, L. M. (1980). Assessment of workers compensation claims for back strains/sprains. Journal of Occupational Medicine, 26, 443-448.

Liles, D. H., & Mahajan, P. (1985, February). Using NIOSH lifting guide decreases risks of back injuries. Occupational Health and Safety, 57-60.

Matheson, L. N. (1984). Work capacity evaluation. Trabuco Canyon, California: ERIC.

Mayer, T. G. (1983). Rehabilitation of the patient with spinal pain. Orthopedic Clinics of North America, 14,(3).

Millon, T., Green, C., & Meagher, R. (1976). Millon Behavioral Health Inventory. Minneapolis: National Computer Systems, Inc.

Morris, A. (1984, March). Program compliance key to preventing low back injuries. Occupational Health and Safety, 44-47.

Morris, A., & Randolph, J. W. (1984, August). Back rehabilitation programs speed recovery of injured workers. Occupational Health and Safety, 53-68.

Nachemson, A. L. (1983). Work for all. Clinical Orthopedics, 179, 77-84.

National Institute for Occupational Safety and Health (NIOSH). (1981). Work Practices Guide for Manual Lifting. Publication No. 81-122.

Nelson, M. A., Allen, P., Clamp, S. E., et al. (1979). Reliability and reproducibility of clinical findings in low back pain, Spine, 47, 97-101.

Orme, T. J., Brown, C. W., & Richardson, H. D. (1985, April). The use of the Millon Behavioral Health

Inventory (MBHI) as a predictor of surgical suitability. Conference proceedings of the International Society for the Study of the Lumbar Spine, Sydney, Australia.

Pope, M. H., Rosen, J. C., Wilder, D. G., & Frymoyer, J. W. (1980). The relation between biomechanical and psychological factors in patients with low back pain. Spine, 5, 173-178.

Rowe, M. L. (1969). Low back pain in industry, a position paper. Journal of Occupational Medicine, 11, 161-169.

Rowe, M. L. (1983). Backache at work. Fairport, New York: Perinton Press.

Saal, J. A. (1987). The physiatric and orthopedic team care approach to sports medicine. State of the Arts Reviews, Physical Medicine and Rehabilitation, 1(4).

Schecter, D. S. (1984, June). Headlines. Hospitals, 24.

Simmons, J. (1984, November). Medicological applications and implications of objective back testing. In Isokinetic testing and rehabilitation of the back. Symposium conducted on November 29, 1984 in New Orleans, LA.

Snook, S. H. (1978). The design of manual handling tasks. Ergonomics, 21, 963-985.

Snook, S. H. (1983, October). The perspective of industry. Proceedings on industrial low back pain, sponsored by the Rehabilitation Engineering Center, University of Vermont and the Department of Orthopedic Surgery, University of Iowa.

Snook, S. H., Campanelli, R. A., & Hart, J. W. (1978). A study of three preventive approaches to low back injury. Journal of Occupational Medicine, 20, 478-481.

Snook, S. H., & Jensen, R. C. (1984). Cost. In M. H. Pope, et al: Occupational Low Back Pain. New York: Praeger.

Sternbach, R. A. (1974). Pain patients: Traits and treatment. San Diego: Academic Press, 44.

U.S. Department of Labor, Dictionary of Occupational Titles, 4, 1977.

U.S. Department of Labor, Handbook for Analyzing Jobs. Menomonie, WI, 1972.

Volski, R. (1984). How to convince management to start a corporate fitness program. Clinical Management, 2, 13-17.

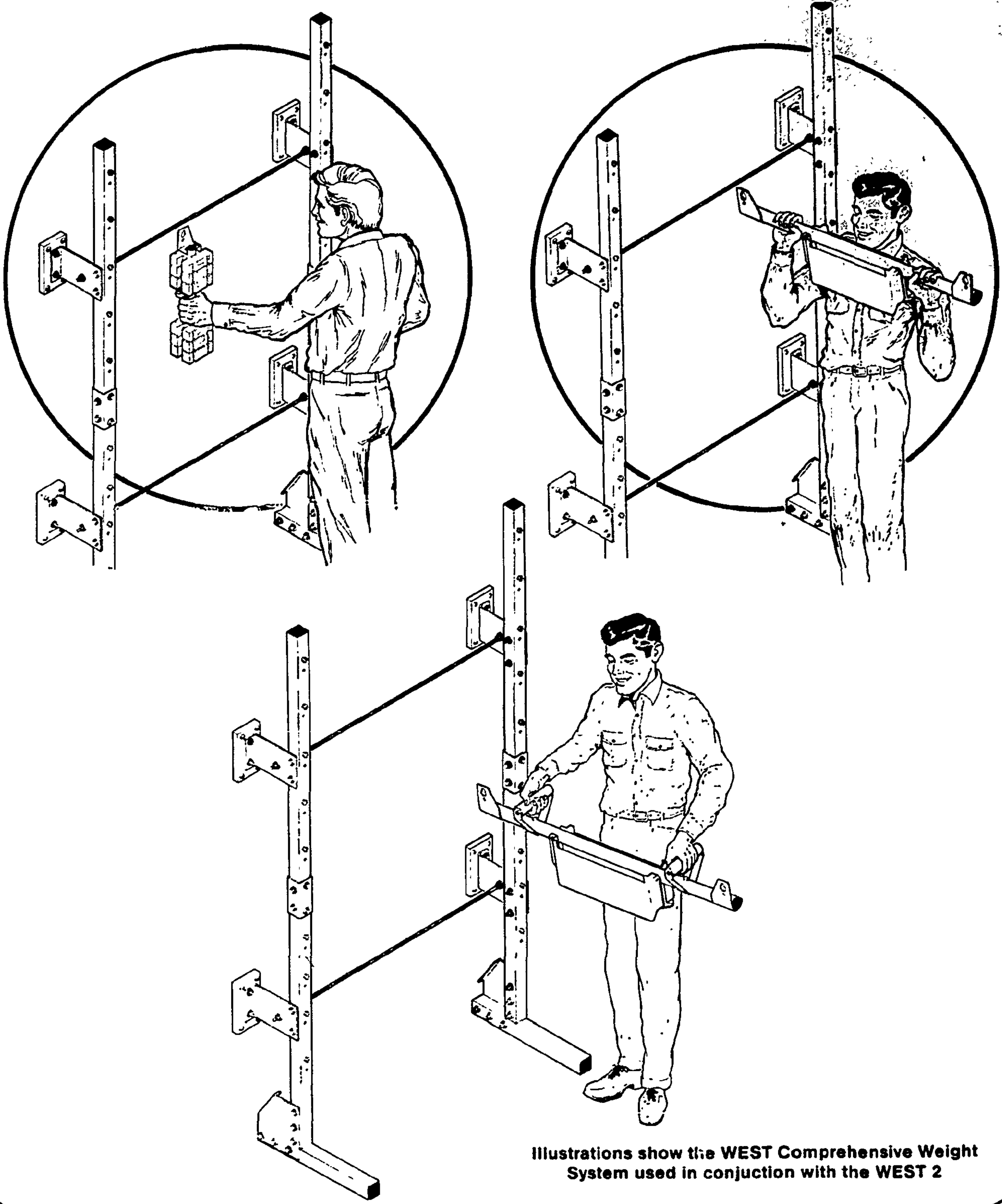
Waylonis, G. W. (1987). Medical history as part of disability evaluation. Archives of Physical Medicine and Rehabilitation, 68, 574-575.

Weisel, S. W., Feffer, H. L., & Rothman, R. H. (1984). Industrial low back pain: A prospective evaluation of a standardized diagnostic and treatment protocol. Proceedings from the 51st annual meeting of the American Academy of Orthopedic Surgeons.

