EFFECT OF PSYCHOSOCIAL VARIABLES ON MAXIMUM
ACCEPTABLE WEIGHT OF LIFT

by

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ABSTRACT

The objectives of this study were (1) to determine the effects of personality type in conjunction with social facilitation effects on the psychophysically-determined maximum acceptable weight of lift (MAWL), and 2) to establish guidelines for the psychophysical approach which control for the effects of psychosocial factors.)

(To accomplish this, a laboratory study was conducted using 15 male subjects classified as Type A personalities (aggressive, impatient) and 15 Type B subjects (passive, patient).) Following a training period, the subjects performed 5 psychophysical lifting tasks consisting of a floor to 30 inch lift using various frequencies of lift. (For the social facilitation manipulation, the subject lifted the box under 3 conditions: alone (box lowered automatically), with a confederate of similar physical ability lowering the box, and with a confederate of superior physical ability lowering the box.) The confederate conditions were introduced under the guise that the lowering apparatus was broken.

Results indicated that Type A subjects worked at a higher percentage of their physical work capacity and selected heavier MAWLs than Type B subjects. Type A

subjects required significantly less time deciding their MAWL, and made fewer weight adjustments in terms of decreasing box weight, than Type B subjects. Significant social facilitation effects were not obtained, nor was there a significant personality type x social condition interaction.

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CHAPTER I

INTRODUCTION

Scope and Objectives

Manual Materials Handling (MMH), and in particular manual lifting, is recognized as a major hazard to the health and safety of industrial workers. It is generally assumed that many MMH-related injuries occur as a result of the operator working in excess of his capabilities, and as such, extensive research has been conducted in order to determine the lifting capacity of workers.

Three main approaches have been used to develop the prediction models upon which lifting capacity is estimated. The biomechanical approach attempts to establish the physical stresses imposed on the musculoskeletal system during lifting. The physiological approach develops limits based on metabolic energy expenditure criteria and determines lifting capacity based on these limits. The psychophysical approach uses the perceived stress of the subject as the criteria upon which the capacity of lift is based.

(Recent evidence (Karwowski, 1982) provides empirical support for the assumption that the psychophysical approach

is the single most appropriate approach to use to determine lifting capacity, because it combines the biomechanical and physiological stresses present in every task under the measure of perceived stress. However, although the psychophysical approach may be the best approach extant, there are problems associated with it. (Asfour (1980) has noted large discrepancies in the recommended weights of lift determined in several psychophysical lifting studies).

Because of these discrepancies, and because of the importance of having valid lifting capacity data upon which job design and employee placement procedures can be based, the multiplicity of factors influencing the psychophysical perceived stress need to be explored and delineated. (There is substantial evidence indicating that psychological, motivational, and sociological factors can effect the expression of human fatigue and physical exertion). The purpose of the present study was to determine the effect of behavior patterns in conjunction with social facilitation effects on the expression of the psychophysical MAWL.

The objectives of this research were:

1. To determine the effects of personality and social facilitation variables on the expression of the psychophysical MAWL in terms of weight of load selected and percentage of aerobic capacity worked at.

2. To establish general guidelines for the psychophysical lifting capacity methodology which take into account and control for the various psychological variables which may affect the expression of the psychophysical MAWL.

CHAPTER II

REVIEW OF LITERATURE

Approaches used to determine lifting capacity

The biomechanical approach

In its most general sense, the biomechanical approach determines what a person can physically do. Based on the laws of Newtonian mechanics, lifting models using the biomechanical approach attempt to establish the physical stresses (forces and torques) imposed on critical portions of the musculoskeletal system during MMH activities. It is these stresses which serve as the criteria upon which capacity of lift is based. Of particular concern among these biomechanical stresses are the compressive and shear forces on the L4-L5 and L5-S1 disks of the lower back. This particular part of the body has been the object of extensive research for two primary reasons. First, it has been demonstrated using biomechanics that extremely high forces are produced on the low back during lifting activities (Chaffin, 1967; 1969; Chaffin and Baker, 1970; Park and Chaffin, 1974; El-Bassoussi, 1974). Second, back injuries arising from manual lifting activities are staggering in terms of their frequency, severity, and cost (National Safety Council statistics, 1978; Nordby, 1981).

Based primarily on this second reason, numerous models have been developed to evaluate the effects of various loads on the lower back. The goal of this modeling, and of the biomechanical approach in general, is to establish limits on the physical stresses imposed during lifting and subsequently determine lifting capacity based on these limits. Extensive reviews of lifting capacity models based on the biomechanical approach have been presented elsewhere (Asfour, 1980; Karwowski, 1982), and as such only a brief summary will be presented here.

Biomechanical lifting models can be divided into those which are static and those which are dynamic, with the majority of the models being the former. (Static models assume that the lifting action is performed both slowly and smoothly, and as such forces due to acceleration are not considered.) Static biomechanical models of lifting activities have been developed by Chaffin (1967), Chaffin and Baker (1970), Martin and Chaffin (1972), Fisher (1967), and numerous other researchers.

(The dynamic biomechanical models of lifting represent an advancement over the static models in that time-displacement relationships of the body segments (kinematics) and the forces and torques involved in motion (kinetics) can be analyzed.) For example, the dynamic

biomechanical model developed by El-Bassoussi (1974) and Ayoub and El-Bassoussi (1976) estimates force-time relationships as the lifting action is carried out. Dynamic models have also been developed by Slote and Stone (1963), Muth, et al. (1978), and Smith (1980), who developed both a dynamic and static lifting model.

The physiological approach

The physiological approach is similar to the biomechanical approach in that this approach also attempts to determine capacity of lift of an individual or group based on empirically established limits. The difference is that the physiological approach uses criteria such as oxygen consumption, heart rate, pulmonary ventilation volume, percent of physical work capacity (PWC), blood lactate levels, etc., to develop the limits upon which lifting capacity is based. (The physiological approach is generally used when the following two conditions are predominant: 1) the lifting is repetitive, and 2) the weight of load is assumed to be within the physical strength capabilities of the individual.)

Several lifting capacity prediction models have been developed using the physiological approach, although far fewer in number than those employing the biomechanical

approach. (Mathematical prediction models for oxygen uptake during manual lifting have been developed by Frederick (1959), Aberg, et al. (1969), Garg, et al. (1978), and Asfour (1980).)

Using the physiological approach, "tolerable" work limits and work periods have been suggested. Table 1 presents workload classifications developed by Astrand and Rodahl (1977) based on oxygen uptake and heart rate.

TABLE 1

Workload Classification Based on Physiological
Criteria (Astrand and Rodahl, 1977)

Work Classification	Based on Oxygen Consumption (liters/min)	Based on Heart Rate (beats/min)
Light work	to 0.5	to 90
Moderate work	0.5 - 1.0	90 - 110
Heavy work	1.0 - 1.5	110 - 130
Very heavy work	1.5 - 2.0	130 - 150
Extremely heavy work	over 2.0	150 - 170

It has been recommended by Garg and Ayoub (1980) and Astrand and Rodahl (1977) that, in order for a task to be performed over the course of a typical 8 hour work day, said task should not require more than 30 to 40 percent of an

individual's maximum oxygen uptake. Snook and Irvine (1969) recommend, in accordance with the previously noted recommendations, that a young, healthy male should not exceed an oxygen uptake of 5 Kcal/min (33 percent of PWC) or a heart rate of approximately 115 beats/min when performing 8 hours of work.)

The psychophysical approach

Psychophysics as a discipline deals with the relationship between sensations and their concomitant physical stimuli. This relationship is expressed by the psychophysical law, which states that a sensation magnitude (S) grows as a power function of the stimulus magnitude (I) as follows (Stevens, 1975):

$$S = kI^n$$

where:

S = strength of a sensation (perceived)

I = intensity of a physical stimulus

k = constant value based on the particular units of the measurement that are used

n = slope of the line representing the power function when plotted in log-log coordinates.

(For the heaviness continuum of interest here, the value of n is 1.45 (Stevens, 1975). This means that a doubling of the weight of load being lifted would increase by a product of approximately three the perceived heaviness of that load.)

There are several different psychophysical methods (Table 2). In applying the psychophysical approach to the study of MMH tasks, the adjustment method is used. The subject is required to adjust one of the task variables such that the work load represents the maximum amount he can handle without excessive strain or discomfort, and without becoming tired, weakened, over-heated, or out of breath. In most instances the task variable adjusted is the weight of load being handled, although in a few studies (Snook and Irvine, 1968; 1969) the subject adjusted the frequency of lift of a fixed load such that the psychophysical maximum was determined. The MMH task that has received the most extensive experimental investigation has been manual lifting, although the psychophysical approach has also been used to determine acceptable loads for lowering, pushing, pulling, and carrying (Snook, et al. 1970; Snook, 1971).

Numerous researchers have employed the psychophysical approach to develop mathematical models to predict the MAWL of an individual or group (McConnville and Herzberg, 1966; McDaniel, 1972; Dryden, 1973; Knipfer, 1974; Ayoub, et al.,

TABLE 2

Methods of Psychophysics (S.S. Stevens, 1951)

Method	Procedure
Adjustment (average error)	Observer adjusts signal intensity until it is subjectively equal to, or in some relation to, a criterion
Minimal change (limits)	Signal is varied up and down in magnitude. Observer reports when it meets criterion.
Constant stimuli	Comparison stimuli are paired at random with a fixed standard stimulus. Observer reports whether comparison stimulus is greater or less than standard.
Paired comparison	Stimuli are presented in pairs, exhausting all combinations of stimuli taken two at a time. Observer reports which of each pair is greater than criterion.
Rating scale (absolute judgment)	Each of a set of stimuli is given an absolute numerical or descriptive rating or index in terms of some selected attribute.

1978; Asfour, 1980; Karwowski, 1982). Based on these models, lifting capacity norms have been proposed by several researchers (Snook, 1978; Ayoub, et al., 1983). Figure 1 presents lifting capacity norms established by Ayoub (1980) based on frequency of lift, population percentile, and box size.

Figure 1: Lifting Capacity Norms for Males (from Ayoub, 1980)

For a given frequency of lift, percentile, and box size, the capacity norm is determined by using the following formula:

$$LC = rv \times a \times b$$

where:

LC = capacity of lift (lb)

rv = reference value at 1 lift/min

a = percent multiplier for a given frequency

b = percent multiplier for a given box size.

Comparison of the approaches

It has been noted by Karwowski (1982) that no OSHA regulations exist regarding the maximum acceptable weight of lift for workers. One of the reasons for this is the discrepancies in recommended weights of lift found among and within the three approaches. A brief look at the literature illustrates these discrepancies.

Das (1951; from Asfour, 1980) conducted a study using the physiological approach on the effects of several task variables on energy expenditure while lifting. He concluded that, from a physiological viewpoint, that lifting a light load repetitively with legs straight and back bent was preferable to lifting with legs bent and back straight; the reason being that in the latter condition additional physiological cost is imposed due to the extra body weight

being lifted. However, from a biomechanical viewpoint, lifting with the back greatly increases the forces acting on the lower back, and should be avoided.

Asfour (1980) conducted both a physiological and a psychophysical lifting (and lowering) study. His results indicated that at low frequencies of lift (lower), the psychophysical capacity data were significantly lower than those values generated using his physiologically-based lifting capacity model. The psychophysical and physiological data did seem to be in agreement for high frequencies of lift.

Figures 2 and 3, based on biomechanical and physiological criteria, respectively, further illustrate the difficulties in arriving at a consensus regarding lifting capacity. Figure 2 is based on the dynamic biomechanical model developed by El-Bassoussi (1974), and presents lifting capacity guidelines based on compressive forces on the spine. The constant compression lines are expressed in terms of the weight of load and distance of the center of gravity of the load from the spine which combine to produce the compressive forces. A weight of load producing compressive forces less than 1100 lbs are considered acceptable in terms of injury risk to the worker, a weight of load producing compressive forces greater than 1540 lbs require immediate job redesign, and weights of load

Figure 2: Maximum weight of load versus horizontal distance of load from spine (El-Bassoussi, 1974)

Figure 3: Effect of frequency of lift and lifting technique on weight of load that can be lifted to maintain 5 Kcal/min energy expenditure (Garg and Ayoub, 1980)

producing compressive forces between these limits require administrative controls. (Figure 3, from Garg and Ayoub (1980), shows the effect of frequency of lift and lifting technique on the weight of load that can be lifted to maintain an energy expenditure of 5 Kcal/min.)

Although it is difficult to make comparisons between the two approaches, the aforementioned discrepancies are evident. For example, based on figure 3 (the physiological approach), a weight of load of 88.2 lb is acceptable at low frequencies of lift. However, this same weight of load significantly exceeds the acceptable lifting region recommended using the biomechanical criterion. In fact, in situations where the horizontal distance of the center of gravity of the load from the spine exceeds approximately 12 inches, a weight of load of 88.2 lbs is considered hazardous based on the biomechanical criterion.

Given the discrepancies among the three approaches, the issue must ultimately be addressed as to which approach, if any, is the "correct" one to use in the determination of lifting capacity. (It is the assertion of this paper, along with numerous other researchers (Karwowski, 1982; Ayoub, et al., 1983), that the psychophysical approach is the single most appropriate approach to use in the determination of lifting capacity.) The problem with the use of the

biomechanical or physiological approach alone is that both biomechanical and physiological stresses, along with other types of stresses, are present in all lifting tasks. The virtue of the psychophysical approach is that it attempts to combine this multitude of stresses under a measure of perceived stress (i.e., the MAWL).

Empirical support for the assumption that the psychophysical perceived stress represents a combination of the stresses in the lifting task has been provided by Karwowski (1982). Karwowski hypothesized that a combination of the acceptability of the biomechanical and physiological stresses imposed during manual lifting results in an overall measure of the lifting task acceptability, which is expressed by the acceptability of the psychophysical stress. (Towards the testing of this hypothesis, Karwowski utilized fuzzy sets theory (Zadeh, 1965) to develop a model for the interaction between biomechanical, physiological, and psychophysical stresses.)

The concept of fuzziness deals with classes in which there exist intermediate grades of membership between full membership and nonmembership (for example, the statement, "I did well on the test" is fuzzy due to imprecision as to what constitutes "doing well"). Karwowski defined fuzzy measures for the acceptability of biomechanical, physiological, and

psychophysical stress. The acceptability measures were determined using membership functions developed by Karwowski. The degree of membership could be any value ranging from 0 to 1, with 0 representing nonmembership in a set and 1 representing full membership. The stresses given a value of 1 were selected based on past research in the areas of acceptable biomechanical, physiological, and psychophysical stresses. Following this, the acceptability measures for biomechanical and physiological stresses were integrated under a measure of combined stress. Specifically, the combined stress was determined by taking the algebraic product of the acceptability measures of the biomechanical and physiological stresses. Mathematical procedures stemming from fuzzy sets theory were then used to determine the relationship between the MAWL from the psychophysical and combined standpoints. (Based on this, Karwowski concluded that the MAWL based on a psychophysical criterion appeared to be the result of the integration of the biomechanical and physiological stresses imposed by the lifting task.)

