CHAPTER ONE

INTRODUCTION

Manual Material Handling activities are defined as unaided human acts of lifting, lowering, pushing, pulling, carrying or holding, and releasing an object. Despite the increased degree of automation in recent years, a large proportion of materials handling in industry is still carried out manually, especially where the product mix is too large to allow economical automated materials handling system. Particularly in India, where labour is cheaper and available in plenty compared to other developed countries, manual handling constitutes a major part of materials handling activities.

Because of the human element involved, manual material handling can lead to occupational hazards. These hazards may be caused due to wrong methods of handling or due to the individual exceeding his safe handling capacity. The injuries may result from slipping and falling, dropping of the load or overstraining. Manual materials handling has been recognized as a major source of hazard to workers by many authorities on occupational health and safety. Estimates of the size of the problem vary but most of the
countries have statistics similar to the Canadian experience of roughly a quarter of all compensatable injuries in industry arising due to manual materials handling (Drury, 1975; Drury et al, 1982; Mital, 1983). In the United Kingdom, 29.7% of all reported accidents are attributed to manual handling (David, 1985). In India, this figure is reported to be 18.14% in the state of Maharashtra (Ovalekar, 1971).

1.1 MANUAL LIFTING

Manual lifting is one of the important components of materials handling. Lifting objects in an industrial context has become a vital problem in recent years because of the numerous compensation claims resulting from back injuries. It is reported that an estimated 20 million man days are lost in Great Britain during the year 1970 as a consequence of low back injuries (Park and Chaffin, 1974). Similarly it is reported that in the United States of America, approximately 35 percent of all compensation claims are related to back injuries and an estimated 14 billion dollars are paid annually in direct financial compensation (Mital, 1984a). The indirect costs may amount to as much as four times this amount. The number of cases of low back injuries as percentage of all industrial accidents during the year 1980, is reported to be 12% in Netherlands (Zuidema, 1985) and 15.2% in U.K (David, 1985). It is believed that the extent of the problem of back injury
suffered during manual lifting is more or less same in almost all countries. From a small industrial survey conducted by the author in the industries of Madras city, it has been found that while injuries like muscle sprains and scratches are common, back pain of various degrees is reported by 24% of the cases interviewed - the details of this survey are presented in Appendix 1. Thus, lifting seems to be the most hazardous task in manual materials handling.

Many of the handling injuries are believed to occur because the worker exceeds or is asked to exceed his/her physical capabilities. Ergonomic design of the job is the primary way to avoid overexertion cases. This requires the determination of lifting capacity of individuals and designing the lifting task within the safe limits for them. Alternatively, if the physical effort demanded by the handling task is known, then one can select and assign a suitable person for the task. Further, secondary means such as selection and training of workers can also be tried.

1.1.1 Manual Lifting Capacity

Strength, in general, implies what a person can do in a single attempt, whereas capacity implies what a person can do over an extended period of time.
Lifting strength, for example, determines the amount of load that can be lifted at infrequent intervals. Similarly, lifting capacity determines the amount of load that can be lifted during continuous or repetitive lifting. Thus, lifting capacity for infrequent lifting tasks can be considered to be lifting strength. Generally, lifting tasks of short duration (less than 4 sec) and performed at less than once every 5 minutes are considered as infrequent lifting tasks (Garg and Chaffin, 1975; Martin and Chaffin, 1972). In the case of infrequent lifting, the capacity is decided primarily by the muscle strength and the loading pattern on the musculoskeletal joints. However, when the task becomes repetitive, physical fatigue governs the lifting capacity. The lifting capacity will be influenced by various factors like the magnitude of load lifted, frequency of lift, level of lift, distance of lift, type of object lifted (its size, shape, hand holds etc), apart from the worker and environmental characteristics.

1.1.2 Current Status of Research

Literature search related to manual lifting studies reveals that extensive research is being done in U.S.A and other countries to reduce the number, severity and the resulting cost of manual handling injuries and this research is jointly sponsored by both Government Organisations and industry together. These efforts in general lead to the publication of work practice guide for

However, in India where manual handling is much more common than in other developed countries, there is very little effort made in studying this problem. Few researchers in India (Das and Sha, 1964; Datta and Ramanathan, 1967 and 1971; Datta et al, 1973) have conducted studies on manual load carrying but no specific studies are reported to have been conducted in the area of manual lifting.

Most of the information available in literature relates to the conditions existing in industries in the western countries and to the physique of an average American or European. However, it is evident that the manual lifting capacity, which is influenced by factors like size, shape, and type of object lifted, the physical condition of the worker and the environment and climatic conditions should differ from country to country. Thus this information on manual lifting may not be applicable to Indian workers because the physique (which affects manual lifting capacity) of Indians is significantly different from their counterparts abroad (Table 1.1).

Thus there is a need to study the problem of manual lifting for the Indian conditions. This investigation is intended to cater to this need.
1.2 THE OBJECTIVES AND SCOPE OF THE PRESENT INVESTIGATION

As already pointed out almost all the research studies concerned with manual materials handling have origin in other countries. Since manual lifting capabilities are functions of the worker's physical conditions and anthropometry and also the environmental or climatic conditions of work, it is probable that the results of those studies may be inapplicable to the Indian conditions and Indian physique. Thus any research on this aspect if it were to assist the Indian Industry or its workers, it should be oriented towards the local condition.

The present study has been undertaken to cater to this need to a certain extent.

The major objective is to study the lifting capacity of Indian industrial workers and develop predictive models for lifting capacity for low level, repetitive, manual lifting tasks. Both single-man lifting and two-men lifting tasks are considered for investigation.
A secondary objective is to investigate the effects of posture, container type, frequency, height level and body twisting on manual lifting performance and also to suggest a methodology for estimating the metabolic cost of lifting activities.

1.3 APPROACH TO THE INVESTIGATION

This investigation is planned in three parts. In the first part a series of experiments is designed to determine the influence of

1. the shape of the container
2. the frequency of lift and height level
3. twisting of the torso while lifting
4. the posture

on the manual lifting performance.

It may be pointed out here that in the Indian industries, in addition to the rectangular type containers, buckets are also frequently used for material handling and this is one of the containers chosen for study.

As it is felt that, in many cases, lifting and placing of material involves twisting of the torso to an extent of 90 degrees, it is decided to study the effect of this aspect also.
In the second part, the experiments are so designed to obtain the metabolic cost of manual lifting in terms of oxygen consumption rate. Herein Bernard's model (1979) for oxygen consumption which is originally proposed for other tasks is checked for its applicability to lifting tasks. Further an equation is proposed for the estimation of pulmonary ventilation.

The third part experiments lead to the development of predictive models for obtaining the maximum acceptable load. Since manual lifting is a dynamic task, these models are developed in terms of job specific dynamic lift strength instead of static strength. This concept has not been studied very much in the past. Further, in the Indian industries, it is a common sight to see two men jointly performing the lifting task. Hence models are developed both for single man lifting tasks and two-men lifting tasks. This is the first time that such a study is undertaken.

Based on the results, certain guidelines are proposed for employing people for manual lifting tasks.