# Appendix A

# WEST COMPREHENSIVE WEIGHT SYSTEM

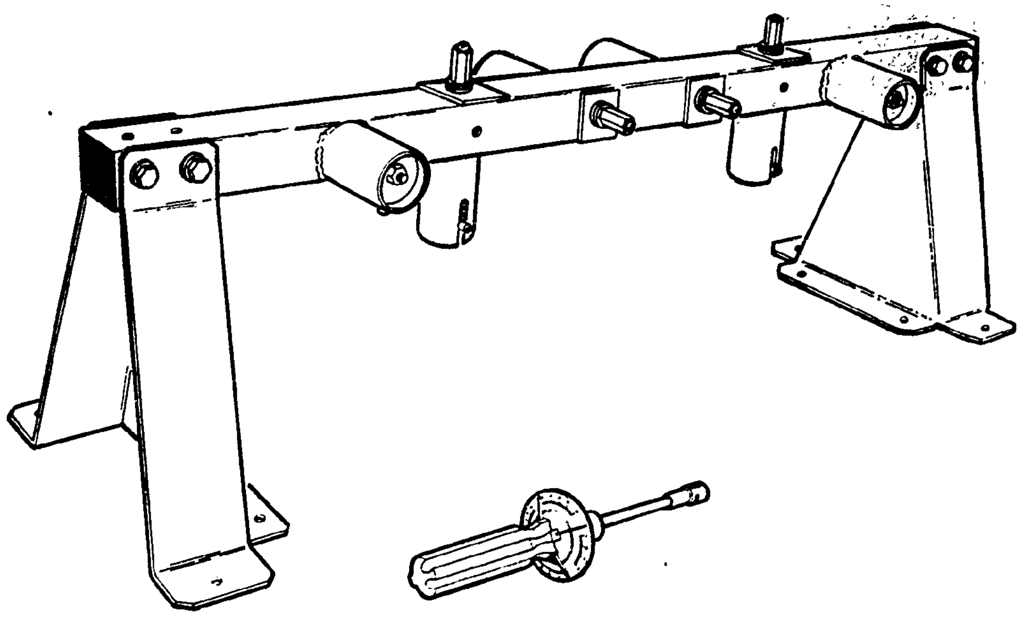
**The WEST Comprehensive Weight System is designed to be used in conjunction with the WEST 1 and WEST 2 to evaluate lifting and carrying capacity. The weight tray load can range from 5 pounds to 90 pounds in five-pound increments.**

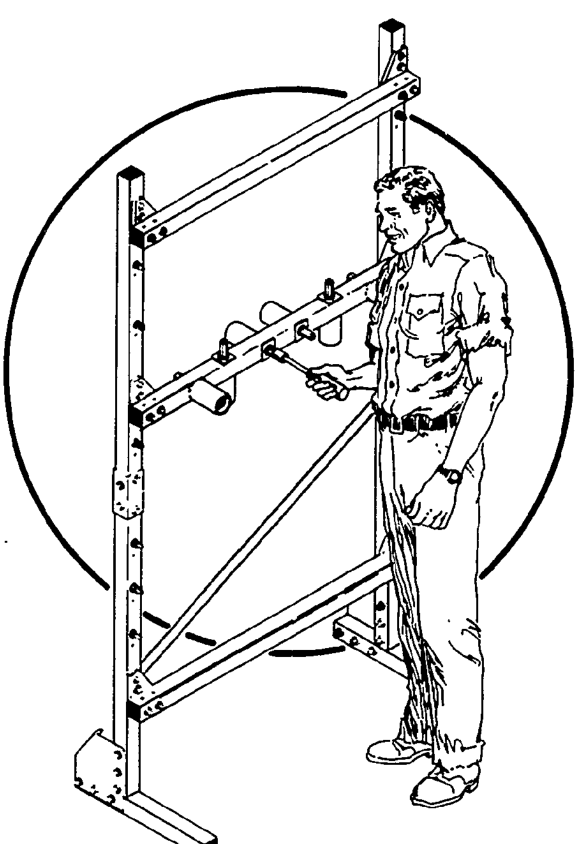


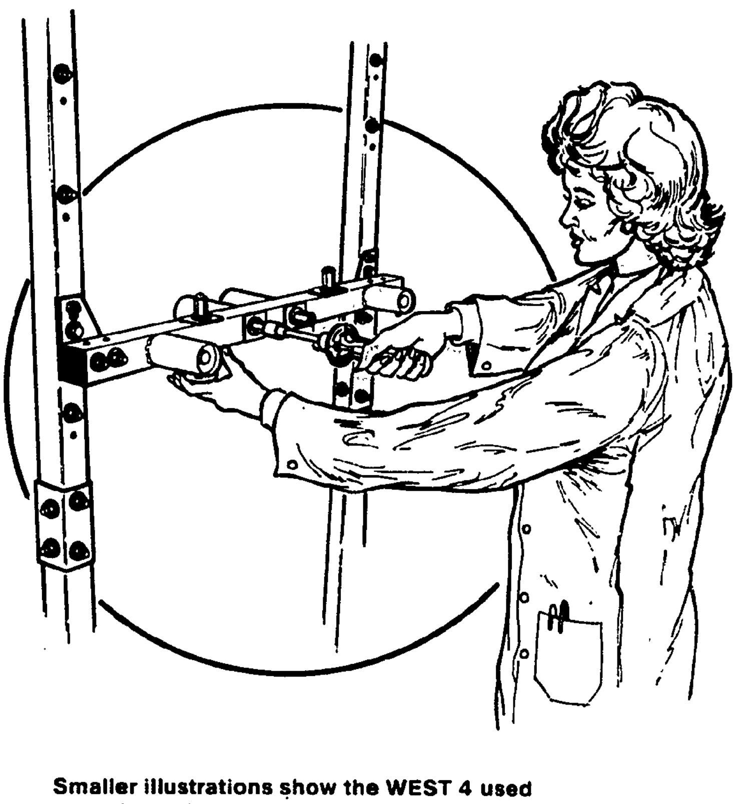
**Illustrations show the WEST Comprehensive Weight System used in conjuction with the WEST 2**

# WEST 4 - norms in manual

**The WEST 4 measures upper extremity strength and fatigue tolerance in tasks that require pronation/supination or internal/external rotation against resistance. Torque resistance values can be calibrated to range from 12 inch-pounds to 50 inch-pounds. When used with the WEST 1 or WEST 2, the WEST 4 measures upper extremity capacity in conjunction with whole body range of motion, including reaches to full extension overhead and prolonged overhead work.**







**Smaller illustrations show the WEST 4 used in conjunction with the WEST 2**

# Appendix B

# HIGH RISK WORK STYLE MEASUREMENT GUIDELINES

| | CONSERVATION OF H | CONTROL OF SPINAL TORQUE | STANCE | PACE/OBJECT CONTROL |
|---|---|---|---|---|
| **DEFINITIONS** | The ability to conserve the horizontal distance between the center of gravity of the load and the center of the spine at the sacrum while engaged in work tasks. | The ability to maintain the shoulders and the pelvis in alignment with no rotation of one in relation to the other while engaged in work tasks. | The ability to maintain placement of the feet in a broad and stable stance while engaged in work tasks. | The ability to maintain a controlled and measured pace while engaged in work tasks. |
| "+" Decreased probability of injury within cardiovascular/metabolic/biomechanical load limits. | H does not exceed 1.5 times minimum during lifts between waist and full extension overhead. | Alignment is maintained during lift/turn from maximum downward position to weight stand. | Feet are shoulder width or greater with forward/rearward placement for stability during lifts between waist and full extension overhead. | Handling of weight is controlled through full available range of motion. |
| "−1" Slightly increased probability of injury within cardiovascular/metabolic/biomechanical load limits. | H exceeds 1.5 times minimum through part of the range of motion. | Spinal torque is observed during lateral motion with the load after the lift and during the turn. | Feet are shoulder width or greater with parallel placement or less than shoulder width with forward/rearward placement. | Handling of weight is not well-controlled through part of available range of motion. |
| "−2" Moderately increased probability of injury within cardiovascular/metabolic/biomechanical load limits. | H exceeds 1.5 times minimum but is less than 2 times the minimum throughout available range of motion. | Spinal torque is observed during the lift/turn. | Feet are less than shoulder width with parallel placement. | Handling of weight is not well-controlled with abrupt acceleration of load while being lifted. |
| "−3" Injury is likely within cardiovascular/metabolic/biomechanical load limits. | H exceeds 2 times the minimum throughout available range of motion. | Spinal torque is observed before and during the lift/turn. | Feet are less than ½ shoulder width with forward/rearward or parallel placement. | Handling is not well-controlled with abrupt deceleration of load while being lowered. |
| **MEASUREMENT** | Determine minimum H. Observe foot placement during lifts between waist and full extension overhead. | Observe shoulders and pelvis during lift/turn from floor to weight stand. | Observe foot placement during lifts between waist and full extension overhead. | Observe lift/lower through full available range of motion. |

# Appendix C

WEST FLORIDA REGIONAL MEDICAL CENTER
REHABILITATION INSTITUTE OF WEST FLORIDA

WORK PERFORMANCE REHABILITATION CENTER

2-HOUR PHYSICAL CAPACITY EVALUATION
MAXIMUM VOLUNTARY STRENGTH MEASURES



DATE: ____________________

DOMINATE SIDE: ____________________

INJURY: ____________________

| CLIENTS | HEIGHT | LEVEL | AROM 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | LEVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 96" | | | | | | | | | | | | | | | | | | | | | | |
| | 90" | | | | | | | | | | | | | | | | | | | | | | |
| | 84" | | | | | | | | | | | | | | | | | | | | | | |
| | 78" | 10 | | | | | | | | | | | | | | | | | | | | | 10 |
| | 72" | 9 | | | | | | | | | | | | | | | | | | | | | 9 |
| | 66" | 8 | | | | | | | | | | | | | | | | | | | | | 8 |
| | 60" | 7 | | | | | | | | | | | | | | | | | | | | | 7 |
| | 54" | 6 | | | | | | | | | | | | | | | | | | | | | 6 |
| | 48" | 5 | | | | | | | | | | | | | | | | | | | | | 5 |
| | 42" | | | | | | | | | | | | | | | | | | | | | | |
| | 36" | 4 | | | | | | | | | | | | | | | | | | | | | 4 |
| | 30" | 3 | | | | | | | | | | | | | | | | | | | | | 3 |
| | 24" | 2 | | | | | | | | | | | | | | | | | | | | | 2 |
| | 18" | 1 | | | | | | | | | | | | | | | | | | | | | 1 |
| | 12" | | | | | | | | | | | | | | | | | | | | | | |
| | 6" | | | | | | | | | | | | | | | | | | | | | | |