Although the evidence cited above indicates that the psychophysical approach is the single most appropriate approach to use in the determination of lifting capacity, there would appear to be problems associated with the use of the psychophysical method. Asfour (1980) and Karwowski

(1982), in reviewing past psychophysical lifting studies, noted substantial discrepancies in the MAWLs reported in several studies; in the studies reviewed by Asfour (1980) the discrepancy being as high as 22 lbs. These discrepancies may be a function of the specific population used in the study or slight task parameter variations. However, an alternative explanation is that these discrepancies are the result of the complex and largely overlooked interplay of psychological variables with the MAWL. The latter explanation is explored in the following section.

Psychological variables possibly
affecting lifting capacity

As noted, it has been empirically demonstrated that an acceptability measure of psychophysical stress can be expressed as the combination of acceptability measures of biomechanical and physiological stress (Karwowski, 1982). This raises the issue of what other classes of variables effect the perceived stress which dictates the psychophysical MAWL. In this section, the relationship between psychological variables and fatigue and level of physical exertion will be presented. Following this, the possible role of social facilitation in affecting MAWL will be explored.

Psychological aspects of fatigue and physical exertion

Since the standard instructions in a psychophysical lifting task specify that the weight of lift must not overly fatigue the subject, then perhaps those studies attempting to delineate the relationship between psychological phenomena and fatigue can be related to the psychophysically-determined MAWL. Unfortunately, the research in this area is hardly conclusive. (One reason for this is probably due to a lack of understanding on our part as to the precise meaning of the term "fatigue," as demonstrated by the following "definitions" of fatigue (from Simonson and Weiser, 1976):

- Fatigue can be defined as a reduction in working capacity (Simonson and Enzer, 1942)
- Fatigue can be defined as a subjective sensation of tiredness (Easton, 1976)
- Fatigue can be defined as a loss of sensitivity resulting from prolonged stimulation (Schmidtke, 1976)
- Fatigue can be defined as a "self-recognizable state in which the individual feels inadequate for his task, based upon bodily experience ... and also upon other cognitive criteria" (Bartley, 1964).

Perhaps the best summary of the concept of fatigue was presented by Bartley (1957), who delineated three interrelated types of fatigue. Objective fatigue was simply an observable work decrement, subjective fatigue was defined as a self-appraisal based on bodily feelings, whereas physiological fatigue was defined in terms of changes in the activities of body mechanisms.)

(This lack of a precise definition as to what constitutes fatigue is of extreme importance when regarding the psychophysical MAWL.) It is not unreasonable to assume that if authorities have difficulty defining fatigue, then so may the subject participating in a psychophysical lifting experiment. Locke and Bryan (1966), using the Complex Coordination apparatus wherein subjects must match visual formats displayed before them, found that subjects given specific (although difficult) instructions did better than subjects instructed to "do their best." (Analogously, subjects in a psychophysical lifting experiment may have difficulty determining their MAWL based on an unclear understanding of fatigue, and may be particularly susceptible to the effects of psychological stress for this same reason (i.e., confusion as to whether their perceived state is due to psychological stress or task-induced physiological fatigue).)

Some of the most basic research in the area of fatigue has used simple reaction time (RT) as the dependant variable, and has indicated the presence of psychological variables. Elbel (1940) measured RT following various exercises (stool-stepping, push-ups, basketball, fencing, and boxing) and found significant decreases in RT. RTs were most improved for those subjects selecting their own exercise, leading Elbel to suggest a possible motivation factor of meaningful activity. Malomsoki and Szmodis (1970, from Simonson and Weiser, 1976) reported a similar decrease in RT following bench-stepping, and Welford (1973) has interpreted this in terms of an inverted U relationship between stress caused by physical exertion and mental performance.

In the majority of studies attempting to isolate the determinants of fatigue other than task parameters, the concept of motivation predominates. The tools commonly used in the measurement of the motivation construct are those projective tests, rating scales, and questionnaires developed to define achievement motivation (Weiner, 1974). Wendt and Palmerton (1976) summarized the presence of achievement motivation in an individual in terms of one who "...thinks" achievement and behaves as an "achiever," (and has complementary) cognitions, expectancies, symbols, fears, hopes, habits, and so forth" (p 291). On a more operational

level, the individual is usually rated via the aforementioned tools in terms of (for example) Need Achievement (N Ach), with higher N Ach ratings corresponding to higher achievement drive on the part of the individual.

Wendt and Palmerton (1976) present a study by Wendt (1956) which summarizes the relationship between achievement motivation (the term achievement orientation was used in the Wendt study) and fatigue. High school students were administered a questionnaire from which an overall score measuring achievement orientation was obtained. The subjects were tested after several hours of "strenuous" school work and were then asked to rate themselves along several scales including degree of avoidance motive and degree of exhaustion. Three principal results were obtained from the study. Self-ratings on the avoidance motive scale were highly correlated with the exhaustion ratings, high achievement orientation was associated with low exhaustion ratings (the author suggesting a certain amount of denial), and students rated high in achievement orientation were significantly more likely to project avoidance motive characteristics onto other students than onto themselves.

Kinsman, et al. (1973) also conducted an extensive study to relate subjective responses to prolonged exercise (bicycle riding). A physical activity questionnaire (PAQ)

developed by the authors was administered to the subjects immediately prior to and following the task. The PAQ consisted of 63 adjectives potentially descriptive of subjective changes during exercise. A key cluster analysis indicated that the PAQ was composed of three unique, collinear, and reliably measureable clusters of symptoms labeled by the authors as Fatigue, Task Aversion, and Motivation. The 18 adjectives making up these clusters (items showing at least a 10 percent change over the course of the exercise) are presented in Table 3. The authors noted that the Motivation cluster had relatively low internal consistency and stability upon replication which could possibly improve with the addition of new items, but also noted was the potential utility of the cluster since pre-work motivational level and motivational changes during work may be highly related to work tolerance.

Clinical data also provide some insights into the relationship between motivation and fatigue. Gross and Bartley (1951) studied fatigue states in housewives during the performance of household work and found those subjects who became "bewildered by the clutter" (p. 207), those who had difficulty in deciding the order with which work should be performed, and those who exhibited a general dislike for work, tended to report greater levels of fatigue. Wendt and

TABLE 3

Physical Activity Questionnaire Clusters (Kinsman, et al., 1973)

FATIGUE=	panting short of breath worn out drained legs weak	heart pounding difficult to breathe shaky legs aching muscles dry mouth
MOTIVATION=	drive vigorous determined lively	
TASK AVERSION=	sweating perspiring comfortable do something else	

Palmerton (1976) reported a study by Hemphill, et al. (1952) which indicated that female depressives reported fatigue more rapidly and tended to quit the experimental task (lifting a 2 Kg weight with the middle finger repeatedly) more quickly than subjects exhibiting other neurotic traits such as anxiety. It is of interest to note that the clinical term "neurasthenia" defines chronic fatigue in terms of an emotional/psychologic reaction with concomitant decrements in performance.

Some of the above-cited studies allude to the relationship between motivational, psychological, and other variables and the voluntary level of physical exertion produced by the subject. However, for the purposes of the present study this relationship needs to be reviewed more specifically.

Needless to say, the expression of physical exertion on the part of an individual is a function of the physiologic limits of the body. However, that this is not the only, or even the critical, factor in determining the level of exertion to be expected from a subject has been recognized by several researchers (Ikai and Steinhaus, 1961; Lehman, et al., 1939; Kroemer, 1974; Kroemer and Marras, 1981). The multiplicity of factors which combine (in a largely unknown fashion) to produce the observed physical exertion is summarized by Ikai and Steinhaus (1961) as follows:

"Physiologic factors set the relatively fixed and outermost limits, psychologic factors, the more proximate ones ... Capacity is the always undetermined measure of the former. Performance is always limited by the latter" (p. 157).

This interpretation is reiterated by Kroemer (1974) and by Kroemer and Marras (1981), who note that in strength testing the subject will generally exert a muscular output

below that of the body's structurally determined capacity by a significant margin. The term "maximal voluntary contraction" (MVC) is used to describe these submaximal exertions, and the relationship between MVC and MAWL should not be overlooked. In the former the subject perceives the stress he feels his body can accommodate on a one-time-only basis; in the latter the subject perceives the maximum stress his body can accommodate repeatedly.

Since the MVC can be viewed as a special case of the MAWL (or vice versa), any evidence indicating the relationship between psychological factors and the expression of strength becomes extremely significant towards the justification of the present research. Kroemer (1974) summarizes those factors thought and/or shown to effect submaximal exertions as follows:

	Likely Effect

1. Feedback of results	positive
2. Instructions on how to exert strength	positive
3. Arousal of ego involvement, aspiration	positive
4. Pharmaceutical agents (drugs)	positive
5. Startling noise, subject's outcry	positive

6. Hypnosis	positive
7. Setting of goals, incentives	pos. or neg.
8. Competition, contest	pos. or neg.
9. Verbal encouragement	pos. or neg.
10. Spectators	?
11. Deception by researcher	?
12. Fear of injury	negative
13. Deception by subject	negative

The list of factors is both extensive and still open to empirical research, and lends credence to the assertion of Kroemer and Marras (1981) that "a subject's muscle strength depends primarily on the voluntary activation of the muscles" (p. 644). To summarize some of the empirical evidence supporting those factors presented above, Lehman, et al. (1939) administered Pervitin (1-phenyl-2-methylaminopropane) to subjects prior to riding on a bicycle ergometer. Administration of the drug resulted in up to three-fold increases in task performance and, in the absence of any defineable facilitation in the physiologic systems of the body, the authors concluded that the drug induced, and the performance was improved due to, central excitation. In what is by now becoming redundant, the authors theorized that the "end point" of human performance occurs when the sum of all possible negative factors (fatigue, muscle pain, etc.)

exceed, in the person's perception, the sum of all possible positive factors (i.e., motivation). The results of this study are largely in agreement with the findings of Alles and Feigen (1942), and Smith and Beecher (1959). A common thread running through all three of the studies was the inability to separate drug effects from psychological effects.

One of the most ambitious studies in this area was conducted by Ikai and Steinhaus (1961). Using a cable tensiometer, the tension exhibited by the right forearm flexors during a MVC was measured. MVC under the following conditions was measured: 1) after having a blank shot fired behind the subject, 2) having the subject shout during the exertion, 3) exerting while under hypnosis, 4) exerting while under a post-hypnotic suggestion, and 5) exerting 25 minutes following the ingestion of 30 mg of amphetamine sulphate. Significant increases in flexor tension occurred under the after-shot condition, when shouting during the exertion, and following the amphetamine sulphate ingestion. Under the hypnosis conditions (during and post) significant increases and decreases in measured tension occurred as a function of the nature of the suggestion given the subject. Ikai and Steinhaus explain their results in terms of Pavlovian classical conditioning. They assumed that a muscular exertion is normally restrained by the negative conditioned

inhibitions associated with maximal contractions (pain and spasms). The shot and the shout served as external inhibitors, in the Pavlovian sense, and similarly the amphetamine sulphate and hypnotic suggestions served to suppress these conditioned inhibitions.

A recent study (Bakken, 1983) looked directly at the effects of psychological factors on the psychophysically-determined MAWL. Bakken designed and administered an attitude questionnaire to 12 subjects participating in a psychophysical lifting experiment. The data indicated that the greatest weight of lift variability reduction occurred with the sole use of attitude or PWC variables (reduction of approximately 70 percent). Use of attitude as a predictor of MAWL was superior to the use of strength measurements (approximately 50 percent reduction), or the sole use of climatic, anthropometric, or task parameter variables (approximately 30 percent reduction).

Unfortunately, the use of the attitude questionnaire in this study was intended only as a preliminary assessment of the worth of this class of variable as a prediction tool. As such, no analyses were conducted to determine the "content" of these attitudes, nor was the questionnaire formally validated. However, it is hypothesized that the questionnaire may have tapped those same clusters as were

found in the Kinsman, et al. (1973) study. For example, the first attitude question read as follows:

1. How would you rate your willingness to do manual labor?

1 Not willing

2

3 Willing but would rather not

4

5 OK

6

7 Enjoy it once in a while

8

9 Enjoy it, very willing.

The analogous nature of "not willing" in the Bakken questionnaire with "do something else" from the adjective list of Kinsman, et al. (1973, see Table 3) may indicate that this particular question measures the construct "task aversion".

Numerous other examples exist to show the effects of psychological factors on physical exertion. These will be explored in terms of social facilitation effects in the following section.

Social facilitation

A major premise of this research is that social facilitation effects can occur in psychophysical lifting tasks. As such, a review of the phenomenon termed social facilitation is called for.

Social facilitation is usually defined as the increased exhibition of dominant responses and the inhibition of subordinate responses under certain conditions of "social stimulation". The exact parameters of this social stimulation have been a matter of theoretical discussion for the last 20 years. Zajonc (1965) was the first to offer a theoretical viewpoint to explain social facilitation.

Zajonc proposed that the mere presence of others, be it in an audience or coactor capacity, was innately arousing and led to the performance effects termed social facilitation. Cottrell (1968, 1972) modified Zajonc's theory, stating that social facilitation effects would only occur to the extent that the audience or coactor(s) were perceived as being evaluative and holding potential reward and/or punishment contingencies. Rather than being innately arousing, the presence of an audience or coactors was viewed as a learned source of evaluation apprehension.

Several studies have compared the theoretical positions of Zajonc and Cottrell (Martens and Landers, 1972; Hunt and

Hillery, 1973; Laughlin and Jacard, 1975; Cohen and Davis, 1973; Good, 1973), with the majority favoring Cottrell's position. A study by Klinger (1969) exemplifies this mass of research. Klinger had subjects perform a visual vigilance task under three experimental conditions: alone, coacting with no information regarding the other's performance, and coacting with the other's feedback (potential evaluation). Results indicated a significantly decreased number of missed signals in the potential evaluation condition with no difference between the coaction without feedback and the alone conditions. Klinger concluded that at least the potential for evaluation was necessary for social facilitation effects to be observed.

A third major theory of social facilitation was advanced by Sanders and Baron (1975) and Sanders, Baron, and Moore (1978a and b). These authors advanced a distraction-conflict theory of social facilitation. In simplest terms, the distraction-conflict theory suggests that the presence of others distracts the individual from his appointed task, leading to a conflict of attention between the task and the irrelevant stimulus (i.e., the other), which in turn leads to an increase in drive on the part of the individual, which finally leads to those behavioral effects associated with social facilitation.

