ERGONOMICS, BIOMECHANICS & MUSCULOSKELETAL DISORDER- A REVIEW

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ABSTRACT

Through this review paper aspects of ergonomics are focused because it is an essential part of industry. In this paper biomechanics is discussed related to ergonomics. Ergonomics is a multidisciplinary field incorporating contributions from psychology, engineering, biomechanics, mechanobiology, industrial design, graphic design, statistics, operations research and anthropometry. Ergonomics is the study of people while they use equipment in specific environments to perform certain tasks. Ergonomics seeks to minimize adverse effects of the environment upon people and thus to enable each person to maximize his or her contribution to a given job. Ergonomic solutions are discussed in the paper. Aspects related to MSD (musculoskeletal disorder) are also discussed. This paper focuses on ergonomics, biomechanics & MSD (musculoskeletal disorder).

***Keywords*: Biomechanics, Ergonomics, Levers, MSD, Musculoskeletal Disorder**

I. INTRODUCTION

Ergonomics is the study of people while they use equipment in specific environments to perform certain tasks. Ergonomics seeks to minimize adverse effects of the environment upon people and thus to enable each person to maximize his or her contribution to a given job. It is also defined as designing a job to fit the worker so the work is safer and more efficient. Implementing ergonomic solutions can make employees more comfortable and increase productivity. The international ergonomics association defines ergonomics or human factors as "ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

II. BIOMECHANICS

Biomechanics is the study of the structural elements of the human body in relation to how the body functions and how much stress, acceleration and impact it can stand. Simply defined, it is the application of the principles of mechanics to living biological material. Today, the total energy demanded from a person in the performance of an industrial task has often been drastically reduced through better engineering and technology. However, stress may be created in small components of the worker's anatomy. Ergonomists use information about the functional anatomy of the living body to eliminate, reduce or manage such stresses. Ergonomists apply the principles of biomechanics to problems of occupational health, occupational safety and industrial productivity.

2.1 Equipment

Improperly designed chairs or other poorly designed equipment may obstruct the blood flow to body tissues. It is essential that designers as well as the evaluators of tools and equipment be familiar with the location of blood vessels vulnerable to compression. Of special importance is a knowledge of the location of blood vessels and other pressure sensitive anatomical structures in the hand. For example, poorly designed or improperly held hand tools may squeeze the hand's ulnar nerve, which can lead to numbness and tingling of the fingers. The simplest of hand tools, if designed without due consideration to biomechanical principles, can adversely affect the health of workers as well as their performance and productivity. Even slight changes in the posture of a limb may affect the mechanical advantage at which muscles operate, and hence their efficiency, to a considerable degree. Outward rotation of the forearm is a very important movement in industrial operation. Outward rotation is employed, for example, when the right forearm and hand are used to close valves, tighten screws and operate lathes. The effectiveness of the muscle is impaired when the angle between the forearm and upper arm is larger or smaller than the optimum of approximately 90 degrees.

2.2 Types of Movements of Body Members

Movements by the body during its performance of particular activities in industry can be described in operational terms:

- Positioning movements are those in which the hand or foot moves from one specific position to another, such as when reaching for a control knob.
- Continuous movements are those that require muscular control adjustments of some type during the movement, such as when operating the steering wheel of a car or guiding a piece of wood through a band saw.
- Manipulative movements involve the handling of parts, tools and control mechanisms, typically with the fingers or hands.
- Repetitive movements are those in which the same movement is repeated. Hammering, using a screwdriver and turning
- a hand wheel are examples of repetitive movements.
- Sequential movements are relatively separate independent movements in a sequence.
- A *static posture* involves maintaining a body segment in a specific position for a period of time. The ability to describe movements of the body in such operational terms permits ergonomists to apply the principles of biomechanics to problems associated with workplace health, safety and productivity.