(TWO HANDED LIFTING)

| AROM | ONE HAND RIGHT | | | AROM | ONE HAND LEFT | | |
|---|---|---|---|---|---|---|---|
| 0 | | | | 0 | | | |

**WEST 2**

DYNAMIC AND ISOMETRIC LIFTING STRENGTH

Isometric Strength Testing

| TESTING LEVELS | TRIAL I | TRIAL II | TRIAL III |
|---|---|---|---|
| Eye | | | |
| Shoulder | | | |
| Waist | | | |
| Knee | | | |

(horizontal distance to item liting) ←

**ISOMETRIC**

| | | Tr. 1 | Tr. 2 | Tr. 3 | |
|---|---|---|---|---|---|
| Grip Strength | Rt. | | | | lbs. of force |
| | Lt. | | | | lbs. of force |
| Static Pulling | | | | | lbs. of force |
| Static Pushing | | | | | lbs. of force |

**WEST 4 UPPER EXTREMITY STRENGTH & FATIGUE**

Test using ¼" nutdrive at level ___ of West 2 (between waist and shoulder)

| ORIENT | LAT. | WAIST/ FOREARM | ELBOW/ SHOULDER | FUNCTIONAL MAX. | # QTR. TURNS |
|---|---|---|---|---|---|
| Toward | | | | | |
| Toward | | | | | |
| Toward | | | | | |
| Toward | | | | | |

**ENDURANCE & REPETITIVE TESTING**

Leg Press-(flexion/extension) R= ____ L= ____
Continuous Walking = ____ mile in ____ min.
(10 minute maximum)
Stair Climbing = ____ flights ____ time
(1 flight = 13 stairs)
Repetitive Bending = ____ x (max. 20)
(1 x 15 seconds)
Repetitive Squatting = ____ x (max. 20)
(1 x 15 seconds)
Carrying (maximum) ____ lbs. ____ feet

NOTE: All Lifts are one repetition at varing height with approximately 5 seconds between lifts. A minute break is given between weight changes. The criteria for a successful lift are: 1) Maintenance of correct posture during lift, 2) Stable and predictable pain and pain that returns to its original level, 3) Compliance of patient with correct lifting techniques.

WPRC: 7/86

Evaluator ____________________

# Appendix D

REHABILITATION INSTITUTE OF WEST FLORIDA
WORK PERFORMANCE REHABILITATION CENTER

## RECOMMENDED MAXIMUM CAPACITIES FOR CONTINUOUS WORK

DATE:

### TWO-HANDED MATERIAL HANDLING

LIFTING:

Maximum = ______________________ lbs.
(Waist Level)

Frequently = ______________________ lbs.
(No more than 1 left per 15 seconds)

Limitations: ______________________________________________

CARRYING:

Maximum = ______________________ lbs.

Limitations: ______________________________________________

PUSHING: Average of __________ lbs. of force

PULLING: Average of __________ lbs. of force

### ONE-HANDED MATERIAL HANDLING

| | RIGHT | LEFT |
|---|---|---|
| Maximum | ________ lbs. | ________ lbs. |
| Grip Strength: | ________ lbs. of force | ________ lbs. of force |
| Fine Manipulation: | ________ (Y/N) | ________ (Y/N) |
| Gross Tool Use: | ________ (Y/N) | ________ (Y/N) |

Limitations: ______________________________________________

### STATIC POSITIONING

Patient is able to:

Continuously Sit: __________ at a time for __________ total in one 8 hour day.

Continuously Stand: __________ at a time for __________ total in one 8 hour day.

Continuously Walk: __________ at a time for __________ total in one 8 hour day.

WPRC: 9/86

Rehabilitation Institute of West Florida
Work Performance Rehabilitation Center
Recommended Maximum Capacities for Continuous Work
Continued
Page 2

REPETITIVE MEOVEMENTS

| Is Patient able to? | YES Occasionally | - Frequently | NO | COMMENTS: |
|---|---|---|---|---|
| 1. bend at waist | | | | |
| 2. squat (feet flat) | | | | |
| 3. kneel | | | | |
| 4. climb stairs | | | | |
| 5. climb a ladder | | | | |
| 6. reach up/out with right arm | | | | |
| 7. reach up/out with left arm | | | | |
| 8. fine control/push with right foot | | | | |
| 9. fine control/push with left foot | | | | |

MEDICAL CONSIDERATIONS

| Does patient? | | | |
|---|---|---|---|
| a. take medication that will affect working | | | |
| b. require assistive devices | | | |
| c. need change of position | | | |
| d. have vision impairment | | | |
| e. have hearing impairment | | | |
| f. have motor coordination problems | | | |
| g. need to avoid heights or moving machinery | | | |

Additional Comments: ______________________________

WPRC: 9/86

REHABILITATION INSTITUTE OF WEST FLORIDA
WORK PERORMANCE REHABILITATION CENTER

RECOMMENDED MAXIMUM CAPACITIES
FOR CONTINUOUS WORK



RECOMMENDED WORK CATAGORY

According to Volume II of the Dictionary of Occupational Titles pp. 654-655 (published by the U.S. Department of Labor (3rd ed. 1965), classification of strength demands in work this patient is capable of performing:

(  ) Sedentary Work: Lifting 10 lbs. maximum and occasionally lifting and/or carrying such articles as dockets, ledgers and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

(  ) Light Work: Lifting 20 lbs. maximum with frequent lifting and/or carrying of objects, weighing up to 10 lbs. Even though the weight lifted may be only a negligible amount, a job is in this category when it involves sitting and standing with a degree of pushing and pulling of arm and/or leg controls.

(  ) Medium Work: Lifting 50 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs.

(  ) Heavy Work: Lifting 100 lbs. maximum with frequent lifting and/or carrying of objects weighting up to 50 lbs.

(  ) Very Heavy Work: Lifting objects in excess of 100 lbs. with frequent lifting and/or carrying of objects weighing up to 50 lbs. or more.

On a level of: __________ full-time ______________ part-time participation.

RECOMMENDATIONS/COMMENTS

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

______________________________, R.P.T.

______________________________
Medical Director
Work Performance Rehabilitation Center

WPRC: 9/86

## Appendix E

WEST FLORIDA REGIONAL MEDICAL CENTER
WORK PERFORMANCE REHABILITATION
JOB ANALYSIS WORKSHEET

Company: ______________________ Date: ______________

Department: ______________________ Job Title: ______________

Task Description: ________________________________________

__________________________________________________________

| | Location | Time | Frequency | Comment |
|---|---|---|---|---|
| Standing | | | | |
| Walking | | | | |
| Sitting | | | | |

| | lbs | H | V | D | F | Comment |
|---|---|---|---|---|---|---|
| Holding | | | | | | |
| Lifting | | | | | | |

AL = 90 (6/H) (1 - .01 | V - 30 | ) (.7 + 3/D) (1 - F/F max)

| | lbs | Distance | V | F | Comments |
|---|---|---|---|---|---|
| Carrying | | | | | |

| | lbs | H | Surface | Comments |
|---|---|---|---|---|
| Pushing/Pulling | | | | |

| | H | Steps | Comments |
|---|---|---|---|
| Climbing/Balancing | | | |
| | H | F | Comments |
| Stooping/Bending | | | |
| Kneeling | | | |
| Crouching/Squat | | | |
| | Distance | F | Comments |
| Crawling | | | |
| Reaching | | | |
| Handling | | | |
| Fingering | | | |
| Feeling | | | |
| Talking/Hearing | | | |
| Seeing | | | |

Work Conditions

1. Inside/Outside/Both; %__________

2. Temp extremes; change__________

3. Wet/humid__________

4. Noise/Vibration__________

5. Hazards__________

6. Fumes, exposure__________

# Appendix F

**WEST FLORIDA REGIONAL MEDICAL CENTER**
**WORK PERFORMANCE REHABILITATION**
**JOB ANALYSIS**

Company:______________________ Date:______________

Department:____________________ Job Title:____________

Task Description:________________________________

________________________________________________

1. Strength T F Total

____Standing ____Minutes at a time ____Times in 8 hours ____Total Day

____Walking ____Minutes at a time ____Times in 8 hours ____Total Day

____Sitting ____Minutes at a time ____Times in 8 hours ____Total Day

Comments:________________________________

________________________________________________

____Lifting ____lbs. force; ____H; ____V; ____D; ____F.

AL____ MPL____

____Lifting ____lbs. force; ____H; ____V; ____D; ____F.

AL____ MPL____

____Lifting ____lbs. force; ____H; ____V; ____D; ____F.

AL____ MPL____

____Carrying ________lbs.; ________Distance; ________F.

Comments:________________________________

________________________________________________

____Holding ____lbs. force; ____H; ____V; ____D; ____F.

Comments:________________________________

________________________________________________

____Pushing ____lbs. force; ____H; ____________Surface

____Pulling ____lbs. force; ____H; ____________Surface

Comments:________________________________

________________________________________________

2. _____Climbing/Balancing _____H; _____Steps

Comments: ________________________________________________

__________________________________________________________

3. _____Stooping/Bending _____H; _____F; _____Total.