Major evidence in support of a distraction-conflict theory of social facilitation comes from those studies demonstrating the equivalence of social facilitators to other types of stimuli. Houston and Jones (1967) demonstrated that auditory distractions can facilitate performance on a variety of simple tasks, while Eschenbrenner (1971) found that performance on complex tasks exhibited decrements under auditory distraction conditions. Pessin (1933) demonstrated that an audience, flashing lights, and a buzzer all impaired learning of a nonsense syllable recall task but facilitated performance of the task after learning.

A fourth theory of social facilitation was proposed by Bond (1982). Bond attributed social facilitation to a performer's (Bond's term) active regulation of a public image. In support of his theory, Bond presented evidence that the presence of an observer impaired learning of simple items embedded in difficult text and facilitated the learning of difficult items embedded in simple text. These are findings which are not consistent with the drive theories underlying the theoretical viewpoints of Zajonc, Cottrell, and Sanders, et al. However, failure on the part of Bond to provide operational definitions for "simple" and "difficult" items indicate the need for further research in this area.

In relating social facilitation effects to psychophysical lifting tasks, it is first important to identify those parameters of the psychophysical lifting task that may make the MAWL amenable to social facilitation effects. Several such parameters can be identified:

1. presence/absence of experimenter during task
2. status of experimenter
3. presence of audience (other than experimenter)
or coactors during task
4. status of audience/coactors
5. knowledge of own/others' results
6. training procedures.

An abundance of research in the social facilitation area has shown the parameters listed above to be important in the invocation of social facilitation effects. Regarding the first and third parameters (presence/absence of experimenter, audience, coactors), research has already been presented regarding audience and coactor effects in social facilitation. Presence of these others may alter performance due to drive induction, or through the introduction of overt competition into the task. Martens and Landers (1969) studied coaction effects during the performance of a leg-lifting muscular endurance task under three experimental conditions: alone, in pairs, and in groups of four.

Performance was significantly improved in the tetrads, and the authors concluded that competition may have been introduced into this group. Sedman, et al. (1957) found that the presence of a partner raised subjects' tolerance for self-administered electric shock significantly. The subjects thought the partner was in the circuit also, and the authors concluded that competition may have been responsible for the results. Carment and Latchford (1970) found a significant main effect for experimenter presence/absence in a 10 min simple motor task. Subjects made significantly more responses when the experimenter was present than when he was absent.

Regarding the second and fourth parameters (status of experimenter, audience, coactors), the issue is more ambiguous. Sanders (1981a) recommended that future research in the social facilitation area needed to quantify the properties of others (e.g., high vs. low status) likely to produce conflict. However, some research implies that this variable may be important in a total explanation of the psychophysical MAWL. Cohen and Davis (1973) studied the effects of audience status, along with evaluation and time of action on performance using a hidden-word problems task. Two audience status levels were used. A peer audience was described to the subject as a student taking the introductory psychology

course. An authority audience was described as graduate students and professors interested in this particular area of research. Results indicated that, in terms of emission of dominant responses, an authority figure evaluating the subject ranked number one, followed in descending order by peer evaluating, authority observing, and peer observing. Similar results were obtained by Bergum and Lehr (1963), who found that the intermittent presence of a commissioned officer resulted in significantly superior vigilance performance compared to visits from a noncommissioned officer. Bergum and Lehr went on to demonstrate that operators performed better based on a continuum relating to the amount of threat imposed by the person (an important form of status from Cottrell's evaluation apprehension theory). Bergum and Lehr compared the ratio of errors between control and experimental conditions in their 1963 study, in a study involving coactors (Bergum and Lehr, 1962), and a study manipulating experimenter presence/absence (Fraser, 1953). The results were as follows:

Bergum and Lehr 1962 = .689

Fraser 1953 = .410

Bergum and Lehr 1963 = .363.

A study by Seta (1982) implicated the relevance of both status and knowledge of results to the psychophysical

lifting paradigm. Feedback was altered such that the subject seemed to be performing with a superior, inferior, or similar-ability coactor on a reaction time task. The results indicated that a subject coacting with a slightly superior other performed better than when coacting with inferior, equal, or very superior others. The results were explained in terms of Festinger's social comparison theory (1954), which states that the "individual is oriented (in terms of comparison) toward some point on the ability continuum slightly better than his own" (p. 126). Seta concluded that, in support of previous results obtained by Beck and Seta (1980), social comparison serves as a cue for competition.

Regarding the final parameter, training procedures are potentially critical in terms of social facilitation effects. Dominant (i.e., well learned) responses are enhanced under social facilitation conditions whereas subordinate (i.e., poorly learned) responses are inhibited. Therefore, the level of training a subject receives in determination of the psychophysical MAWL may determine the susceptibility of the subject to social facilitation effects. Social facilitation effects during the training period itself may also occur. Berger, et al. (1981) demonstrated that the presence of the experimenter inhibited practice of

unfamiliar and familiar words leading to poorer learning of the unfamiliar words.

Several studies have already noted the effects of social facilitation on muscular endurance (Martens and Landers, 1969) and on pain tolerance (Sedman, et al., 1957). In addition, Paulus, et al. (1972) noted that gymnastic performance exhibited decrements (based on judges' ratings) during spectator presence when the subject was forewarned of the presence of the spectators.

While all of the above findings relate to psychophysical lifting, no experiments dealing specifically with this subject were located in the literature. However, a study on psychophysical bi-manual lifting conducted by Fox (1982) may have unintentionally uncovered social facilitation effects. Fox determined the psychophysical MAWL for subjects lifting individually and with a partner, the hypothesis being that for a given bi-manual team a team member would lift approximately one half of a weight of load equal to twice his individual MAWL. However, the results indicated that, for a given bi-manual team, the team member with the smaller individual MAWL lifted 23.22 lbs over his individual MAWL while the team member with the higher individual MAWL lifted 12.76 lbs over his individual MAWL. Table 4 presents the average MAWL selected by each team. Table 5 presents the bi-manual

MAWLs if the weight of load selection were based on the lower individual MAWL. As the tables indicate, in some instances the team was lifting over twice as much weight as would be expected based on the smaller individual MAWL.

TABLE 4

Actual Weights of Lift Selected by Bi-Manual Teams
(Fox, 1982)

S#	1	2	3	4	5	6	7	8
1	-	117.5	100.5	129.0	113.8	113.3	118.3	119.5*
2		-	103.3	100.8	121.5	86.8	104.5	135.8
3			-	115.3	111.8	103.5	93.5	97.8
4				-	117.3	99.0	118.3	134.3
5					-	122.5	119.5	144.3
6						-	107.0	124.8
7							-	113.8
8								-

* average of 2 trials

Fox also found that the subjects with the smaller individual MAWL had statistically significant higher heart rates (increase of approximately 4 beats/min) and percent PWC (increase of approximately 2 percent) working bi-manually than working alone. Fox termed these differences of no practical significance. The subject with

TABLE 5

Predicted Bi-Manual Capacities Based on Individual
MAWL (Fox, 1982)

S#	1	2	3	4	5	6	7	8
1	-	63.0 64.0	55.0 64.0	73.0 76.0	80.0 82.0	66.5 67.0	82.0 87.0	94.5* 96.0**
2		-	55.0 64.0	63.0 64.0	63.0 64.0	63.0 64.0	63.0 64.0	63.0 64.0
3			-	55.0 64.0	55.0 64.0	55.0 64.0	55.0 64.0	55.0 64.0
4				-	73.0 76.0	66.5 67.0	73.0 76.0	73.0 76.0
5					-	66.5 67.0	80.0 82.0	80.0 82.0
6						-	66.5 67.0	66.5 67.0
7							-	82.0 87.0
8								-

* lower individual's average MAWL

** lower individual's highest MAWL

the higher individual MAWL showed no significant change in heart rate or percent PWC when working alone or when working bi-manually. However, a reanalysis of Fox's data looking at the performance of each subject working alone or bi-manually

indicated that, in terms of heart rate (Table 6), four subjects showed an overall increase in heart rate, three subjects showed a decrease, while one subject was unchanged. Looking at percent PWC (Table 7), the results were more consistent. Six of eight subjects showed an overall increase in percent PWC when working bi-manually as opposed to lifting individually.

TABLE 6

Changes in Heart Rate When Lifting Alone or in Teams
(Fox, 1982)

SUBJECT	ALONE	BI-MANUAL	%CHANGE
1	127.0	116.9	8% d*
2	111.2	117.7	6% i**
3	102.4	99.6	3% d
4	118.3	124.6	5% i
5	136.6	136.5	-
6	104.3	117.1	11% i
7	133.6	140.9	5% i
8	112.6	109.4	3% d
Average:	118.3	120.3	2% i

* d = decrease

** i = increase

TABLE 7

Changes in Percent PWC When Lifting Alone or in Teams
(Fox, 1982)

SUBJECT -----	ALONE -----	BI-MANUAL -----	%CHANGE -----
1	45.6	39.0	14% d*
2	23.2	25.7	10% i**
3	34.4	32.6	5% d
4	33.5	37.0	10% i
5	36.4	37.0	2% i
6	33.7	38.3	12% i
7	34.3	40.6	16% i
8	28.3	29.7	5% i
	-----	-----	-----
Average:	33.7	35.0	4% i

* d = decrease

** i = increase

Drawing firm conclusions from Fox's study is difficult because it was noted that in the bi-manual condition a biomechanical advantage may have been introduced (type of box and lift) which contributed to the unexpectedly high bi-manual MAWL. However, Fox also noted that, in post-experiment interviews, subjects agreed that the bi-manual lifting was more interesting and less boring than the individual lifting, and therefore increased drive (in social

facilitation terms) cannot be dismissed as a possible explanation of the results.

The experiment described herein was largely based on evidence that the extent to which social facilitation effects are observed is dependent on both the personality type of the subject and the social stimuli to which he is introduced. The efforts of researchers to describe a behavior pattern typical of persons who develop atherosclerosis and coronary heart disease led to the concept of the Type A personality (Friedman and Rosenman, 1959). The Type A behavior pattern encompasses the following traits: "excessive drive, aggressiveness, ambition, involvement in competitive activities, frequent vocational deadlines, pressure for vocational productivity, an enhanced sense of time urgency and restless motor mannerisms" (Jenkins, et al., 1967). A second identified behavior pattern (Type B) is characterized by a relative absence of the above traits.

In addition to being more prone to coronary heart disease, Gastorf, et al. (1980) noted that the Type A personality exhibited exaggerated achievement striving in comparison to Type B's (Burnam, et al., 1975), exhibited more interest in social comparison in stressful situations than Type B's (Dembroski and McDougall, 1978), and exhibited higher levels of physiological arousal in response to challenges than did

Type B's (Dembroski, et al., 1977). Given these findings, in addition to the general characterization of the Type A behavior pattern, it is reasonable to hypothesize that individuals exhibiting the Type A behavior pattern may be extremely susceptible to social facilitation effects.

This hypothesis was tested by Gastorf, et al. (1980). Subjects were identified as Type A or Type B using the Jenkins Activity Survey (JAS) Form T (Krantz, et al., 1974). The subjects performed two copying tasks (one simple, one complex) either alone, with a similar ability coactor, or with a superior ability coactor. Gastorf, et al. found that, for Type A subjects, performance on the simple copying task was enhanced by either the similar or superior coactor, whereas performance decrements occurred on the complex copying task in the presence of the similar or superior coactor. Type B subjects did not demonstrate significant social facilitation effects.

Hypotheses

The purpose of the present study was to extend the findings of Gastorf, et al. (1980) to the psychophysical lifting paradigm. Based on the literature reviewed, the following results were hypothesized:

1) Subjects classified as possessing the Type A behavior pattern will work during the psychophysical lifting tasks at a higher percentage of their physical work capacity (PWC) than subjects classified as Type B regardless of the social condition.

2) Subjects classified as Type B will select a higher MAWL when working with a confederate who is similar in ability than when lifting alone or with a confederate who is superior in ability.

3) Subjects classified as Type A will select a higher MAWL when working with a confederate, regardless of the level of ability of the confederate, than when working alone.

CHAPTER III

METHODS AND PROCEDURES

Subjects

Thirty male subjects served as paid volunteers for the experiment. Although the majority of subjects had little experience in the area of MMH, they were used on the basis of schedule flexibility and duration of the experiment. Only male subjects were used in order to control the size of the study. Subjects were required to pass a physical examination prior to experimentation. Subjects with physical conditions such as high blood pressure, a history of or present back injuries, etc., were excluded from participation in the study for safety reasons.

Familiarization period

Asfour (1980) reported that the capacity to lift was significantly increased by training. Therefore, prior to the actual experiment, each subject underwent a familiarization program for 5 days, 1 hour per day. Whenever possible, sessions were conducted over consecutive days. The purposes of the familiarization period were to 1) familiarize the subject with the use of the equipment (in

particular the breathing apparatus), 2) tone the muscle groups required to perform the lifting tasks, and 3) allow the subject practice in the determination of the psychophysical MAWL. This last purpose of the familiarization period was of particular importance since improved performance as a function of social facilitation effects can only be expected if the task is well learned.

For the first four days of the familiarization period, upon arrival to the experimental site, the subject was required to perform a psychophysical floor-to-knuckle height (30 inches) lifting task for 40 minutes. The subject adjusted the weight of load in the box until he felt it represented the maximum amount he perceived he could handle without excessive strain and discomfort, and without becoming tired, weakened, over-heated, or out of breath. The subject adjusted the weight by adding or removing lead weight from the box. The number of weight adjustments was dependent on two factors: the frequency of lift (lifts/min) and the duration of the lifting session. The subject was given 30 minutes to decide his MAWL, so that frequency of lift determined the number of possible weight adjustments. For example, for a frequency of 9 lifts/min, the number of possible weight adjustments would be 9×30 or 270 possible weight adjustments. For a frequency of 1 lift/min, the number of possible weight adjustments would be 30.

The experiment was explained to the subject as involving the use of personality, task, and aerobic capacity variables to predict capacity of lift. No information was given to the subject regarding the personality types being investigated or the social facilitation manipulations. The information was reiterated in a personal data and consent form that each subject filled out and signed prior to the experiment. A copy of the consent form is given in Appendix A.

Subjects were asked to refrain from eating for at least two hours prior to their scheduled data collection sessions. They were also asked to avoid participation in any strenuous exercise prior to the experiment, and to try to get their normal amount of sleep.

At the beginning of each lifting session taped instructions (experimenter's voice) concerning the lifting task were presented. The instructions were as follows:

"This experiment is designed to develop prediction equations for the maximum amount of weight you feel you can lift based on task, aerobic capacity, and personality variables. Every time you hear the tone on the tape, you are to lift the box from the floor to the platform. Keep adjusting the weight of the load in the box using the lead weights provided until you feel the weight is the maximum (emphasis on

this word) weight you feel you could lift over an 8 hour work day without becoming overtired, weakened, over-heated, out of breath, or experiencing excessive strain or discomfort. Adjust the weight as often as you like. You cannot make too many adjustments. Continue adjusting the weight until you feel you have reached your maximum acceptable weight of load. When you reach your maximum acceptable weight of load, inform the experimenter and make no more weight adjustments but continue lifting when you hear the signal. Remember, try your best to select the maximum amount of weight you feel you could lift safely over an 8 hour period."