2.3 Muscles

When any form of bodily activity calls for a considerable expenditure of effort, the necessary movements must be organized such that muscle power is used most effectively and skillfully. Since a muscle is most powerful at the beginning of its contraction, it is a good idea, in principle, to start from a posture in which the muscle is fully extended. There are so many exceptions to this general rule, however, that it has more theoretical than practical value. One must also take into account the leverage effect of the bones. If several muscles join forces, exertion is usually at its greatest when as many muscles as possible contract simultaneously. The maximum force of which a muscle, or group of muscles, is capable depends upon (a) age, (b) sex, (c) constitution, (d) state of

training and (e) momentary motivation. Muscle power peaks, for both men and women, at between 25 and 35 years of age. Older workers, between 50 and 60 years of age, can produce only about 75 to 85 percent as much muscular power as during those peak years.

2.4 Levers

A lever is a simple machine used to perform work. It consists of a long object, such as a rod or plank, and a braced object on which the rod rests. The braced, or fixed part, is called the fulcrum.

- **First-Class Levers**

First-class levers have the fulcrum placed between the load and the effort. Examples include the seesaw, crowbar and the balance scale. If the two arms of the lever are of equal length, the effort must be equal to the load. In the instance of the crowbar, the effort travels farther than the load and is less than the load. A pair of scissors is a double lever of the first class. The first-class lever is illustrated in Figure 1.

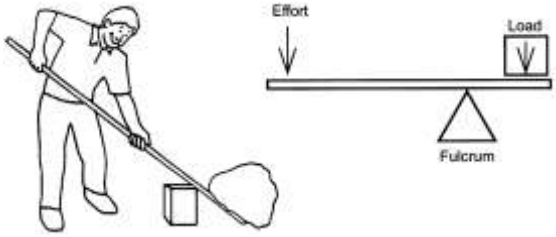

Fig. 1: Examples of a First-Class Lever

- **Second-Class Levers**

Second-class levers have the load between the effort and the fulcrum. A wheelbarrow is a second class lever. The wheel is the fulcrum, the handles take the effort, and the load is placed between the wheel and the effort (person doing the lifting). The effort always travels a greater distance and is less than the load. A nutcracker is a double lever of this class. The second-class lever is illustrated by Figure 2.

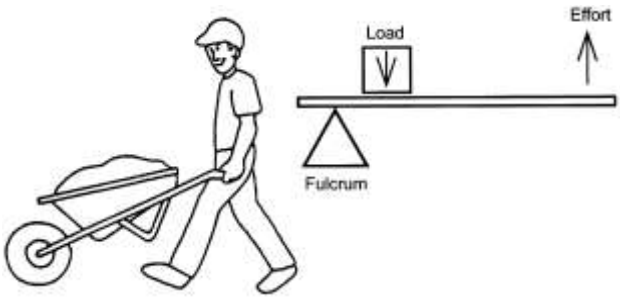

Fig. 2: Examples of a Second-Class Lever

- **Third-Class Levers**

Third-class levers have the effort placed between the load and the fulcrum. The effort always travels a shorter distance and must be greater than the load. The forearm is a third-class lever. When the hand is holding a weight, the weight is lifted by the biceps muscle of the upper arm, which is attached to the forearm near the elbow. The elbow joint is the fulcrum. The third-class lever is illustrated in Figure 3.

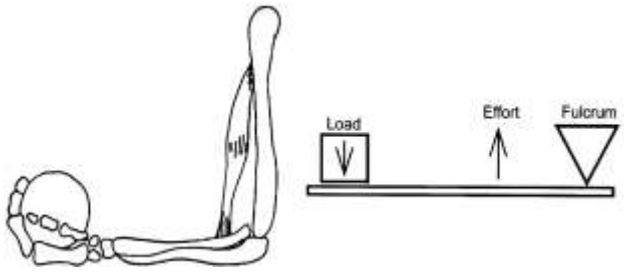

Fig. 3: Examples of a Third-Class Lever

III. ADVANTAGES OF ERGONOMICS

Stressed	Better
 Bent posture	 Extension handle allows for natural posture
 Seat is too small and provides minimal support	 Higher back seat with lumbar support and more support under legs
 Manual screw driver with bent wrist	 Powered in-line screw driver allows for straight wrist

 No neck support or padding under body	 Creeper gets worker off floor and provides neck and shoulders support
 Bent posture and extended reach	 Tilt table brings work within reach