Comments: ________________________________________________

__________________________________________________________

_____Kneeling _____H; _____F; _____Total.

Comments: ________________________________________________

_____Crouching/Squat _____H; _____F; _____Total.

Comments: ________________________________________________

_____Crawling _____Dis; _____F; _____Total.

Comments: ________________________________________________

4. _____Reaching; Comments: ______________________________

_____Handling; Comments: ______________________________

_____Fingering; Comments: ______________________________

5. _____Talking, Hearing; Comments: ______________________

6. _____Seeing; Comments: ______________________________

Working Conditions

Describe:

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

# Appendix G

Medical Center Clinic, P.A.

Department of
PHYSICAL MEDICINE
AND REHABILITATION
S. M. VerVOORT, M.D.

September 18, 1987

Gulf Power
Attention: Al Abdon
P. O. Box 1151
Pensacola, Florida 32520

160089

RE: [illegible]
MCC: 636677-5
DOB: 9/3/29

**PHYSICAL CAPACITIES EVALUATION:**

Mr. Millard is a fifty-eight year old white male that began to experience some pressing chest pain during the last week of January. On or about 2/2/87, he began to experience significant chest pain that caused him to present to the hospital in Tallahassee. He was being followed by Dr. Ellee in Tallahassee for his problems with hypertension. He was under good control on Atenolol at that time. Diagnosis at the time of admission to the hospital was a two week history of classic effort angina with good relief with nitroglycerin. EKG revealed frequent PVCs which had been a prior finding with inferior wall infarction and inferior wall ischemia, probably recent. Admission revealed 90% stenosis of the proximal right coronary artery on angiogram with no significant disease in the left system and mild hypokinesis of the inferior wall. Balloon transilluminal angioplasty of the right coronary artery was performed and had significant reduction in gradient pressure from greater than 50 mm. of mercury to less than 15. The patient was discharged home in good condition. On 2/19/87, he underwent a stress test where he completed one minute of stage IV at a heart rate of 150 with a normal blood pressure response. There were no STT wave changes and no symptoms. PVCs were present during the entire test and reduced with exercise. Dr. Ellee's assessment at that time was a normal exercise tolerance test. The patient was cleared to return to full time employment on Verapamil LA 245 mg. and one a day aspirin. The patient has continued to do well in follow-up. The only other problems that he has had is the development of shingles in his L5-S1 distribution of his right leg. This has caused him a significant amount of pain during the last several months but is generally under control at this point. The patient states that he still experiences occasional chest pain of a bloating pressure sensation in his chest when he is performing heavy work at work. He says this goes away quickly when the exertion is stopped. Additionally he relates a history of intermittent claudication of the lower extremities with a lot of walking. The patient presently is working as a heavy equipment operator for Gulf Power for which he has been in this position for over twenty-four years. He smokes four to five cigars

8333 North Davis Highway, Pensacola, Florida 32514-6049 904 474-8000 — Day or Night Answering Service
904 474-5358, Ext. 6112 — Office & Appointments

RE: [illegible] 160089
September 18, 1987
Page Two

a day but otherwise does not smoke other tobacco. He is married; this is his second wife. He has four children; all of which live away from home. He lives in Grand Ridge, Florida, in a one-story house.

**PHYSICAL EXAMINATION:** In general, reveals an alert, friendly white male in no acute distress. HEENT is unremarkable. Neck is supple. Full range of motion. Carotids 2+ bilaterally. No bruits. Lungs are clear to auscultation except for some end-inspiratory crackles in the left base. Heart regular rate and rhythm with no murmurs, rubs or gallops. Abdomen is soft and nontender, benign, no bruits noted. Back and spine nontender. No costovertebral angle tenderness. Extremities reveal full active range of motion of all extremities. Both lower extremities reveal skin changes compatible with arterial insufficiency. Pulses of the dorsalis pedis and posterior tibial in the feet are 1+ bilaterally. Femoral pulses are 2+ bilaterally. No femoral bruits are heard. The skin is without lesions. Neurologic exam - mental status - alert and oriented times three. Cranial nerves II-XII intact. Motor 5/5 in all extremities. Sensation is intact to light touch all dermatomes. Reflexes are 1+ bilaterally brachioradialis, 2+ bilaterally at the knees. Cerebellar intact to finger to nose bilaterally. Gait - the patient is able to ambulate independently with no abnormalities. Heel walk and toe walk are independent.

**IMPRESSIONS:** A gentleman with history of hypertension and inferior wall infarction requiring balloon angioplasty of 90% stenosis of right coronary artery. Subsequent to this, there was only 60% stenosis and the patient has had major relief from angina. He still experiences a small amount during work and has learned to limit himself because of this. With the present results of the physical capacities evaluation, the patient is able to perform significant work load activities but will require occasional periods of rest for fatigue and possible episodes of angina if this occurs. The patient can continue in his present work load given the results of this PCE. However, he should be allowed to have occasional periods of rest when he feels symptoms of angina or significant fatigue. He should be encouraged to continue as much work as possible. However, not to allow himself to become deconditioned. Therefore, I concur with the results of the PCE in that the patient can return to medium to a heavy work load on a full-time basis.

Shane M. VerVoort, M.D.

SMV/lln

original sent Dr. VanVoort 9/21/87

160089

**REHABILITATION INSTITUTE OF WEST FLORIDA**

**PAIN REHABILITATION PROGRAM**

**DEPARTMENT OF PHYSICAL THERAPY**
**EVALUATION HISTORY SHEET**

**DATE:** 9-18-87

**I. PERSONAL:**

**Name:** [illegible] **Age:** 58 **Ht.:** 5'7" **Wt.:** 175

**Dx.:** MI **Referring MD:** D. Allee

**Occupational Classification** ✓ **Industrial** Heavy Equip. Handles Gulf Power

— **Non-Indistrial**

**Date of Injury** Feb. '87 **Last Full Day of Work** presently working

**II. MEDICAL HISTORY:**

**Present Episode:** Pt. was laid off about 6-8 wks. following heart attack - angioplasty. Pt was at work during attack; was able to work through day.

**Surgery:** yes **Special Tests:** EKG, stress, arteriogram

**III. SUBJECTIVE:**

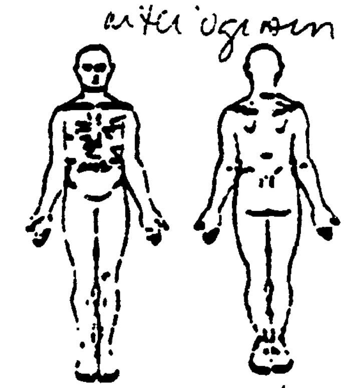
**Pain Location:** intermittent chest pain

**Other Symptoms:** abdominal spasms "indigestion"

**Pain Level (0-10):** Now 5

At Best 1

At Worst 9



**Other:** Occasional sleep disturbances, slight ↑ fatigue at night

**IV. FUNCTIONAL: JOB ACTIVITIES:**

✓ Lifting: 5-100# cables, chains, tools
✓ Pushing: "
✓ Pulling: "
✓ Carrying: "
✓ Bending:
✓ Squatting:
✓ Sitting: Bulldozer seat, lunch + breaks =60
✓ Standing:
✓ Walking:

8 hr. - 40 hr. week

PR/PT-3/85

160089

**REHABILITATION INSTITUTE OF WEST FLORIDA**
**WORK PERFORMANCE REHABILITATION CENTER**

**RECOMMENDED MAXIMUM CAPACITIES FOR CONTINUOUS WORK**

DATE: 9.18.87

**TWO-HANDED MATERIAL HANDLING**

LIFTING:

Maximum = 80 - 90 lbs.
(Waist Level)

Frequently = 35 - 40 lbs.
(No more than 1 left per 15 seconds)

Limitations: Pt. demonstrates slight shortness of breath and fatigue with repetitive tasks

CARRYING:

Maximum = 40.4 lbs.