These instructions were also played prior to each lifting session during the psychophysical lifting experiment. After deciding his MAWL, the subject continued to lift the box for the remainder of the session without additional weight adjustments. On each of the first four familiarization period days a different frequency of lift ranging from 1 to 9 lifts/min was randomly selected (without replacement) and the subject determined his MAWL for that frequency. The frequency of lift of 6 lifts/min was not used during the familiarization period since it was to be used during three sessions of the actual psychophysical lifting experiment

(i.e., exposure to that particular frequency of lift was minimized). During the familiarization period lifting tasks the subject breathed through a two-way valve, wore a nose clip and Exersentry heart rate monitor. Heart rate was monitored during the familiarization period as a safety factor and to monitor training effects.

On the fifth day of the familiarization period, the physical work capacity (PWC) of the subject was determined. PWC was predicted from submaximal techniques using a Cybex Fitron bicycle ergometer (figure 4). A nine minute protocol was used in which the work load was increased after the third and sixth minute of exercise. All measurements were made at a pedaling speed of 60 revolutions per minute. The basic workloads used were 400, 600, and 800 kilopond meters per minute. Workloads were varied based on individual responses to the workloads. Heart rate, oxygen consumption, and blood pressure were monitored. Blood pressure was monitored so that testing could be stopped if the subject showed an increase in diastolic blood pressure greater than 20 mm Hg, if systolic pressure exceeded 250 mm Hg, or if systolic pressure failed to increase with increasing work load.

To obtain the predicted maximum oxygen uptake the following procedure was used:

Figure 4: Bicycle Ergometer and Metabolic Measurement Cart

1. Oxygen uptake and heart rate were measured for each minute of the test session.
2. The steady state heart rate (obtained at the third minute of each work load) was plotted against the steady state oxygen uptake, and the straight line of best fit was drawn through the data points.
- 3) At the point where the straight line intersected the age-predicted maximum heart rate of $220 - \text{age}$, the oxygen uptake corresponding to that point was read as the predicted maximum oxygen uptake. This value was then converted to milliliters per kilogram of body weight (ml/kg min) by dividing the predicted maximum oxygen uptake (in ml) by the subject's body weight (in kg).

The subjects were told prior to the PWC test that PWC was to be used in this experiment as a predictor of lifting capacity.

Apparatus

A Beckman Metabolic Measurement Cart (MMC) was used for measurement of oxygen consumption. During a period when the MMC required maintenance, oxygen consumption was predicted from ventilation volume using a Max Planck Respirometer. Subjects breathed through a two-way valve connected to the MMC or respirometer with an air hose. Heart rate was recorded using an Exersentry heart rate monitoring device.

When the subject lifted alone, a pneumatic lifting apparatus was used. The lifting apparatus consisted of a pneumatic mechanism within a steel frame. For this experiment, the shelf was set at a height of 30 inches (Karwowski, 1982). The lifting apparatus was designed such that, when a weight was placed on the shelf, the shelf automatically lowered (via the pneumatic mechanism) and dumped the weight onto the floor. Once the weight was removed, the shelf returned to its preset position (30 inches). In the confederate conditions, a table 30 inches high was used.

Experimental variables

For the purposes of this study the following experimental variables were taken into consideration:

Independent variables

1. Personality type of subject (Type A or Type B). Type A and B behavior patterns were determined using the Jenkins Activity Survey (JAS) Form N. The JAS consists of 67 multiple choice questions regarding aspects of an individual's behavior. The JAS Form N was specifically designed for use by persons whose primary daily activity is not paid employment (e.g., students). The JAS provides a raw score and standard score (based on a linear transformation of the raw score) for four separate scales:

- a. Type A Scale. The Type A scale consists of 19 items on the JAS. The Type A scale measures the degree to which the subject exhibits the Type A behavior pattern, as defined by Jenkins, et al. 1967.
- b. Speed and Impatience scale. The scale consists of 15 items on the JAS. The scale measures the degree to which the subject exhibits an enhanced sense of time urgency regarding daily events.
- c. Involvement scale. The scale consists of 20 items on the JAS. The scale measures the importance with which the subject rates the daily activities and events in his life.
- d. Hard-Driving and Competitive Scale. The scale consists of 16 items on the JAS. The scale measures the degree to which the subject exhibits drive, aggressiveness, and involvement in competitive activities.

For the present study, only the Type A scale was used in the classification of subjects. Subjects were classified as Type A if they scored more than one SD above the median and as Type B if they scored more than one SD below the median on the JAS Type A scale (classification system from Gastorf, et al. 1980).

2. Social condition (subject lifts alone, subject lifts while superior or similar ability confederate lowers). For the subject alone condition, the subject lifted the box which was automatically lowered by a pneumatic lifting apparatus. For the confederate conditions, the confederate lowered the box lifted by the subject. To justify the use of the confederates, the subjects were told that the lifting apparatus was broken and another subject in the experiment had been recruited to lower the box. The level of ability of the confederate was established based on the confederates' physical appearance (height, weight, morphology) relative to the subject. As a validation check of the status of the confederates as perceived by the subject, each subject filled out the survey shown in Figure 5 upon the completion of the experiment.

Dependent variables

1. MAWL selected by the subject.

2. Percent of PWC at which subject worked. Following the selection of their MAWL, the subjects lifted the selected weight for the remainder of the lifting session.

(The minute oxygen uptake values for the final three minutes of the lifting session were averaged and then divided by the PWC value to obtain the percent of PWC at which the subject

worked. Only the final three minutes were used to insure that a steady state value was obtained.

- 3. Total number of weight adjustments made by subject.
- 4. Number of weight adjustments increasing box weight.
- 5. Number of weight adjustments decreasing box weight.
- 6. Time (minutes) required to determine MAWL.

SUBJECT NAME: _____

SUBJECT ID# : _____

1. During session ____ of this experiment, you lifted the box while _____ lowered the box. How would you rate the strength of that subject compared to your own strength?

1234567

much weaker

same strength

much stronger

2. During session ____ of this experiment, you lifted the box while _____ lowered the box. How would you rate the strength of that subject compared to your own strength?

1234567

much weaker

same strength

much stronger

Figure 5: Confederate Rating Survey

7. Number of times heart rate exceeded 66 percent of the subject's maximum heart rate of $220 - \text{age}$.

Controlled variables

1. Population (college students).
2. Sex (male).
3. Height of lift (floor to 30 inches).
4. Box size (15"x15"x10" with handles).
5. Starting weight in box (33 percent of subject's selected MAWL for that frequency of lift estimated using equations developed by Ayoub, et al., 1983, or 20 lb minimum weight based on lifting apparatus constraints).
6. Lifting technique (free style).
7. Lifting plane (sagittal).
8. Lifting frequency. Each Type A subject was paired with a Type B subject and the pair was randomly assigned a series of frequencies of lift for the four familiarization period lifting sessions and the five experimental psychophysical lifting sessions. Table 8 presents the lifting frequencies assigned to each pair of subjects.

TABLE 8

Frequencies of Lift Assigned to Subject Pairs

S(A,B)	SESSION:	FP*				PLE**				
		1	2	3	4	1	2	3	4	5
1		4	7	1	5	6	2	6	8	6***
2		3	5	2	9	6	8	6	1	6
3		8	4	3	2	6	7	6	5	6
4		5	8	9	2	6	3	6	4	6
5		4	7	1	9	6	8	6	2	6
6		7	1	4	8	6	3	6	5	6
7		7	2	5	1	6	3	6	9	6
8		9	8	3	5	6	7	6	1	6
9		3	7	4	8	6	5	6	2	6
10		9	5	7	4	6	1	6	8	6
11		7	8	1	2	6	5	6	4	6
12		5	4	8	3	6	2	6	9	6
13		3	8	9	4	6	7	6	1	6
14		5	1	2	7	6	4	6	9	6
15		4	7	1	2	6	3	6	9	6

* FP = familiarization period

** PLE = psychophysical lifting experiment

*** lifts per minute

Experimental procedures

The first step in the experiment was the identification of 15 subjects exhibiting the Type A behavior pattern and 15 subjects exhibiting the Type B behavior pattern. The Jenkins Activity Survey (JAS) Form N was completed by 193 male students enrolled at Texas Tech University. The form was completed by the students in single- and mass-testing

situations. Those subjects classified as Type A or Type B were subsequently recruited to serve as paid volunteers in the psychophysical lifting experiment (this purpose was explained to the subjects prior to the administration of the form). To the extent possible, subjects were matched in terms of height and weight to minimize any possible confounding due to anthropometric differences between the two groups.

The second step in the experiment was the psychophysical lifting study. The subject performed a series of psychophysical lifting tasks using the protocol described previously. With ten minutes remaining in the experimental session the MMC was activated and oxygen consumption data were collected during this period. The average oxygen uptake during the final three minutes of the session was used to determine the percent of PWC at which the subject was working.

The social condition manipulations were introduced on the first, third, and fifth experimental session. The sequence of the social conditions was randomly determined for each subject. Subjects lifted at a frequency of 6 lifts/min during the social condition sessions. Subjects lifted alone during the second and fourth experimental sessions. The frequencies of lift were randomly determined from a range of

1 to 9 (excluding 6) lifts/min for the second and fourth experimental sessions. The lifting tasks during these sessions served as a "buffer zone" in that the probability of the subject recalling the fact that the frequency of lift was repeated during the third and fifth session, and recalling the MAWL selected previously (on the first and third sessions), was reduced by the inclusion of these lifting tasks.

A split-plot design of type SPF-2.3 was used to perform the statistical analysis. The design is depicted below:

	b1	b2	b3
a1	s1,...s15	s1,...s15	s1,...s15
a2	s16,...s30	s16,...s30	s16,...s30

where

a = two levels of personality type (Type A, Type B)

b = three levels of social conditions (subject lifts alone, subject lifts with similar or superior confederate lowering).

CHAPTER IV

RESULTS

Jenkins Activity Survey administration

The Jenkins Activity Survey (JAS) Form N was administered to 193 male college students in mass- and single-testing situations. The JAS provided a raw and standard score for four separate scales:

1. Type A scale (A)
2. Speed and Impatience Scale (S)
3. Involvement scale (I)
4. Hard-Driving and Competitive scale (C).

Table 9 provides descriptive statistics for these scores, along with age of the survey participants. The raw data are given in Appendix B. Of particular importance for this study were the Type A scores. The JAS converts raw scores to standard scores based on a linear transformation, with a mean of 0.0 and standard deviation of 10.0 in the normative population. The Type A standard scores obtained using the present sample closely approximated those values (mean = -0.777, SD = 9.035). Also, analysis using a modified version of the Komogorov-Smirnov D-statistic failed to reject the null hypothesis that the scores represented a random sample from a normal distribution (Table 10).

TABLE 9

Descriptive Statistics from JAS Survey Participants

VAR	N	MEAN	MEDIAN	SD	MINIMUM VALUE	MAXIMUM VALUE
Age	191	21.08	21	2.78	17	34
A Raw	193	235.78	234	73.07	82	401
A ST	193	-0.78	-1	9.03	-19.8	19.6
S Raw	193	206.84	205	68.41	72	376
S ST	193	-2.42	-2.6	8.19	-18.6	17.8
I Raw	193	255.17	256	42.80	152	358
I ST	193	0.33	0.4	8.08	-19.2	19.8
C Raw	193	131.45	130	38.06	53	245
C ST	193	-1.62	-2.0	8.55	-19.2	23.8

Raw = raw score, ST = standard score

TABLE 10

Test of Normality for JAS Scores using Modified Kolmogorov-Smirnov Test (n=193)

VARIABLE	D-STATISTIC	P>D
A Raw	0.0609	0.080
A Standard	0.0616	0.074
S Raw	0.0451	0.150
S Standard	0.0455	0.150
I Raw	0.0430	0.150
I Standard	0.0421	0.150
C Raw	0.0498	0.150
C Standard	0.0484	0.150

Table 11 presents a correlation matrix of the raw and standard scores for the four scales. Although the primary purpose of the matrix was to provide a final check of the raw score to standard score conversion, it also provided information regarding the relationships among the four scales. The Type A scale scores exhibited a strong positive correlation with the Competitive scale scores (approximately 0.697) and a moderate relationship with the Speed/Impatience scale scores (approximately 0.441).

From the 193 students to whom the JAS was administered, 15 subjects exhibiting the Type A behavior pattern and 15 subjects exhibiting the Type B behavior pattern were selected for participation in the psychophysical lifting study. The Type A subjects were selected on the basis of their Type A scale scores being greater than 1 SD above the population median score. The Type B subjects selected had Type A scale scores 1 or more SD below the population median. Based on willingness of subjects to participate in the study, in the case of three subjects an exception was made to the selection rule. Two subjects were classified as Type A although their Type A scale scores were slightly less than 1 SD above the median (standard scores = 8.0, 8.9), and one subject was classified as Type B although his Type A scale score was not 1 SD below the median (standard

TABLE 11
Correlation Matrix of JAS Scale Scores (n=193)

	A ST	S ST	I ST	C ST
A ST	-	0.441 .0001	0.265 .0002	0.697* .0001**
S ST		-	0.007 .9258	0.258 .0003
I ST			-	0.305 .0001
C ST				-

* Pearson correlation coefficient

** Prob > |R| under $H_0: \rho = 0$

score=-9.3). Table 12 presents descriptive statistics for the JAS scale scores for the 30 subjects participating in the psychophysical lifting experiment.

Familiarization period

During performance of the familiarization period tasks, the experimenter recorded the following:

1. Total number of weight adjustments

TABLE 12

Descriptive Statistics for Type A and B Subjects

TYPE	VAR	N	MEAN	MEDIAN	SD	MINIMUM VALUE	MAXIMUM VALUE
A	A ST	15	11.67	11.2	3.28	8.0	19.0
	C ST	15	5.64	5.2	8.19	-10.0	17.8
	S ST	15	4.05	3.2	6.79	-5.6	17.8
	I ST	15	-0.75	-1.8	7.57	-16.8	14.2
B	A ST	15	-13.03	-12.6	2.56	-19.8	-9.3
	C ST	15	-8.77	-6.9	5.63	-19.0	2.0
	S ST	15	-9.59	-10.4	6.51	-18.6	5.3
	I ST	15	-1.6	-2.0	6.28	-14.0	9.4

2. Number of adjustments increasing box weight
3. Number of adjustments decreasing box weight
4. Time required to determine MAWL
5. Number of times heart rate exceeded 66 percent
of age-predicted maximum heart rate.