VI. MSD: MUSCULOSKELETAL DISORDERS

MSDs, or musculoskeletal disorders, are injuries and disorders of the soft tissues (muscles, tendons, ligaments, joints, and cartilage) and nervous system. They can affect nearly all tissues, including the nerves and tendon sheaths, and most frequently involve the arms and back. Occupational safety and health professionals have called these disorders a variety of names, including cumulative trauma disorders, repeated trauma, repetitive stress injuries, and occupational overexertion syndrome. These painful and often disabling injuries generally develop gradually over weeks, months, and years. MSDs usually result from exposure to multiple risk factors that can cause or exacerbate the disorders, not from a single event or trauma such as a fall, collision, or entanglement. MSDs can cause a number of conditions, including pain, numbness, tingling, stiff joints, difficulty moving, muscle loss, and sometimes paralysis. Frequently, workers must lose time from work to recover; some never regain full health. These disorders include carpal tunnel syndrome, tendinitis, sciatica, herniated discs, and low back pain. MSDs do not include injuries resulting from slips, trips, falls, or similar accidents.

4.1 Conditions that cause MSD problems

- Exerting excessive force
- Excessive repetition of movements that can irritate tendons and increase pressure on nerves
- Awkward postures, or unsupported positions that stretch physical limits, can compress nerves and irritate tendons
- Static postures, or positions that a worker must hold for long periods of time, can restrict blood flow and damage muscles

- Motion, such as increased speed or acceleration when bending and twisting, can increase the amount of force exerted on the body
- Compression, from grasping sharp edges like tool handles, can concentrate force on small areas of the body, reduce blood flow and nerve transmission, and damage tendons and tendon sheaths
- Inadequate recovery time due to overtime, lack of breaks, and failure to vary tasks can leave insufficient time for tissue repair

4.3 Direct Costs are those Directly Associated with the Claim and Include

• Medical treatment
• Prescription costs
• Insurance premiums

4.4 Indirect Costs Associated with the Injury Can Include

• Overtime due to staff coverage during absence of injured worker
• Accommodation for modified duty
• Increased absenteeism
• Decreased morale
• Legal and investigation costs
• Presenteeism: when an employee comes back to work too early and is less productive than in a healthy state
• Replacement worker costs
• Advertising and recruiting if employee doesn't return to work
• Orientation and training costs

V. CONCLUSION

Ergonomics is a multidisciplinary field incorporating contributions from psychology, engineering, biomechanics, mechanobiology, industrial design, graphic design, statistics, operations research and anthropometry. Ergonomics is the study of people while they use equipment in specific environments to perform certain tasks. Ergonomics seeks to minimize adverse effects of the environment upon people and thus to enable each person to maximize his or her contribution to a given job. Ergonomic solutions are discussed in the paper. Aspects related to MSD (musculoskeletal disorder) are also discussed. This paper focuses on ergonomics, biomechanics & MSD musculoskeletal disorder. MSDs usually result from exposure to multiple risk factors that can cause or exacerbate the disorders, not from a single event or trauma such as a fall, collision, or entanglement. MSDs can cause a number of conditions, including pain, numbness, tingling, stiff joints, difficulty moving, muscle loss, and sometimes paralysis. Direct costs are those directly associated with the claim and includes Medical treatment, Prescription costs and Insurance premiums but Indirect costs associated with the injury can includes Overtime due to staff coverage during absence of injured worker, Accommodation for modified duty, Increased absenteeism, Decreased morale, Legal and investigation costs, Presenteeism: when an employee comes back to work too early and is less productive than in a healthy state, Replacement worker costs, Advertising and recruiting if employee doesn't return to work *and* Orientation and training costs. It is found that Indirect costs are estimated to be 3-5 times more expensive than the direct costs of that claim.

VI. ACKNOWLEDGMENT

I would like to thank my M. Tech Guide, Er. Manoj Kumar, for the patient guidance, encouragement and advice he has provided throughout my time as his student. I have been extremely lucky to have a Guide who cared so much about my work, and who responded to my questions and queries so promptly. I would also like to thank Er. Rajeev Arora, HoD, who helped me in my work. In particular I would like to thank Er. Anees Siddiqui for the suggestions he made in reference to this work.

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