Limitations:

PUSHING: Average of 30 lbs. of force

PULLING: Average of 60 lbs. of force

**ONE-HANDED MATERIAL HANDLING**

| | RIGHT | LEFT |
|---|---|---|
| Maximum: | 20 lbs. | 20 lbs. |
| | lbs. | lbs. |
| | lbs. | lbs. |
| Grip Strength: | 80 lbs. of force | 83 lbs. of force |
| Fine Manipulation: | yes (Y/N) | yes (Y/N) |
| Gross Tool Use: | yes (Y/N) | yes (Y/N) |

Limitations: Pt. should monitor fatigue levels to prevent physical stress

**STATIC POSITIONING**

Patient is able to:

Continuously Sit: 30-40 min at a time for 4-5 hr. total in one 8 hour day.

Continuously Stand: 40-50 min at a time for 4 hr. total in one 8 hour day.

Continuously Walk: 40-50 min at a time for 4 hr. total in one 8 hour day.

WPRC: 9/86

Rehabilitation Institute of West Florida
Work Performance Rehabilitation Center
Recommended Maximum Capacities for Continuous Work
Continued
Page 2

160089

REPETITIVE MEOVEMENTS

| Is Patient able to? | YES Occasionally | YES Frequently | NO | COMMENTS: |
|---|---|---|---|---|
| 1. bend at waist | ✓ | | | |
| 2. squat (feet flat) | ✓ | | | |
| 3. kneel | ✓ | | | |
| 4. climb stairs | ✓ | | | |
| 5. climb a ladder | ✓ | | | |
| 6. reach up/out with right arm | | ✓ | | |
| 7. reach up/out with left arm | | ✓ | | |
| 8. fine control/push with right foot | | ✓ | | |
| 9. fine control/push with left foot | | ✓ | | |

MEDICAL CONSIDERATIONS

| Does patient? | YES | NO | COMMENTS |
|---|---|---|---|
| a. take medication that will affect working | | ✓ | |
| b. require assistive devices | | ✓ | |
| c. need change of position | ✓ | | |
| d. have vision impairment | | ✓ | |
| e. have hearing impairment | ✓ | | slight hearing loss |
| f. have motor coordination problems | | ✓ | |
| g. need to avoid heights or moving machinery | | ✓ | |

Additional Comments: Pt. tolerated 2hr. PCE without complaint of discomfort or pain. Slight increase in respiration rate was noted with repetitive activity, esp. lift and carry tasks with loads > 30 lbs. Pt. demonstrated ability to pace physical activity levels and appeared only slightly fatigued at the end of the eval. procedure.

WPRC: 9/86

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**REHABILITATION INSTITUTE OF WEST FLORIDA**
**WORK PERORMANCE REHABILITATION CENTER**

**RECOMMENDED MAXIMUM CAPACITIES**
**FOR CONTINUOUS WORK**

Page 3

**RECOMMENDED WORK CATAGORY**

According to Volume II of the Dictionary of Occupational Titles pp. 654-655 (published by the U.S. Department of Labor (3rd ed. 1965), classification of strength demands in work this patient is capable of performing:

( ) Sedentary Work: Lifting 10 lbs. maximum and occasionally lifting and/or carrying such articles as dockets, ledgers and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

( ) Light Work: Lifting 20 lbs. maximum with frequent lifting and/or carrying of objects, weighing up to 10 lbs. Even though the weight lifted may be only a negligible amount, a job is in this category when it involves sitting and standing with a degree of pushing and pulling of arm and/or leg controls.

( ) Medium Work: Lifting 50 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs.

(✓) Heavy Work: Lifting 100 lbs. maximum with frequent lifting and/or carrying of objects weighting up to 50 lbs.

( ) Very Heavy Work: Lifting objects in excess of 100 lbs. with frequent lifting and/or carrying of objects weighing up to 50 lbs. or more.

On a level of: X full-time ______ part-time participation.

**RECOMMENDATIONS/COMMENTS**

Mr. Millard demonstrates ability to perform heavy work on a full-time basis. Gross physical strength is very good and pt. is well aware of pacing to prevent fatigue. Minimal cardiovascular changes (shortness of breath) were noted with lifting loads > 30-40 lbs, and I would recommend infrequent lifting as part of his job description/responsibilities. In my opinion, Mr. Millard is qualified to continue in his present position with Gulf Power. He should be allowed periodic rests to prevent stress fatigue.

Marna L. McCulloch, R.P.T.

Medical Director
Work Performance Rehabilitation Center

WPRC: 9/86

WEST , R CAL CENTER
REHABIL ATION STITUTE OF WEST FLORIDA

160089

## WORK PERFORMANCE REHABILITATION CENTER

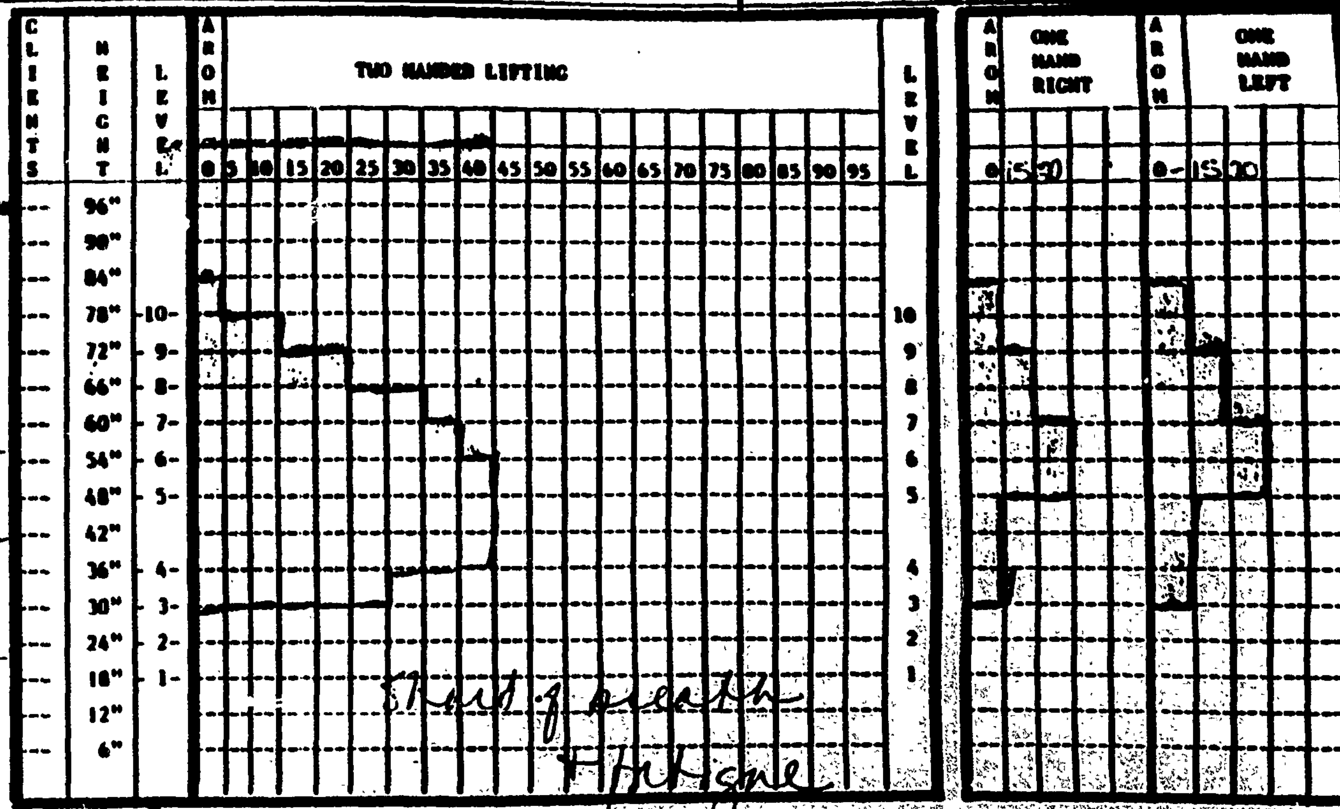
## 2-HOUR PHYSICAL CAPACITY EVALUATION
## MAXIMUM VOLUNTARY STRENGTH MEASURES



DATE: 9·18·87

DOMINATE SIDE: (R)