To determine whether changes occurred for the above parameters over the course of the familiarization period, t-tests were conducted for each of the parameters comparing

familiarization session 1 with session 4. Tables 14 and 15 present the results. For the Type A and B subjects analyzed separately, no significant differences were found between sessions 1 and 4, although for both groups a decrease in the number of weight adjustments across the two sessions approached significance ($p > 0.0645$ for Type A, $p > 0.0744$ for Type B). For Type A and Type B subjects combined, significant decreases in total number of weight adjustments ($p > 0.0113$) and number of adjustments increasing box weight ($p > 0.0359$) were found. It should be noted that different frequencies of lift (F) were employed during sessions 1 and 4. However, no significant difference was found between the frequencies of lift employed during the two sessions ($p > 0.2888$), indicating that an equivalent range of lifting frequencies were represented for the two sessions.

Figures 6 through 9 depict the changes in number of adjustments, time to decide MAWL, adjustment increases and decreases, across the four familiarization sessions (Type A and B subjects combined).

As indicated in the figures, the MAWL selection parameters display a linear decrease across the familiarization period sessions.

Following the familiarization period, the physical work capacity (PWC) of each subject was determined. The PWC data

TABLE 14

Descriptive Statistics and T-Tests: Session 1 and Session 4
of Familiarization Period

DAY		VARIABLE	N	MEAN	SD	MINIMUM VALUE	MAXIMUM VALUE
T Y P E	1	ADJ	15	9.67	6.37	3	24
		TD	15	7.60	6.63	1	25
		AI	15	7.60	5.75	3	21
		AD	15	2.07	2.79	0	9
		OC	15	1.13	2.33	0	9
A	4	ADJ	15	5.93	3.31	2	14
		TD	15	4.67	4.22	1	14
		AI	15	5.40	2.85	2	14
		AD	15	0.53	1.81	0	7
		OC	15	0.33	1.29	0	5
T Y P E	1	ADJ	15	8.73	5.81	2	26
		TD	15	9.07	7.00	1	22
		AI	15	6.53	4.03	0	15
		AD	15	2.20	2.91	0	11
		OC	15	0.40	0.91	0	3
B	4	ADJ	15	6.73	6.49	0	25
		TD	15	7.47	6.65	2	22
		AI	15	5.07	4.22	0	16
		AD	15	1.67	2.87	0	9
		OC	15	0.20	0.77	0	3
VARIABLE			T	PR> T			
TYPE A			ADJ1-4	2.01	0.0645		
			TD1-4	1.62	0.1276		
			AI1-4	1.47	0.1645		
			AD1-4	1.77	0.0986		
			OC1-4	1.10	0.2885		
			F1-4	0.75	0.4652		
TYPE B			ADJ1-4	1.93	0.0744		
			TD1-4	0.86	0.4058		
			AI1-4	1.88	0.0810		
			AD1-4	0.75	0.4647		
			OC1-4	0.61	0.5501		
			F1-4	0.75	0.4652		

TABLE 15

Descriptive Statistics and T-Tests: Session 1 and Session 4 of Familiarization Period (A and B Subject Data combined)

DAY	VARIABLE	N	MEAN	SD	MINIMUM VALUE	MAXIMUM VALUE
1	ADJ	30	9.20	6.01	2	26
	TD	30	8.33	6.74	1	25
	AI	30	7.07	4.91	0	21
	AD	30	2.13	2.80	0	11
	OC	30	0.77	1.77	0	9
4	ADJ	30	6.33	5.07	0	25
	TD	30	6.07	5.66	1	22
	AI	30	5.23	3.54	0	16
	AD	30	1.10	2.43	0	9
	OC	30	0.27	1.05	0	5
VARIABLE		T		PR> T		
ADJ1-4		2.71		0.0113		
TD1-4		1.77		0.0880		
AI1-4		2.20		0.0359		
AD1-4		1.85		0.0743		
OC1-4		1.27		0.2153		
F1-4		1.08		0.2888		

are presented in Table 16 both in terms of liters/min and ml/kg body weight/min. No significant difference in PWC between the Type A and Type B subjects was indicated based on a t-test ($p > 0.8559$). Figure 10 shows the PWC being determined for a subject.

Figure 6: Weight Adjustments Across Familiarization Sessions

Figure 7: Time to Decide Mawl Across Familiarization Sessions

Figure 8: Weight Adjustment Increases Across Familiarization Sessions

Figure 9: Weight Adjustment Decreases Across Familiarization Sessions

Figure 10: Determination of Physical Work Capacity

TABLE 16

Descriptive Statistics and T-Tests for Physical Work Capacity of Type A and Type B Subjects

VARIABLE: PWC (ml/kg/min)

TYPE	N	MEAN	SD	MINIMUM VALUE	MAXIMUM VALUE	T	P> T
A	15	35.97	6.11	26.04	47.98	-0.16	0.8721
B	15	36.32	5.75	29.93	47.29		

VARIABLE: PWC (liters/min)

TYPE	N	MEAN	SD	MINIMUM VALUE	MAXIMUM VALUE	T	P> T
A	15	2.85	0.61	1.67	3.85	-0.18	0.8559
B	15	2.90	0.69	2.09	4.78		

Psychophysical lifting experiment

The psychophysical lifting experiment consisted of five psychophysical lifting sessions under three social facilitation conditions (subject lifted alone, or with a perceived similar or superior ability confederate lowering the box). Figures 11 and 12 depict the lifting alone condition. Figures 13 through 15 depict the superior confederate lifting condition.

After the final lifting session, the subjects rated the physical ability of the confederates relative to his own. Based on these ratings, several pieces of data were

Figure 11: Start Position for Subject Alone Lift

Figure 12: End Position for Subject Alone Lift

Figure 13: Start Position for Superior Confederate Lifting Condition

Figure 14: Superior Confederate Lifting Condition (cont.)

Figure 15: Superior Confederate Lifting Condition (cont.)

recategorized from the superior to similar ability confederate condition and vice versa. Also, a data point from one subject was omitted from analysis due to the fact that he rated the similar ability confederate as being much lower in physical ability than himself.

The rating of the confederate's ability relative to the subject was done using a seven point scale as follows:

1	2	3	4	5	6	7
much			same			much
weaker			strength			stronger

The criteria used to determine whether a confederate would be categorized as similar or superior to the confederate was as follows: To be categorized as similar, the confederate had to receive a rating from the subject of 3, 4, or 5 on the above scale. To be categorized as superior, the confederate had to receive a rating of 6 or 7. A rating below 3 (one case noted previously) was considered grounds for omission of that data point from analysis. The categorization criteria resulted in the following sample sizes for the social conditions:

	similar ability	superior ability
	-----	-----
Type A	15	14
Type B	17	13

Two split-plot analyses of variance of Blocks of Subjects (15) x Personality Type (2) x Social Condition (3) were conducted, using percentage PWC at which subject worked (%PWC) and MAWL as the two dependent variables. Because the categorization criteria resulted in unequal sample sizes, data points selected randomly were deleted from the various social conditions to achieve equal sample sizes.

Table 17 presents descriptive statistics for the two major dependent variables for the two personality types and three social conditions. Results of the analysis of variance using %PWC and MAWL as dependent variables are presented in Tables 18 and 19, respectively. As the results indicate, Type A subjects worked at a significantly higher %PWC ($F(1,11) = 12.65, p < .0045$) and selected a significantly higher MAWL ($F(1,11) = 6.05, p < .0317$) than Type B subjects. Significant results were not obtained for the social condition manipulation or the personality type x social condition interaction for %PWC or MAWL.

To test the hypothesis that Type A subjects would work at a higher %PWC than Type B subjects regardless of the social condition, t-tests were performed comparing %PWC for Type A and B subjects for each of the social conditions. Table 20 presents the results of these analyses. Type A subjects worked at a significantly higher %PWC when lifting

TABLE 17
Descriptive Statistics from Psychophysical Lifting
Experiment

CONDITION	TYPE	VAR	N	MEAN	SD	MAXIMUM VALUE	MINIMUM VALUE
LIFT ALONE	A	EW	15	45.40	16.64	25	89
		PC	15	39.87	6.14	28	50
	B	EW	15	34.07	11.85	20	56
		PC	15	34.80	6.46	23	44
	C	EW	30	39.73	15.32	20	89
		PC	30	37.33	6.71	23	50
SIMILAR CONF.	A	EW	15	51.40	18.89	26	97
		PC	15	41.40	7.21	30	62
	B	EW	17	35.40	11.28	20	54
		PC	17	34.29	6.21	25	48
	C	EW	32	42.90	17.32	20	97
		PC	32	37.63	7.99	25	62
SUPERIOR CONF.	A	EW	14	48.67	17.51	25	95
		PC	14	42.43	8.02	29	54
	B	EW	13	34.73	11.28	21	54
		PC	13	37.08	7.39	24	47
	C	EW	27	41.96	16.11	21	95
		PC	27	39.85	7.47	24	54

TYPE C = Combined Type A and B Data
EW = End Weight (MAWL), PC = %PWC

alone ($t = 2.20$, $p < 0.036$) and when lifting with the similar ability confederate ($t = 2.996$, $p < 0.006$). When lifting with the superior ability confederate, the difference in %PWC approached statistical significance ($t = 1.80$, $p < 0.084$).

TABLE 18

Analysis of Variance using %PWC as Dependent Variable

Source	DF	MS	F	P
Personality Type	1	997.96	12.65	0.0045
Error (Blocks x Personality Type)	11	78.90		
Social Condition	2	82.19	1.55	0.2648
Error (Blocks x Social Condition)	26	53.03		
Personality Type x Social Cond.	2	6.27	0.12	0.8901
Error (Blocks x Personality Type x Social Condition)	12	52.25		

TABLE 19

Analysis of Variance using MAWL as Dependent Variable

Source	DF	MS	F	P
Personality Type	1	3906.46	6.05	0.0317
Error (Blocks x Personality Type)	11	645.71		
Social Condition	2	169.09	1.33	0.2831
Error (Blocks x Social Con.)	26	127.58		
Personality Type x Social Cond.	2	57.04	0.47	0.6417
Error (Blocks x Personality Type x Social Condition)	12	121.36		

TABLE 20

%PWC of Type A and Type B Subjects for Three Social Conditions

SOCIAL CONDITION*	TYPE	N	MEAN	SD	T	DF	P> T
1	A	15	39.87	6.14	2.20	28	0.0361
	B	15	34.80	6.46			
2	A	15	41.40	7.21	2.99	30	0.0055
	B	17	34.29	6.21			
3	A	14	42.43	8.02	1.80	25	0.0840
	B	13	37.08	7.39			

* 1 = lift alone

2 = lift with similar ability confederate

3 = lift with superior ability confederate

Overall, significant results were not obtained for the social condition manipulation. However, there were a number of subjects who exhibited performance changes consistent with those hypothesized based on social facilitation theory. Table 21 presents the data from these subjects. It was attempted to determine whether these subjects differed along some defineable dimension from those subjects who did not exhibit performance changes as a function of social condition. A randomly selected sample consisting of 3 Type A and 5 Type B subjects were compared to the sample

presented in Table 21 using discriminant analysis. The two groups were compared along the following parameters:

1. Type A scale standard score (A)
2. Speed/Impatience scale standard score (S)
3. Involvement scale standard score (I)
4. Competitive scale standard score (C)
5. PWC
6. Rating of superior ability confederate (RS)
7. Rating of similar ability confederate (RE).

TABLE 21

MAWL and O2 Uptake of Subjects Exhibiting Social Facilitation Effects

TYPE	SUPERIOR CONFEDERATE		ALONE		SIMILAR CONFEDERATE	
	MAWL	O2	MAWL	O2	MAWL	O2
A	43	0.711	36	0.597	44	0.727
B	44	1.306	34	0.998	47	1.377
B	39,46	1.07,1.26*	34	0.925		
B	28	0.980	23	0.810	30	1.050
B			43	0.895	31,36	0.90,0.75**
A	47	1.728	40	1.463	47	1.743
A	62	1.660	50	1.333	***	
B	48	1.303	38	1.055	45	1.220

* subject rated both confederates superior

** subject rated both confederates similar

*** subject rated confederate lower in ability - data discarded

Table 22 presents the results of the discriminant analysis. As Table 22 indicates, all individuals were classified correctly using the seven parameters listed above. Additional discriminant analyses were conducted using all possible combinations of the above parameters. Discriminant analysis using the following combinations of parameters resulted in perfect classification of the subjects into the two groups:

1. A, S, I, C, PWC
2. A, S, C, PWC.

Discriminant analysis using A, C, and PWC resulted in 3 of 16 subjects being misclassified. Tables 23 through 25 present the results of these three discriminant analyses. The remaining discriminant analyses resulted in the misclassification of six or more pieces of data.

Factor analyses were conducted for the two groups of subjects using A, S, C, and PWC. Figures 16 and 17 present the results of the factor analyses. Based on the figures, A, S, and C appear to constitute one factor, while PWC appears to constitute a second factor. Variable C was not as strongly loaded with A and S for the group exhibiting performance changes as a function of social condition.

Based on the above data, analyses of variance were conducted using three levels of personality type based on

TABLE 22

Discriminant Analysis Using Seven Parameters*

A. Generalized Squared Distance to Group

FROM GROUP	1	2
1	6.437	18.277
2	173.737	7.697

B. Classification Results

OBS	FROM GROUP	INTO GROUP	POSTERIOR PROBABILITY OF MEMBERSHIP IN GROUP	
			1	2
1	1	1	1.000	0.000
2	1	1	0.993	0.007
3	1	1	1.000	0.000
4	1	1	1.000	0.000
5	1	1	1.000	0.000
6	1	1	1.000	0.000
7	1	1	1.000	0.000
8	1	1	0.855	0.145
9	2	2	0.000	1.000
10	2	2	0.000	1.000
11	2	2	0.000	1.000
12	2	2	0.000	1.000
13	2	2	0.000	1.000
14	2	2	0.000	1.000
15	2	2	0.000	1.000
16	2	2	0.000	1.000

* variables used: Type A scale score, Speed/Impatience scale score, Involvement scale score, Competitive scale score, PWC, Rating of superior confederate, Rating of similar confederate

TABLE 23

Discriminant Analysis Using Five Parameters*

A: Generalized Squared Distance to Group

FROM GROUP		1	2
1		10.397	14.631
2		39.591	13.394

B: Classification Results

OBS	FROM GROUP	INTO GROUP	POSTERIOR PROBABILITY OF MEMBERSHIP IN GROUP	
			1	2
1	1	1	1.000	0.000
2	1	1	0.829	0.171
3	1	1	0.755	0.245
4	1	1	1.000	0.000
5	1	1	0.885	0.115
6	1	1	0.964	0.036
7	1	1	0.994	0.006
8	1	1	0.904	0.096
9	2	2	0.000	1.000
10	2	2	0.000	1.000
11	2	2	0.331	0.669
12	2	2	0.000	1.000
13	2	2	0.001	0.999
14	2	2	0.000	1.000
15	2	2	0.002	0.998
16	2	2	0.000	1.000

* variables used: Type A scale score, Speed/Impatience scale score, Involvement scale score, Competitive scale score, PWC

TABLE 24

Discriminant Analysis Using Four Parameters*

A: Generalized Squared Distance to Group

FROM GROUP	1	2
1	7.306	12.080
2	36.443	10.920

B: Classification Results

OBS	FROM GROUP	INTO GROUP	POSTERIOR PROBABILITY OF MEMBERSHIP IN GROUP	
			1	2
1	1	1	0.948	0.052
2	1	1	0.809	0.191
3	1	1	0.738	0.262
4	1	1	0.994	0.006
5	1	1	0.919	0.081
6	1	1	0.966	0.034
7	1	1	0.993	0.007
8	1	1	0.885	0.115
9	2	2	0.000	1.000
10	2	2	0.000	1.000
11	2	2	0.358	0.642
12	2	2	0.000	1.000
13	2	2	0.003	0.997
14	2	2	0.000	1.000
15	2	2	0.009	0.991
16	2	2	0.000	1.000

* variables used: Type A scale score, Speed/Impatience scale score, Competitive scale score, PWC

TABLE 25

Discriminant Analysis Using Three Parameters*

A: Generalized Squared Distance to Group

FROM GROUP		1	2
1		6.219	8.851
2		17.939	7.906

B: Classification Results

OBS	FROM GROUP	INTO GROUP	POSTERIOR PROBABILITY OF MEMBERSHIP IN GROUP	
			1	2
1	1	1	0.892	0.108
2	1	1	0.851	0.149
3	1	1	0.707	0.293
4	1	1	0.973	0.027
5	1	1	0.847	0.153
6	1	1	0.912	0.088
7	1	1	0.821	0.179
8	1	1	0.753	0.247
9	2	2	0.001	0.999
10	2	2	0.009	0.991
11	2	1**	0.868	0.132
12	2	2	0.008	0.992
13	2	1**	0.746	0.254
14	2	2	0.000	1.000
15	2	1**	0.723	0.277
16	2	2	0.000	1.000

* variables used: Type A scale score, Competitive scale score, PWC

** misclassified observation

Figure 16: Factor Analysis for Group Exhibiting Performance Changes as a Function of Social Condition

Figure 17: Factor Analysis for Group Exhibiting no Performance Changes as a Function of Social Condition

Competitive scale standard scores. The three levels consisted of six subjects with a Competitive scale standard score 1-2 SD below the median, six subjects 1-2 SD above the median, and six subjects with Competitive scale standard scores within 1 SD of the median (the remaining data were deleted to achieve equal sample sizes). Table 26 presents the results of the analyses using MAWL and %PWC as dependent variables. As indicated in the table, significant differences in MAWL and %PWC as a function of Competitive scale score were not obtained.

During the second and fourth psychophysical lifting sessions, the subjects lifted alone at randomly selected frequencies of lift. Tables 27 and 28 compare the %PWC and MAWL, respectively, at each frequency of lift (included for comparison purposes are the %PWC and MAWL obtained when the subject was lifting alone at 6 lifts/min). As the tables indicate, Type A subjects consistently worked at a higher %PWC and selected higher MAWLs than did Type B subjects. In general, %PWC increased and MAWL decreased as frequency of lift increased.

Table 29 compares the lifting capacity data obtained in the present study with psychophysical lifting capacity data obtained by other researchers (Asfour, 1980; Ayoub, et al. 1983; Fernandez, 1986; Jiang, 1984). Overall, the

TABLE 26

Analysis of Variance using Three Levels of Personality Type
Based on Competitive Scale Score

Dependent Variable=%PWC

SOURCE	DF	ANOVA SS	F VALUE	PR>F
Personality Type	2	722.48	3.49	0.0707
Social Condition	2	40.48	2.16	0.1656
Personality Type * Social Condition	4	83.52	2.16	0.1105

Dependent Variable=MAWL

SOURCE	DF	ANOVA SS	F VALUE	PR>F
Personality Type	2	6028.48	3.62	0.0658
Social Condition	2	23.26	1.01	0.3974
Personality Type * Social Condition	4	63.19	1.38	0.2762

TABLE 27

%PWC of Type A and B Subjects for Various Frequencies of
Lift

Lifts/Min	N	TYPE A		TYPE B	
		Mean %PWC	SD	Mean %PWC	SD
1	4	19.75	3.77	19.00	1.41
2	4	21.75	3.59	21.00	3.37
3	4	36.00	7.70	23.75	4.27
4	3	37.33	5.03	24.67	5.03
5	4	40.00	5.48	30.75	5.32
6	15	39.87	6.14	34.80	6.46
7	3	42.00	6.56	38.67	0.58
8	4	43.00	3.56	40.00	1.83
9	4	47.50	7.05	34.75	9.78

TABLE 28

MAWL of Type A and B Subjects for Various Frequencies of Lift

Lifts/Minute	N	TYPE A		TYPE B	
		Mean MAWL	SD	Mean MAWL	SD
1	4	72.50	24.37	47.00	16.02
2	4	56.75	10.78	44.50	15.20
3	4	49.75	16.78	39.50	16.38
4	3	45.00	11.27	32.33	10.60
5	4	41.75	9.67	42.75	5.38
6	15	45.40	16.64	34.07	11.85
7	3	55.67	27.68	31.00	8.19
8	4	37.25	18.68	36.00	11.97
9	4	39.00	10.39	19.00	3.46

TABLE 29

Comparison of Lifting Capacities (lb) with Previous Studies

F	PRESENT STUDY TYPE A	PRESENT STUDY TYPE B	PRESENT STUDY COMBINED DATA	AYOUB, ET AL. 1983	ADDITIONAL DATA
1	72.50	47.00	59.75	57.20	88.70*
2	56.75	44.50	50.63	55.20	53.75**
3	49.75	39.50	44.63	53.20	65.15***
4	45.00	32.33	38.67	51.20	
5	41.75	42.75	42.25	49.20	
6	45.40	34.07	39.74	47.20	57.70*
7	55.67	31.00	43.33	45.20	
8	37.25	36.00	36.63	43.20	30.42**
9	39.00	19.00	29.00	41.20	42.40***

* Jiang (1984), n=12

** Fernandez (1986), n=12

*** Asfour (1980), n=10

capacities of lift determined in the present study were lower than those reported by the other researchers.

While the subject was selecting his MAWL, the experimenter monitored several parameters related to weight selection methodologies. Chi-Squares were conducted comparing the performance of Type A and B subjects for each of the parameters. The results are presented in Table 30 for those sessions during which the subject lifted alone.

Both Type A and Type B subjects made an average of 5.62 weight adjustments in deciding their MAWL. However, Type A subjects decided their MAWL in significantly less time than did Type B subjects ($\text{Chi-square}=7.408, p=0.006$). Also, Type A subjects made significantly fewer adjustments decreasing box weight, and more adjustments increasing box weight, than did Type B subjects.

Tables 31 through 33 compare the performance of Type A and B subjects for each of the MAWL selection parameters under the three social conditions. Type A subjects made a higher total number of weight adjustments and more adjustments increasing box weight for all three social conditions. Type A subjects required less time to decide their MAWL for each of the social conditions.

The Type A and Type B subjects were combined in terms of their MAWL selection parameters to compare differences

TABLE 30

Comparison of MAWL Selection Parameters for Type A and B
Subjects when Lifting Alone

VARIABLE	TYPE	N	MEAN	CHI-SQUARE VALUE	P
1	A	45	5.62	-	-
	B	45	5.62		
2	A	45	3.62	5.137	0.023
	B	45	7.07		
3	A	45	5.24	3.185	0.074
	B	45	4.44		
4	A	45	0.40	1.401	0.237
	B	45	1.22		
5	A	45	0.18	1.134	0.287
	B	45	0.24		

where VARIABLE 1 = Total # of weight adjustments
 2 = Time required to select MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum

TABLE 31

MAWL Selection Parameters for Type A and B Subjects under
Similar Ability Confederate Condition

VARIABLE	TYPE	N	MEAN	CHI-SQUARE VALUE	P
1	A	15	5.33	0.587	0.443
	B	17	4.67		
2	A	14	3.21	2.138	0.144
	B	17	5.73		
3	A	15	5.27	0.682	0.409
	B	17	3.93		
4	A	15	0.07	1.171	0.279
	B	17	0.73		
5	A	15	0.00	.	.
	B	17	0.00		

where VARIABLE 1 = Total # weight adjustments
 2 = Time required to decide MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum

TABLE 32

MAWL Selection Parameters for Type A and B Subjects under
Lifting Alone Condition

VARIABLE	TYPE	N	MEAN	CHI-SQUARE VALUE	P
1	A	15	6.47	1.942	0.163
	B	15	5.20		
2	A	15	3.00	8.803	0.003
	B	15	7.00		
3	A	15	5.93	0.880	0.467
	B	15	4.33		
4	A	15	0.53	0.614	0.433
	B	15	1.00		
5	A	15	0.00	.	.
	B	15	0.00		

where VARIABLE 1 = Total # weight adjustments
 2 = Time required to decide MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum

TABLE 33

MAWL Selection Parameters for Type A and B Subjects under
Superior Ability Confederate Condition

VARIABLE	TYPE	N	MEAN	CHI-SQUARE VALUE	P
1	A	14	6.53	1.330	0.249
	B	13	4.67		
2	A	14	2.67	4.904	0.027
	B	13	5.40		
3	A	14	6.20	7.408	0.006
	B	13	3.80		
4	A	14	0.33	0.523	0.470
	B	13	0.27		
5	A	14	0.47	1.067	0.302
	B	13	0.00		

where VARIABLE 1 = Total # weight adjustments
 2 = Time required to decide MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum

among the social conditions. Table 34 compares the similar ability confederate lifting condition with the lifting alone condition. Table 35 compares the superior ability confederate lifting condition with the lifting alone condition. Table 36 compares the similar ability confederate condition with the superior ability confederate condition. As indicated in the tables, no significant differences were found among the MAWL selection parameters for any of the social conditions.

During the course of the experiment, it was decided to perform a post-experiment PWC on subjects to determine if the subjects had stabilized in terms of PWC following the familiarization period. For the 15 subjects on who post-experiment PWCs were performed, the results (in liters oxygen/min) were as follows:

PWC1: Mean = 2.962, SD = 0.539

PWC2: Mean = 2.916, SD = 0.549.

No significant difference between the two capacities was indicated using a t-test ($t = 0.96$, $p > 0.3524$). Surprisingly, the post-experiment PWC was slightly lower than the first PWC, although the difference between the two PWCs (1.6%) fell within established limits for PWC test-retest reliability (Mellerowicz and Smodlaka, 1981).

TABLE 34

MAWL Selection Parameters Similar Ability Confederate
Condition and Lifting Alone

VAR	CONDITION	N	MEAN	CHI-SQUARE VALUE	P
1	S	32	5.00	0.614	0.433
	A	30	5.83		
2	S	31	4.52	0.523	0.470
	A	30	5.00		
3	S	32	4.60	0.704	0.401
	A	30	5.13		
4	S	32	0.40	0.657	0.422
	A	30	0.77		
5	S	32	0.00	.	.
	A	30	0.00		

where VAR 1 = Total # of weight adjustments
 2 = Time required to decide MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum
 CONDITION S = similar ability confederate
 A = lifting alone

TABLE 35

MAWL Selection Parameters Superior Ability Confederate
Condition and Lifting Alone

VAR	CONDITION	N	MEAN	CHI-SQUARE VALUE	P
1	A	30	5.83	0.322	0.570
	S	27	5.60		
2	A	30	5.00	2.160	0.142
	S	27	4.03		
3	A	30	5.13	1.019	0.313
	S	27	5.00		
4	A	30	0.77	2.127	0.145
	S	27	0.30		
5	A	30	0.00	0.106	0.744
	S	27	0.23		

where VAR 1 = Total # weight adjustments
 2 = Time required to decide MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum
 CONDITION A = Lifting alone
 S = Superior ability confederate

TABLE 36

MAWL Selection Parameters Similar Ability Confederate
Condition and Superior Ability Confederate Condition

VAR	CONDITION	N	MEAN	CHI-SQUARE VALUE	P
1	SI	32	5.00	1.125	0.289
	SU	27	5.60		
2	SI	31	4.52	0.107	0.744
	SU	27	4.03		
3	SI	32	4.60	0.676	0.411
	SU	27	5.00		
4	SI	32	0.40	0.145	0.703
	SU	27	0.30		
5	SI	32	0.00	0.143	0.705
	SU	27	0.23		

where VAR 1 = Total # weight adjustments
 2 = Time required to decide MAWL
 3 = Adjustments increasing box weight
 4 = Adjustments decreasing box weight
 5 = HR over 66% maximum
 CONDITION SI = Similar ability confederate
 SU = Superior ability confederate

CHAPTER V
DISCUSSION AND RECOMMENDATIONS

Discussion

The study hypothesized the following results:

- 1) Subjects classified as possesssing the Type A behavior pattern would work during the psychophysical lifting tasks at a higher %PWC than subjects classified as Type B regardless of the social condition.
- 2) Subjects classified as Type B would select a higher MAWL when working with a confederate who was similar in ability than when lifting alone or when lifting with a confederate who was superior in ability.
- 3) Subjects classified as Type A would select a higher MAWL when working with a confederate, regardless of the confederate's level of ability, than when working alone.

The first hypothesis was largely substantiated. Type A subjects worked at a significantly higher %PWC than Type B subjects for the alone and similar ability confederate conditions. For the superior ability confederate condition, Type A subjects worked at a higher %PWC which approached statistical significance ($p > 0.0840$).

The finding that human performance is related to the Type A behavior pattern is consistent with previous research employing a variety of tasks. Damos (1985) found that Type A subjects responded more rapidly than Type B subjects when performing a reaction time task. Gastorf, et al. (1980) found significant differences between Type A and B subjects in the performance of copying tasks. These findings, along with the results of the present study, would indicate that differences between Type A and B individuals are not task-dependent.

Differences between the Type A and Type B subjects were also found when examining the method with which each group selected their MAWL. Based on those experimental sessions in which the subject lifted alone, Type A subjects determined their MAWL in an average of 3.62 minutes whereas Type B subjects required an average of 7.07 minutes to determine their MAWL. This time differential occurred despite the fact that both groups made approximately six weight adjustments in deciding their MAWL. This indicates that, following a weight adjustment, Type B subjects would sample that weight (via a number of lifts) more times than Type A subjects before making their next weight adjustment or deciding that the present weight represented their MAWL. The higher sampling rate employed by the Type A subjects is

consistent with the enhanced sense of time urgency that typifies the Type A behavior pattern.