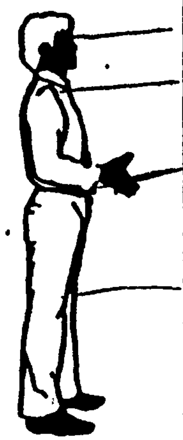
INJURY: MI




**WEST 2**

**DYNAMIC AND ISOMETRIC LIFTING STRENGTH**

Isometric Strength Testing



| TESTING LEVELS | TRIAL I | TRIAL II | TRIAL III |
|---|---|---|---|
| Eye | 63 | 73 | 75 |
| Shoulder | 83 | 65 | 87 |
| Waist | 65 | 65 | 90 |
| Knee | u | m | p- |

(horizontal distance to item liting) ← 10"

**ISOMETRIC**

| | | Tr. 1 | Tr. 2 | Tr. 3 | |
|---|---|---|---|---|---|
| Grip Strength | Rt. | 70 | 80 | 90 | lbs. of force |
| | Lt. | 80 | 80 | 90 | lbs. of force |
| Static Pulling | | 65 | 50 | 60 | lbs. of force |
| Static Pushing | | 45 | 30 | 20 | lbs. of force |

GOOD EFFORT

**WEST 4 UPPER EXTREMITY STRENGTH & FATIGUE**

Test using ¼" nutdrive at level 5 of West 2 (between waist and shoulder)

| ORIENT | LAT. | WAIST/ FOREARM | ELBOW/ SHOULDER | FUNCTIONAL MAX. | # QTR. TURNS |
|---|---|---|---|---|---|
| Toward | Lt | Pron | 90° | 18" # | 8 |
| Toward | Rt | Pron | / | 22" # | 10 |
| Toward | Lt | Sup | / | 24" # | 10 |
| Toward | Rt | Sup | / | 24" # | 10 |

**ENDURANCE & REPETITIVE TESTING**

Leg Press-(flexion/extension) R= 109 L=109
Continuous Walking = .375 mile in 10 min.
(10 minute maximum)
Stair Climbing = 4 flights 42" time
(1 flight = 13 stairs)
Repetitive Bending = 20 x (max. 20)
(1 x 15 seconds)
Repetitive Squatting = 20 x (max. 20)
(1 x 15 seconds)
Carrying (maximum) 40.4 lbs. 24 feet

NOTE: All Lifts are one repetition at varing height with approximately 5 seconds between lifts. A minute break is given between weight changes. The criteria for a successful lift are: 1) Maintenance of correct posture during lift, 2) Stable and predictable pain and pain that returns to the original level, 3) Compliance of patient with correct lifting techniques.

... able to maintain correct body posture.

Evaluator Marnia M. McCulloch PT

# Appendix H

## SUMMARY OF JOB ANALYSIS/STRENGTH DEMANDS

**JOB TITLE:** Journeyman Lineman

**PURPOSE:** The journeyman lineman is responsible for the installation and maintenance of utility poles, powerlines and all accessories.

**STRENGTH:** This worker must perform "heavy" work for hours at a time while climbing a utility pole. Some lifting on the ground involves weights that exceed 100 lbs. Although most lifting on the pole does not exceed 100 lbs. it can be up to 75 lbs. and can include holding the object in position for some time. According to NIOSH standards the Action Limit (the load at or below which 99% of the American adult male population and 75% of the American adult female population should be able to perform without increased risk of injury) and the Maximum Permissible Limit (the point at which only 25% of the men and 1% of the women will not experience an increased risk of injury) are exceeded by some of the lifting tasks. Consequently this job must be classified as "very heavy" work, safe for strong, healthy individuals.

**WORKING CONDITIONS:** Ninety nine percent of this job is conducted outdoors. Weather extremes can be encountered and workers are particularly exposed while on the utility pole. Safety guidelines must be closely adhered to as established by the industry in order to prevent injury.

**JOB CLASSIFICATION:** According to the Handbook for Analyzing Jobs (U.S. Department of Labor, 1972), the strength demands of this job classify it as "very heavy work". This is characterized by "lifting objects in excess of 100 lbs. with frequent lifting and/or carrying of objects weighing up to 50 lbs. or more".

**WEST FLORIDA REGIONAL MEDICAL CENTER**
**WORK PERFORMANCE REHABILITATION**
**JOB ANALYSIS/**
STRENGTH DEMANDS

Company: GULF POWER    Date: 8-4-87

Department: WEST DIVISION    Job Title: Journeyman Lineman

Task Description: Install and maintain poles, powerlines and all accessories.

1. Strength    T    F    Total

X Standing 4-5hrs. Minutes at a time    2 Times in 8 hours    ____ Total Day

____ Walking ____ Minutes at a time    ____ Times in 8 hours    ____ Total Day

____ Sitting ____ Minutes at a time    ____ Times in 8 hours    ____ Total Day

Comments: The worker is constantly on his feet. While on the pole his feet support his weight. He may be on the pole 4-5 hours without a break.

X Lifting 55 lbs. force; 24 H; 48 V; 24 D; 1 F.

AL 14.4 MPL 43

X Lifting 74 lbs. force; 24 H; 48 V; 24 D; 1 F.

AL 14.4 MPL 43

X Lifting 182.5 lbs. force; 6 H; 30 V; 6" D; 1 F.

AL 101 MPL 303

X Carrying 182.5 lbs.; 30' Distance; 1 F. (transformer)

Comments: The above lifts are among the heavier lifts and can occur while on a pole.

X Holding 67 lbs. force; 6 H; 40 V; N/A D; N/A F.

Comments: Represents holding a directional light in place while attaching to the pole.

X Pushing 160 lbs. force; 8 H; hoist handle Surface

X Pulling 120 lbs. force; 24 H; crimper handle Surface

Comments: Above represents force needed to apply hand tools.

2. __X__ Climbing/Balancing _____H; _____Steps

Comments: Lineman climbs up to 75 feet high on utility pole. Worker must balance for long periods on climbing hooks and belt.

3. __X__ Stooping/Bending _____H; _____F; _____Total.

Comments: Infrequent, but with heavy loads.

__X__ Kneeling _____H; _____F; _____Total.

Comments: occasional

__X__ Crouching/Squat _____H; _____F; _____Total.

Comments: occasional

__X__ Crawling _____Dis; _____F; _____Total.

Comments: infrequent

4. __X__ Reaching; Comments: frequently reaches at arms length to work on pole.

__X__ Handling; Comments: must handle many articles of awkward shape.

__X__ Fingering; Comments: wears thick rubber gloves while fingering bolts and other small objects.

5. __X__ Talking, Hearing; Comments: communicates with co-workers from ground to pole.

6. __X__ Seeing; Comments: normal visual skills

**Working Conditions**

**Describe:**

Ninety nine percent of this job is outdoors. Weather can be extreme and worker is exposed while on the pole to environmental elements. Extreme caution must be taken when working around high voltage lines.

## JOB CLASSIFICATION

According to the Handbook for Analyzing Jobs (published by the U.S. Department of Labor, 1972), the strength demands of this job classify it as:

( ) Sedentary Work: Lifting 10 lbs. maximum and occasionally lifting and/or carrying such articles as dockets, ledgers and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

( ) Light Work: Lifting 20 lbs. maximum with frequent lifting and/or carrying of objects, weighing up to 10 lbs. Even though the weight lifted may be only a negligible amount, a job is in this category when it involves sitting and standing with a degree of pushing and pulling of arm and/or leg controls.

( ) Medium Work: Lifting50 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs.

( ) Heavy Work: Lifting 100 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 50 lbs.

(X) Very Heavy Work: Lifting objects in excess of 100 lbs. with frequent lifting and/or carrying of objects weighing up to 50 lbs. or more.

### DEFINITIONS

(H) Horizontal location - of the hands at ori~in of lift measured forward of the bodv centerline of midnoint be-tweenankles (in centimeters or inches).

(V) Verticle location - of the hands at origin of lift mea-sured from floor level in (centemeters or inches).

(D) Verticle travel distance - from origin to destination of lift in (centemeters of inches).

(F) Frequency of lifting - average number of lifts per minute.

(T) Duration or period - assumed to be occasional (less than one hour) or continuous (8 hours).

Infrequent - either occasional or continuous lifting less than once per 3 minutes.

Occasional high frequency - lifting one or more times per 3 minutes for a period up to 1 hour.

Continuous high frequency - lifting one or more times per 3 minutes continuously for 8 hours.