It was also found, for those sessions in which the subjects lifted alone, that Type A subjects made significantly fewer weight adjustments decreasing box weight than did Type B subjects. Although this finding could be interpreted as being consistent with the competitive component of the Type A behavior pattern, the difference between the two groups (mean = 0.40 weight decreases for Type A subjects, 1.22 weight decreases for Type B subjects) lacks practical significance.

(Empirical support for the second and third hypotheses, regarding social facilitation effects, was not found in this study.) The finding that Type B subjects did not exhibit any social facilitation effects is consistent with the findings of Gastorf, et al. (1980). However, the fact that the Type A subjects also failed to exhibit any social facilitation effects indicates that the presence of the confederate, regardless of perceived ability, was not a sufficiently strong variable to induce social facilitation effects. The absence of significant findings may in part be due to the fact that social facilitation effects are, generally, relatively small in magnitude. Also, several researchers (Cottrell, 1968; 1972; Martens and Landers, 1972; Hunt and Hillery, 1973;

Laughlin and Jaccard, 1975; Cohen and Davis, 1973; Good, 1973; Klinger, 1969) have indicated that the potential for evaluation must be present for social facilitation effects to be observed. Although the experimenter was never present during selection of the MAWL, and did not weigh the box until the subject was dismissed, the experimenter was still ultimately the evaluator of the subjects' performance. In this sense it can be argued that the social facilitation manipulation was constant across all lifting sessions, which would explain the lack of any significant results.

The above explanation for the lack of significant social facilitation effects is based on an assumption of the validity of the evaluation apprehension theory of social facilitation (Cottrell, 1968; 1972). In terms of the distraction-conflict theory of social facilitation (Sanders and Baron, 1975; Sanders, Baron, and Moore, 1978a and b), the only explanation for the lack of significant results would be that the confederates did not distract the subjects. The fact that 26 of the 30 subjects rated the superior ability confederate higher than the similar ability confederate in terms of physical ability indicates that the confederates did produce some degree of attentional demand on the subjects, which lends support for the previous explanation of the lack of a significant social facilitation effect in this study.

Two additional factors need to be considered when discussing the lack of significant social facilitation effects found in the present study. A post-hoc analysis indicated the power of the overall F test to be approximately 0.66. To achieve a traditionally acceptable power of 0.80, given the effect size exhibited in the study, would require a sample size of 100 or greater. However, even were the sample size to be greatly increased, the effect size lacks practical significance. Across all social conditions, the mean difference in %PWC was approximately 1.65%; for MAWL the mean difference across social conditions was 2.7 lb. This latter difference falls within the acceptable range of test-retest reliability for psychophysical lifting tasks. In short, although the power of the F test was low, the results lacked any practical significance.

A second factor to be considered is the method by which the behavior pattern of the individuals was determined. Gastorf, et al. (1980) used the JAS Form T to identify Type A and Type B individuals. The present study utilized the JAS Form N based on information from the developers of the JAS that a test of the validity of the JAS Form T proved unsuccessful. This raises the possibility that differences between the findings of Gastorf, et al. (1980) and the present study may be due to different measurement techniques used in the identification of the Type A behavior pattern.

While a significant social facilitation effect was not found in the present study, there were a group of subjects who exhibited changes in performance (MAWL and %PWC) as a function of the social condition. The results of discriminant and factor analyses indicate that these subjects differ from subjects not exhibiting performance changes as a function of social condition in terms of a rather complex interplay of both psychological and physiological variables. The simplest discriminant function providing perfect classification of subjects into the two groups employed the following variables:

1. Type A scale standard score (A)
2. Speed/Impatience scale standard score (S)
3. Competitive scale standard score (C)
4. PWC.

Subsequent factor analyses indicated that A, S, and C appeared to constitute one factor while PWC appeared to constitute a second factor. The factor consisting of A, S, and C is termed the psychological factor; PWC is termed the physiological factor. In comparing the two groups of subjects, C did not appear to be as strongly associated with A and S for those subjects exhibiting performance changes compared to those subjects who did not exhibit performance changes as a function of social condition. It is difficult

to say whether this is a significant fact. An analysis of variance indicated no significant social facilitation effects when categorizing subjects on the basis of their Competitive scale standard score. However, the power of the F test was only approximately 0.5 (due to the deletion of data to achieve equal sample sizes), and as such the Competitive behavior pattern warrants further investigation as a predictor of human performance.

It should be noted that for those subjects exhibiting performance changes as a function of the social condition, there was no apparent difference in performance between the superior and similar ability confederate conditions. For example, the mean difference in MAWL between the superior and similar ability confederate conditions was 1.8 lb; whereas the mean difference in MAWL between the alone and confederate conditions was 8.6 lb. Therefore, even for those subjects exhibiting performance changes consistent with social facilitation theory, the findings of Gastorf, et al. (1980) and the results predicted by social comparison theory (Festinger, 1957) were not supported in the present study.

A critical assumption of the psychophysical approach is that an individual can accurately estimate his MAWL for a typical 8 hour work shift within a relatively short period

of time. Subjects participating in psychophysical lifting experiments are generally given from 20 minutes to 1 hour to decide their MAWL. Fernandez (1986) found that subjects performing an 8 hour psychophysical lifting task selected significantly lower weights than during performance of a 40 minute psychophysical lifting task. Given the finding of the present study that Type A subjects worked at a significantly higher %PWC than Type B subjects, it is possible that the differences between the two groups might diminish were an 8 hour psychophysical session employed (i.e., Type A subjects might display a larger decrease in MAWL over 8 hours relative to Type B subjects).

It was noted that the psychophysical lifting capacities determined in the present study were, in general, lower than those obtained by previous researchers (see Table 29). This finding was true for both the data of the Type A and Type B subjects, although the disparity was more pronounced for the Type B subjects. It may appear inconsistent with the Type A behavior pattern that the MAWLs of the Type A subjects were lower than those of the comparison populations. However, an examination of these comparison populations provides explanations for the finding. The Ayoub, et al. (1983) lifting capacity data were gathered from industrial workers with MMH experience. The strength and MMH capacities of

industrial workers have generally been found to be greater than the capacities of populations outside industry (i.e. students). Asfour's (1980) subjects underwent an intensive 3 month training program prior to the collection of lifting capacity data; the training program resulting in significant increases in the strength, aerobic capacity, and lifting capacity of the subjects. Explanations for the disparities among the data of Jiang (1984) and Fernandez (1986) and the present data are not readily apparent.

The discrepancies among the data in Table 29, along with the finding of the present study that MAWL is affected by the personality type of the subject, raises the issue of whether the psychophysical design criterion is the most appropriate criterion for the establishment of lifting capacity guidelines. It is the opinion of the author that the psychophysical approach is the most appropriate method available, providing that strict care is taken to control for the myriad of factors demonstrated (or suspected) to effect MAWL. An objective of this research was to establish general guidelines for the psychophysical lifting capacity methodology which take into account and control for the various psychological variables which may effect the expression of the psychophysical MAWL. Based on the literature reviewed and the results of the present study,

the following variables should be accounted for when performing psychophysical lifting studies:

1. Personality type of subject. Since no significant difference was found between the PWCs of the Type A and Type B subjects, it can be concluded that personality type was a better predictor of lifting capacity in the present study. This conclusion is in general agreement with the findings of Bakken (1983), who found attitude survey results and PWC to be the best single predictors of lifting capacity. Based on these findings it would appear that the behavior pattern, attitude towards physical work, should be used as a predictor of psychophysical lifting capacity.

2. Although significant results were not obtained in the present study, social variables should be accounted for when performing psychophysical lifting experiments. This conclusion is justified on the basis that instances of overt competition, if not social facilitation, may be detected via the monitoring of such variables. Specifically, social variables to account for would include presence/absence of the experimenter during psychophysical lifting tasks (in particular during the determination of MAWL), status of experimenter, presence of audience/coactors and their status, knowledge of results (own and others), and gender makeup of the group.

Recommendations for future research

The study presented herein represented an initial effort to identify and delineate those psychological, sociological, and motivational factors which may affect the psychophysical MAWL. The results indicate that the behavior pattern of an individual has a significant effect on his response to the psychophysical lifting paradigm, although social pairings as manipulated in the present did not significantly effect lifting performance. Based on these results and discussion, the following areas are suggested for future research:

1. Although the variables employed in the present study did not produce significant social facilitation effects, it still appears logical that social facilitation effects can occur during the performance of psychophysical lifting tasks. An experimental procedure utilizing coaction (two subjects performing psychophysical lifting tasks simultaneously and independently) might provide, as Seta (1982) hypothesized, social comparison serving as a cue for competition. It could also provide a more objective means of establishing the status of the confederate.

2. The results of this study indicated that Type A subjects worked at a significantly higher %PWC and lifted heavier MAWLs than did Type B subjects.) The Type A and Type

B subjects used in the present study represent two extremes on a behavior pattern scale. It would be interesting to determine whether a continuum of performance could be established by the inclusion of a behavior pattern group between these two extremes. Operationally, this "middle-ground" group could be defined as having a Type A scale score plus or minus one-half standard deviation from the median score. It is hypothesized that Type A subjects (1 to 2 SD above the median) would work at a higher %PWC and select higher MAWLs than "middle-ground" subjects, and that "middle-ground" subjects would work at a higher %PWC and select higher MAWLs than Type B subjects (1 to 2 SD below the median score).

3. Damos and Bloom (1985) provided evidence that Type A and Type B subjects experience workload differently. Rating perceived workload under single- and dual-task conditions, Type A subjects reported less frustration under single- than dual-task conditions, and less fatigue under dual- than single-task conditions. Type B subjects reported the reverse patterns for frustration and fatigue. (Since, in the present study, all subjects received the same instructions as to what should constitute their MAWL, (it would appear that Type A and Type B subjects experienced perceived stress differently.) To determine this, the Rating of Perceived Exertion (RPE) scale (Borg, 1960) should be used in future

research in this area. Asfour (1980) found heart rate and oxygen consumption to be linearly related to RPE scale reports. (It would be of both experimental and practical interest to determine if these two personality types perceived their measurably different workloads as being subjectively different.)

4. The issue of the practical importance of the present research is addressed in this final recommendation for future research. The National Safety Council reports that at least 25 percent of all injuries, accounting annually for 12 million lost workdays and over 1 billion dollars in compensation costs, can be attributed to overexertion associated with manual handling (NIOSH, 1981). (It has been demonstrated in the present study that Type A subjects volitionally work harder than do Type B subjects.) Extending this to the industrial arena, an epidemiological study is suggested to establish whether a relationship exists between the Type A behavior pattern and job injury frequency, severity, and cost. Of particular interest would be those industrial situations in which the employee has a high degree of control over the establishment of his work rate. The identification of an "accident-prone" behavior pattern could serve to reduce injuries and their costs in the workplace.

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APPENDIX A
CONSENT FORM

PERSONAL DATA AND CONSENT FORM

Date: _____

Texas Tech University

Subj. No.: _____

Institute for Ergonomics Research

Effect of Task and Individual Variables on Lifting Capacity

NAME: _____ AGE: _____

SEX: _____ HEIGHT: _____ WEIGHT: _____

CHECK IF SUSCEPTIBLE TO:

Shortness of Breath: _____ Dizziness: _____ Headaches: _____

Fatigue: _____ Pain in arm, shoulder, or chest: _____

IF SO, EXPLAIN: _____

Have you ever had a heart attack? _____ If so, give history:

Are you currently taking any type of medicine? _____ If so,
explain: _____

Have you had or do you now have any problems with your blood
pressure? _____ If so, explain: _____

In the last six months, have you had any type of surgery or
serious illness? _____ If so, explain: _____

In the last six months, have you had any back pain? _____
If so, explain: _____

Have you had or do you now have a hernia?____Corrective date:

PLEASE READ CAREFULLY

I have truthfully answered the questions to the best of my knowledge, pertaining to my personal data. I hereby give my consent for my participation in the project entitled: Effect of Task and Individual Variables on Lifting Capacity. I understand that the person responsible for this project is Dr. Charles G. Halcomb (806) 742-3722. He or his authorized representative (806) 742-3429 has explained that these studies are part of a project that has the objective: to establish lifting limits for use in industry.

Dr. Halcomb or his representative has agreed to answer any inquiries I may have concerning the procedures and has informed me that I may contact the Texas Tech University Institutional Review Board for the Protection of Human Subjects by writing them in care of the Office of Research Services, Texas Tech University, Lubbock, Texas 79409, or by calling (806) 742-3884.

He or his authorized representative has (1) explained the procedures to be followed and identified those which are experimental and (2) described the attendant discomforts and risks.

(1) Briefly these procedures involve the following: (a) measurement of aerobic capacity, and (b) measurement of psychophysical

lifting capacity. To measure aerobic capacity, you will be asked to pedal a stationary bicycle at increasing workloads while oxygen consumption and heart rate are monitored. To measure your psychophysical lifting capacity, you will be asked to lift a container given specific task parameters and adjust the load until it represents your maximum safe weight of lift.

(2) The risks have been explained to me as follows: muscle strain or sprains, pulled tendons, back pain or strain, or hernia. There are also possible changes such as abnormalities of blood pressure or heart rate, or ineffective heart function, and in rare instances heart attacks, or cardiac arrest, strokes, or pulmonary embolism.

If this research project causes any physical injury to participants, treatment is not necessarily available at Texas Tech University or the Student Health Center, nor is there necessarily any insurance carried by the University or its personnel applicable to cover any such injury. Financial compensation for any such injury must be provided through the participant's own insurance program. Further information about these matters may be obtained from the Office of Research Services, 742-3884, Room 203 Holden Hall, Texas Tech University, Lubbock, Texas 79409.

I understand that I will not derive any therapeutic treatment from participation in this study. I understand that I may discontinue participation in the project at any time without

prejudice.

I understand that all data will be kept confidential and that my name will not be used in any reports, written or unwritten.