# Appendix I

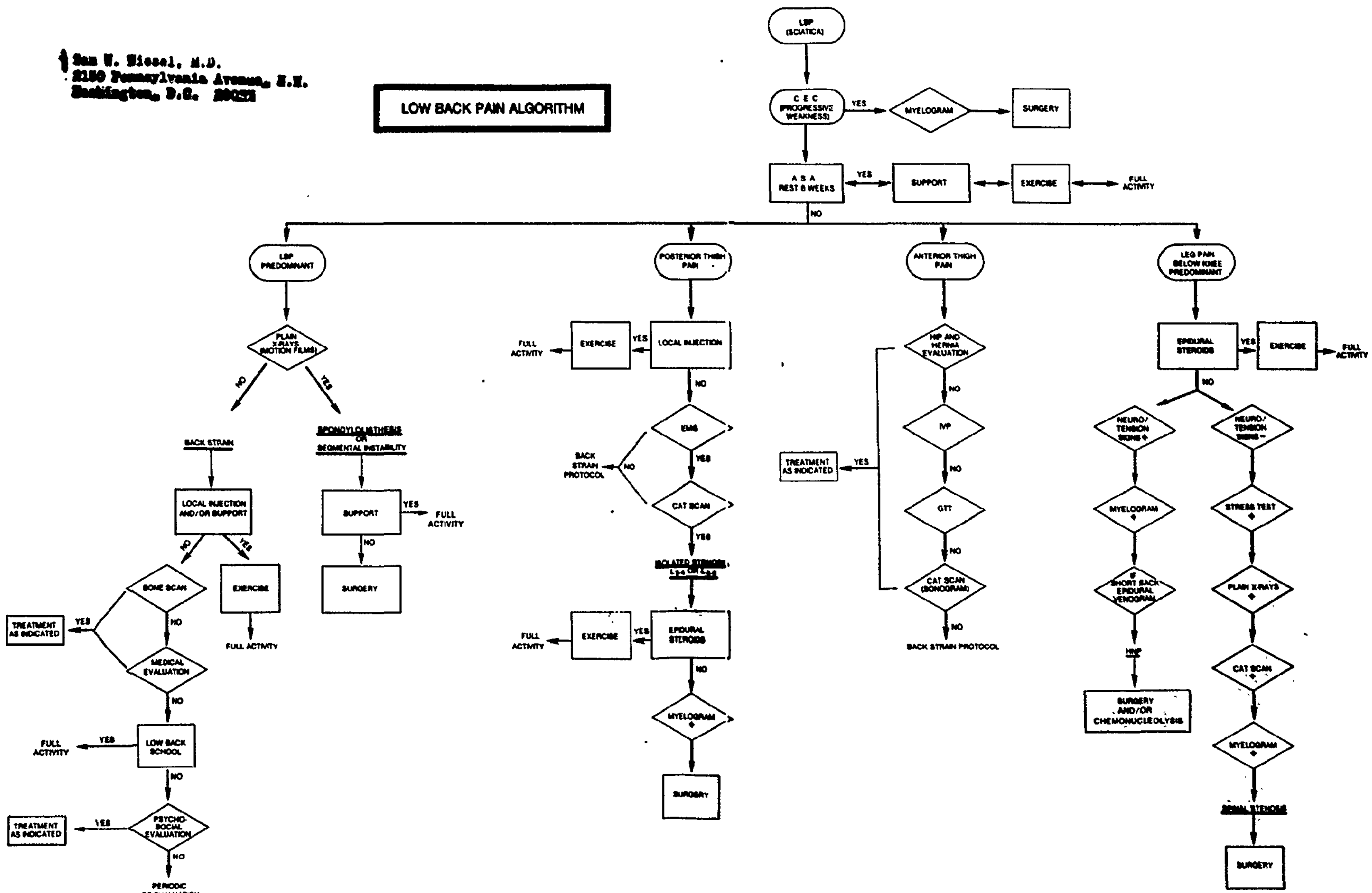
## COVERED FULL TIME POSITIONS

7050 UTILITYMAN (LINE)
7060 UTILITYMAN (SUBSTAT)
7080 UTILITYMAN (METER)
7090 UTILITYMAN (REPRSHOP)
7100 UTILITYMAN (GARAGE)
7110 UTILITYMAN (WAREHOUSE)
7120 DIS. SYS OPER CLERK
7124 RADIO & TEL CLK C
7130 UTILITYMAN (PLANT)
7350 APPL TECHNICIAN
7395 JUNIOR OPERATOR
7550 STOCK HANDLER-PLT
7565 STOCK HANDLER
7607 MATLMN & TMKPR B
7623 RADIO & TEL CLK B
7748 METERMAN C
7864 TRACTOR TRUCK OPER
7988 CONV & ASSC EQUIP OP
8006 WINCH TRK OPER II
8103 APPRENTICE-LINE
8115 APPRENTICE-CABLE SP
8120 APPR DISTR SYS OPER
8121 APPRENTICE-ELEC SERV
8130 APPRENTICE-SUBST
8136 APPRENTICE-COMM
8154 APPREN-REPAIR SHOP
8159 APPRENTICE-GARAGE
8192 APPR MECH-PLANT
8193 APPR WELDER-MECHANIC
8194 APPR ELECTRICIAN-PLT
8198 CONNECT & DISCONNECT
8206 MATLMN & TMKPR A
8250 WAREHOUSEMAN-PLT
8263 WAREHOUSEMAN
8370 METER READER
8447 METERMAN B
8571 CUT OUT COLLECTOR
8588 ASST LABORATORYMAN
8802 LINEMAN
8818 DISTR SYST OPERATOR
8819 SERVICEMAN-ELECTRIC
8829 ELECTRICIAN-SUBST
8835 REPAIRMAN-COMM
8840 SERVICEMAN A-APPL
8846 METERMAN A
8853 REPAIRMAN-SHOPS
8858 MECHANIC-GARAGE
8987 HVY COAL EQUIP OPER
8988 LABORATORYMAN
8989 MECHANIC-PLANT
8990 WELDER-MECHANIC-PLT
8991 ELECTRICIAN-PLANT
9078 PLANT EQUIP OPER

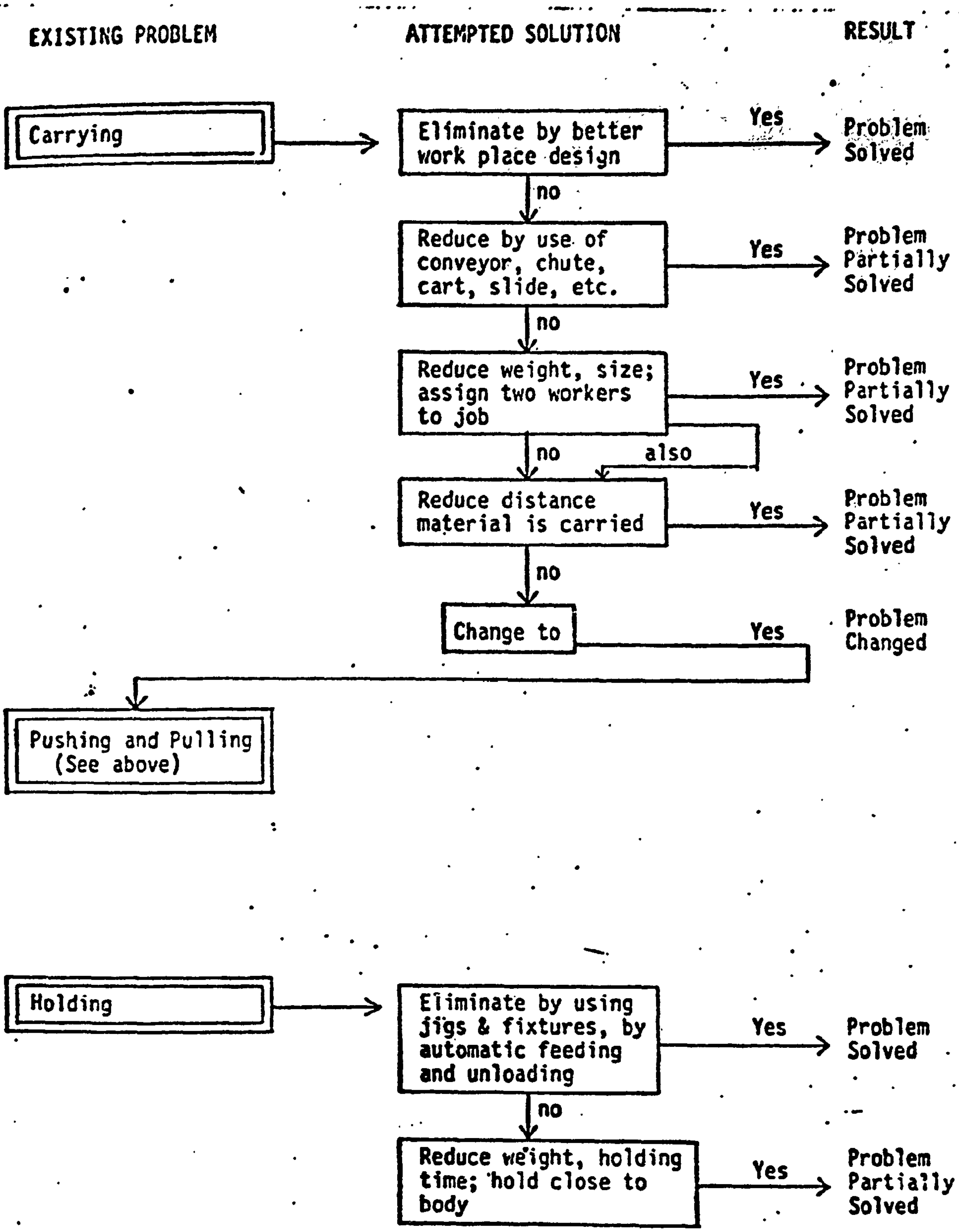
# Appendix J

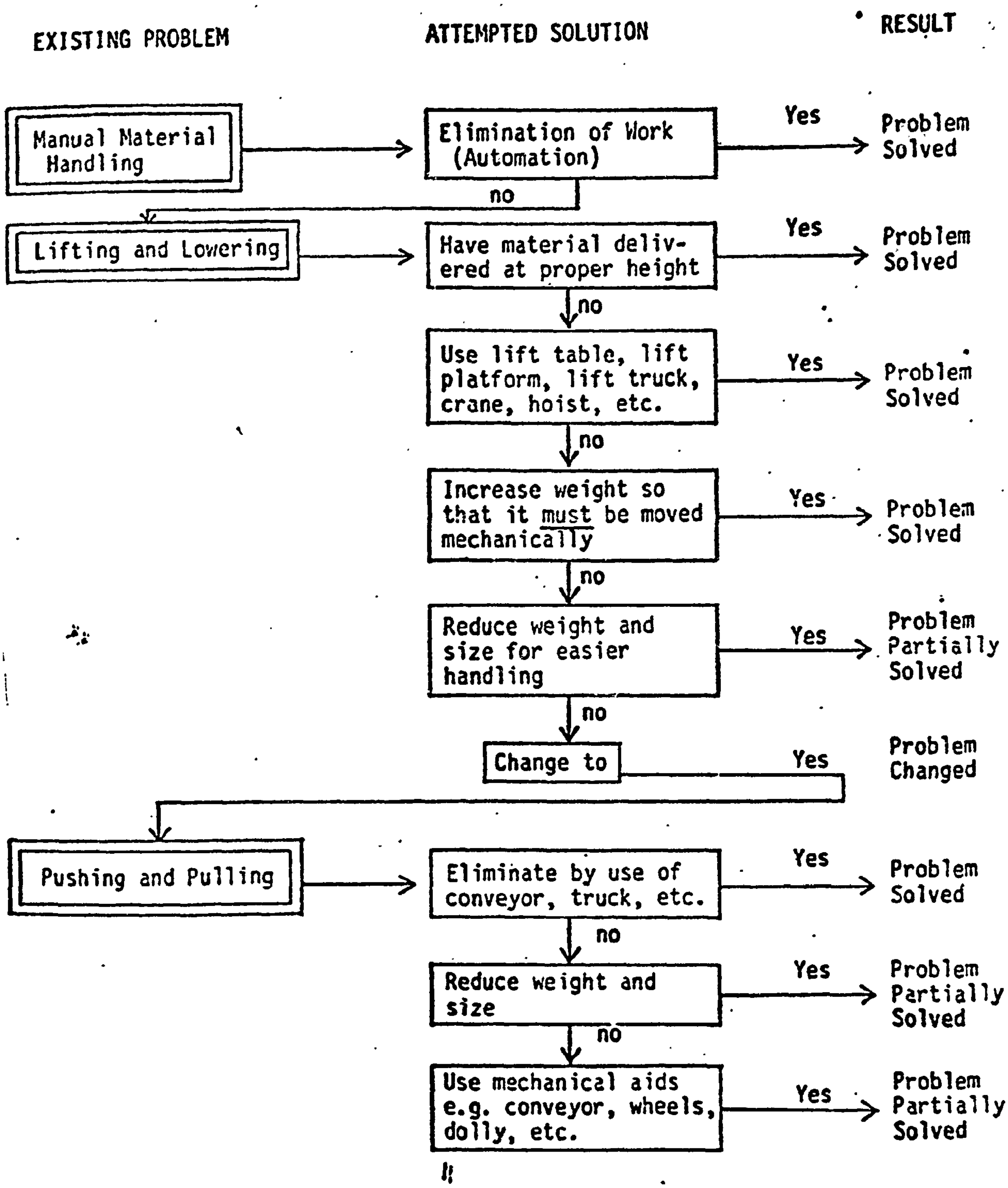
Sam W. Wiesel, M.D.
2150 Pennsylvania Avenue, N.W.
Washington, D.C. 20037

## LOW BACK PAIN ALGORITHM



# Appendix K


EXISTING PROBLEM
ATTEMPTED SOLUTION
RESULT
Carrying
Eliminate by better work place design
Yes
Problem Solved
no
Reduce by use of conveyor, chute, cart, slide, etc.
Yes
Problem Partially Solved
no
Reduce weight, size; assign two workers to job
Yes
Problem Partially Solved
no
also
Reduce distance material is carried
Yes
Problem Partially Solved
no
Change to
Yes
Problem Changed
Pushing and Pulling (See above)
Holding
Eliminate by using jigs & fixtures, by automatic feeding and unloading
Yes
Problem Solved
no
Reduce weight, holding time; hold close to body
Yes
Problem Partially Solved


EXISTING PROBLEM
ATTEMPTED SOLUTION
RESULT
Manual Material Handling
Elimination of Work (Automation)
Yes
Problem Solved
no
Lifting and Lowering
Have material delivered at proper height
Yes
Problem Solved
no
Use lift table, lift platform, lift truck, crane, hoist, etc.
Yes
Problem Solved
no
Increase weight so that it must be moved mechanically
Yes
Problem Solved
no
Reduce weight and size for easier handling
Yes
Problem Partially Solved
no
Change to
Yes
Problem Changed
Pushing and Pulling
Eliminate by use of conveyor, truck, etc.
Yes
Problem Solved
no
Reduce weight and size
Yes
Problem Partially Solved
no
Use mechanical aids e.g. conveyor, wheels, dolly, etc.
Yes
Problem Partially Solved

# GLOSSARY

Anthropometry. The measurement of man.

Biomechanics. A study of the application of forces by the human body.

Body Mechanics. The position the body is in while performing a task.

Collagen fibers. Proteinous white fibers of connective tissues.

Disability. Reduced ability of an individual to complete certain tasks.

Dynamometer. A force measurement device in either kilograms or pounds.

Endurance. Ability to sustain a performance.

Ergonomic job analysis. A quantification of the various tasks performed on a job from the worker's point of view.

Ergonomics. A multidisciplinary activity dealing with the interactions between man and his total working environment, plus such traditional and environmental aspects as atmosphere, heat, light, and sun, as well as of tools and equipment of the work place.

Facet. A small smooth area on a bone.

Fibrocytis. Inflammation of fibrous tissue.

Fibromyalgia. Pain associated with damaged muscle fibers.

Hyperostosis. Hypertrophy of bone.

Idiopathic. Denoting a disease of unknown cause.

Impairment. Reduced ability of the body to function.

Interarticular. Between two joints.

Isokinetics. A muscle exerts a force (i.e. contracts) and is met by an accommodating resistance with controlled speed.

Isometrics. A muscle exerts a force (i.e. contracts) against resistance without producing any motion, for example, to hold a weight still with the extended arm.

Job injury profile. Detailed records of any injury associated with a particular job. Combined with job analysis provides input toward modifications.

Light duty. Work at a reduced level from normal and to subjective tolerance.

Lost time. Absence from work for illness or injury.

Malingering. Willfull misrepresentation of ability to perform, suggesting illness/injury.

Malapposition. Poor or incorrect fitting together of two substances.

MMI. Maximum Medical Improvement. A medicolegal term terminating medical treatment.

Pacing. Rate of activity related to energy resources/demands.

Physical (functional) capacity. Measured ability to perform physical activity related to work.

Physiology. The science that deals with the normal function of the living organ and its parts.

Psychophysics. A study of the relationship between stimulus and sensation.

Range of motion. The range of translation and rotation of a joint for each of its degrees of freedom.

Rotation. Motion in which all points describe circular arcs about an immovable line or axis.

Sclerosis. Hardening of chronic inflammatory origin.

Shear. A loading mode in which a load is applied parallel to the surface of the structure, causing internal angular deformation or slip.

Spondyloarthropathy. Disease of the vertebrae.

Spondylolisthesis. Forward movement of the body of one of the lower lumbar vertebrae on the vertebrae below it.

Strain. Deformation (lengthening or shortening) of a body divided by its original length.

Strain guage. A device that permits strain to be measured.

Strength. Generated force.

Subluxation. A dislocation of bone surfaces.

VO2 Max. The amount of air an individual can voluntarily exhale after taking a deep breath.

Work. The amount of energy required to move a body from one position to another.