SIGNATURE OF SUBJECT: _____ DATE: _____

Signature of Project Director/authorized representative:

Signature of Witness to Oral Presentation: _____

APPENDIX B
JENKINS ACTIVITY SURVEY DATA

DATA JOEDIS

INPUT ID AGE ARAW AST SRAW SST IRAW IST CRAW CST
CARDS

1	18	335	11.5	326	11.8	264	2.0	151	2.8
2	21	345	12.7	237	1.2	302	9.2	227	19.8
3	19	336	11.6	228	0.1	306	10.0	165	5.9
4	22	333	11.2	230	0.4	221	-6.2	142	0.8
5	19	344	12.6	268	4.9	260	1.2	222	18.7
6	19	334	11.4	238	1.3	271	3.4	179	9.0
7	20	336	11.6	300	8.8	255	0.3	151	2.8
8	18	157	-10.5	268	4.9	223	-5.8	117	-4.8
9	20	142	-12.4	185	-5.0	223	-5.8	75	-14.3
10	20	82	-19.8	117	-13.2	223	-5.8	54	-19.0
11	19	143	-12.2	176	-6.1	264	2.0	116	-5.1
12	24	95	-18.2	221	-0.7	197	-10.6	100	-8.7
13	21	142	-12.4	162	-7.8	190	-12.0	81	-13.0
14	20	132	-13.6	105	-14.6	207	-8.8	148	2.0
15	18	236	-0.8	233	0.7	265	2.2	123	-3.6
16	19	169	-9.0	312	10.2	299	8.6	87	-11.6
17	18	300	7.2	169	-7.0	260	1.2	146	1.6
18	19	209	-4.1	181	-5.5	240	-2.6	100	-8.7
19	19	213	-3.6	224	-0.4	246	-1.4	122	-3.8

20 18 206 -4.5 194 -4.0 208 -8.6 95 -9.8
21 19 192 -6.2 230 0.4 258 0.8 143 1.0
22 19 256 1.7 293 7.9 277 4.4 187 10.8
23 19 242 0.0 240 1.6 325 13.6 150 2.6
24 18 253 1.4 175 -6.2 312 11.0 173 7.7
25 21 263 2.6 251 2.9 197 -10.6 133 -1.2
26 20 246 0.5 261 4.1 249 -0.8 150 2.6
27 21 208 -4.2 141 -10.3 197 -10.6 169 6.8
28 18 197 -5.6 129 -11.7 228 -4.8 124 -3.1
29 18 262 2.4 187 -4.8 311 10.8 130 -2.0
30 17 234 -1.0 192 -4.2 236 -3.2 132 -1.5
31 18 177 -8.0 326 11.8 212 -7.8 90 -11.0
32 20 188 -6.7 171 -6.7 182 -13.4 100 -8.7
33 18 225 -2.1 299 8.6 263 1.8 122 -3.8
34 20 296 6.6 199 -3.4 247 -1.2 157 4.1
35 21 246 0.5 223 -0.5 281 5.2 138 -0.2
36 21 220 -2.7 242 1.8 260 1.2 84 -12.3
37 23 277 4.3 197 -3.6 252 -0.2 191 11.8
38 25 302 7.4 164 -7.6 298 8.4 135 -0.8
39 19 230 -1.5 206 -2.5 183 -13.2 94 -10.0
40 20 220 -2.7 237 1.2 218 -6.6 133 -1.2
41 21 289 5.8 358 15.5 317 12.0 207 15.4
42 _ 246 0.3 350 14.7 220 -6.3 109 -6.6
43 20 292 6.2 345 14.3 227 -5.0 123 -3.6
44 20 218 -3.0 116 -13.3 246 -1.4 131 -1.8

45 20 222 -2.5 184 -5.2 224 -5.6 79 -13.4
46 18 187 -6.8 273 5.5 172 -15.4 102 -8.2
47 22 224 -2.2 320 11.1 250 -0.6 155 3.6
48 31 202 -5 205 -2.6 279 4.8 80 -13.2
49 21 266 3.0 242 1.8 303 9.4 134 -1.0
50 22 354 13.8 235 1.0 348 17.8 245 23.8
51 28 216 -3.2 206 -2.5 325 13.6 140 2.0
52 21 276 4.2 137 -10.8 286 6.2 167 6.4
53 22 278 4.4 109 -14.1 309 10.4 122 -3.8
54 23 289 5.8 210 -2.0 276 4.2 108 -6.9
55 23 205 -4.6 209 -2.2 309 10.4 109 -6.6
56 25 256 1.7 193 -4.1 339 16.2 104 -7.8
57 21 193 -6.1 205 -2.6 296 8.0 83 -12.6
58 23 253 1.4 102 -15.0 286 6.2 143 1.0
59 25 229 -1.6 187 -4.8 358 19.8 134 -1.0
60 18 188 -6.7 148 -9.4 251 -0.4 96 -9.6
61 25 296 6.6 285 7.0 298 8.4 114 -5.6
62 26 375 16.4 212 -1.8 312 11.0 227 19.8
63 20 251 1.1 88 -16.6 244 -1.8 145 1.4
64 21 238 -0.5 150 -9.2 282 5.4 103 -8.0
65 23 233 -1.1 294 8.0 152 -19.2 119 -4.4
66 18 244 0.2 147 -9.6 284 5.8 145 1.4
67 22 240 -0.3 271 5.3 306 10.0 128 -2.4
68 22 226 -2.0 196 -3.7 308 10.3 161 5.0
69 24 228 -1.8 187 -4.8 320 12.6 93 -10.2

70 22 256 1.7 131 -11.5 271 3.4 143 1.0
71 21 280 4.7 212 -1.8 297 8.2 119 -4.4
72 20 232 -1.2 131 -11.5 233 -3.8 110 -6.4
73 19 233 -1.1 143 -10.0 292 7.2 152 3.0
74 21 304 7.6 311 10.0 259 1.0 161 5.0
75 19 302 7.4 278 6.1 213 -7.6 137 -0.4
76 21 273 5.5 208 -2.3 326 13.7 99 -9.0
77 19 293 6.3 205 -2.6 258 0.8 145 1.4
78 23 274 4.0 152 -9.0 348 17.8 107 -7.2
79 22 280 4.7 257 3.6 273 3.7 128 -2.4
80 18 254 1.5 110 -14.0 207 -8.8 105 -7.6
81 19 249 0.8 264 4.4 219 -6.4 114 -5.6
82 21 237 -0.6 208 -2.3 263 1.8 129 -2.2
83 18 231 -1.4 92 -16.2 286 6.2 156 3.8
84 20 189 -6.6 209 -2.2 231 -4.2 93 -10.2
85 23 184 -7.2 191 -4.3 224 -5.6 137 -0.4
86 24 182 -7.4 316 10.6 208 -8.6 79 -13.4
87 25 178 -7.9 216 -1.3 265 2.2 53 -19.2
88 34 178 -7.9 184 -5.2 277 4.4 142 0.8
89 21 177 -8.0 196 -3.7 308 10.3 133 -1.2
90 23 175 -8.3 116 -13.3 218 -6.6 94 -10.0
91 19 170 -8.9 152 -9.0 178 -14.2 98 -9.2
92 19 167 -9.3 164 -7.6 234 -3.6 110 -6.4
93 19 162 -9.9 236 1.1 210 -8.2 90 -11.0
94 23 155 -10.8 143 -10.0 252 -0.2 123 -3.6

95 24 150 -11.4 238 1.3 246 -1.4 115 -5.4
96 20 151 -11.3 227 0.0 206 -9.0 66 -16.4
97 21 143 -12.2 103 -14.8 269 3.0 94 -10.0
98 22 140 -12.6 160 -8.0 250 -0.6 78 -13.6
99 21 132 -13.6 133 -11.2 301 9.0 104 -7.8
100 19 149 -11.5 194 -4.0 257 0.6 87 -11.6
101 34 139 -12.8 139 -10.5 240 -2.6 121 -4.0
102 21 133 -13.5 72 -18.6 179 -14 78 -13.6
103 21 314 8.9 180 -5.6 259 1.0 153 3.2
104 19 315 9.0 247 2.4 256 0.4 94 -10.0
105 19 315 9.0 279 6.2 268 2.8 110 -6.4
106 20 323 10.0 239 1.4 294 7.6 130 -2.0
107 18 329 10.7 180 -5.6 222 -6.0 165 5.9
108 20 339 12.0 254 3.2 225 -5.4 189 11.3
109 20 341 12.2 355 15.3 164 -16.8 130 -2.0
110 19 366 15.3 311 10.0 232 -4.0 214 16.9
111 22 370 15.8 293 7.9 269 3.0 204 14.6
112 23 380 17.0 270 5.2 216 -7.0 146 1.6
113 25 155 -10.8 280 6.4 243 -2.0 85 -12.0
114 21 121 -15.0 99 -15.3 267 2.6 122 -3.8
115 23 148 -11.6 97 -15.6 243 -2.0 118 -4.6
116 24 109 -16.4 271 5.3 303 9.4 86 -11.8
117 22 396 19 376 17.8 244 -1.8 218 17.8
118 19 401 19.6 246 2.3 343 17 205 14.8
119 30 131 -13.7 94 -15.9 240 -2.6 90 -11

120 19 320 9.6 194 -4 232 -4 162 5.2
121 19 323 10 236 1.1 240 -2.6 175 8.2
122 21 342 12.4 278 6.1 229 -4.6 149 2.3
123 18 340 12.1 206 -2.5 312 11 201 14
124 18 136 -13.1 154 -8.8 197 -10.6 63 -17
125 21 154 -10.9 149 -9.3 265 2.2 113 -5.8
126 20 146 -11.9 89 -16.5 282 5.4 103 -8
127 20 258 2 309 9.8 250 -0.6 170 7
128 24 194 -6 149 -9.3 276 4.2 142 0.8
129 21 225 -2.1 212 -1.8 299 8.6 188 11
130 19 166 -9.4 290 7.6 301 9 118 -4.6
131 20 215 -3.4 196 -3.7 273 3.7 134 -1
132 25 249 0.8 166 -7.3 229 -4.6 101 -8.4
133 19 209 -4.1 222 -0.6 316 11.8 131 -1.8
134 19 177 -8 86 -16.9 258 0.8 100 -8.7
135 21 223 -2.4 178 -5.9 295 7.8 100 -8.7
136 19 238 -0.7 162 -7.8 239 -2.8 130 -2
137 23 188 -6.7 158 -8.3 182 -13.4 133 -1.2
138 18 279 4.6 138 -10.6 287 6.4 161 5
139 21 178 -7.9 173 -6.5 229 -4.6 147 1.8
140 21 286 5.4 139 -10.5 193 -11.4 163 5.4
141 25 189 -6.6 101 -15.1 202 -9.9 78 -13.6
142 21 190 -6.4 176 -6.1 243 -2 115 -5.4
143 18 299 7.0 336 13 152 -19.2 163 5.4
144 19 267 3.1 108 -14.2 244 -1.8 132 -1.5

145 18 166 -9.4 111 -13.9 223 -5.8 120 -4.2
146 22 298 6.9 213 -1.7 289 6.8 196 12.8
147 18 276 4.2 158 -8.3 311 10.8 138 -0.2
148 20 172 -8.7 176 -6.1 214 -7.4 110 -6.4
149 19 357 14.2 372 17.4 261 1.4 160 4.8
150 21 345 12.7 237 1.2 302 9.2 227 19.8
151 21 142 -12.4 162 -7.8 190 -12 81 -13
152 22 128 -14.1 278 6.1 266 2.4 67 -16.1
153 18 335 11.5 326 11.8 264 2.0 151 2.8
154 30 184 -7.2 274 5.6 289 6.8 151 2.8
155 22 200 -5.2 223 -0.5 231 -4.2 130 -2
156 24 253 1.4 256 3.5 253 0.0 102 -8.2
157 _ 283 5.0 271 5.3 250 -0.6 115 -5.4
158 22 229 -1.6 196 -3.7 185 -12.9 157 4.1
159 29 271 3.6 335 12.9 264 2 98 -9.2
160 23 164 -9.6 232 0.6 225 -5.4 133 -1.2
161 22 280 4.7 258 3.7 318 12.2 148 2.0
162 21 270 3.4 166 -7.3 290 7.0 129 -2.2
163 21 266 3.0 94 -15.9 208 -8.6 142 0.8
164 26 216 -3.2 142 -10.2 331 14.6 176 8.4
165 21 320 9.6 202 -3 278 4.6 159 4.6
166 20 257 1.8 283 6.7 214 -7.4 161 5.0
167 20 248 0.7 203 -2.9 292 7.2 206 15.1
168 23 274 4.0 111 -13.9 325 13.6 167 6.4
169 20 151 -11.3 140 -10.4 297 8.2 108 -6.9

170 21 137 -13 194 -4 250 -0.6 87 -11.6
171 21 265 2.8 168 -7.1 299 8.6 112 -6
172 21 197 -5.6 158 -8.3 272 3.6 147 1.8
173 22 251 1.1 126 -12.1 231 -4.2 105 -7.6
174 25 159 -10.3 124 -12.3 267 2.6 118 -4.6
175 21 295 6.5 160 -8 205 -9.2 139 0.0
176 22 333 11.2 230 0.4 221 -6.2 142 0.8
177 20 82 -19.8 117 -13.2 223 -5.8 54 -19.0
178 20 132 -13.6 105 -14.6 207 -8.8 148 2.0
179 19 143 -12.2 176 -6.1 264 2.0 116 -5.1
180 19 334 11.4 238 1.3 271 3.4 179 9.0
181 24 95 -18.2 221 -0.7 197 -10.6 100 -8.7
182 24 307 8.0 340 13.5 235 -3.4 136 -0.6
183 21 349 13.2 283 6.7 338 16 165 5.9
184 19 336 11.6 228 0.1 306 10 165 5.9
185 19 344 12.6 268 4.9 260 1.2 222 18.7
186 22 123 -14.7 167 -7.2 152 -19.2 84 -12.3
187 20 142 -12.4 185 -5.0 223 -5.8 75 -14.3
188 18 157 -10.5 268 4.9 223 -5.8 117 -4.8
189 20 336 11.6 300 8.8 255 0.3 151 2.8
190 20 334 11.4 208 -2.3 201 -9.8 153 3.2
191 22 345 12.7 261 4.1 259 1.0 198 13.3
192 22 171 -8.8 211 -1.9 217 -6.8 155 3.6
193 22 120 -15.1 97 -15.6 254 0.2 96 -9.6

PSYCHOPHYSICAL LIFTING DATA

INPUT	ID	DAY	F	SHR	EHR	SW	EW	ADJ	TD
-------	----	-----	---	-----	-----	----	----	-----	----

01	01	4	64	142	30	60	24	25	21	3	1	20	1	-	-
01	02	7	67	138	25	50	09	2	9	0	0	4	1	-	-
01	03	1	80	111	60	78	06	6	0	0	0	20	1	-	-
01	04	5	67	111	30	62	06	1	6	0	0	4	1	-	-
01	05													31.99	-
01	06	6	73	130	20	66	09	2	9	0	0	5	1	31.99	45
01	07	2	68	100	25	67	05	0	0	0	0	8	1	31.99	24
01	08	6	72	124	20	58	08	2	8	0	0	4	1	31.99	43
01	09	8	65	137	20	59	09	1	9	0	0	4	1	31.99	40
01	10	6	65	125	20	59	06	1	6	0	0	3	1	31.99	36
02	01	3	105	135	30	42	04	3	3	1	0	4	1	-	-
02	02	5	86	142	20	42	07	4	5	2	0	5	1	-	-
02	03	2	74	119	20	34	11	9	9	2	1	8	1	-	-
02	04	9	108	147	17	15	12	13	5	7	5	5	1	-	-
02	05													34.26	-
02	06	6	82	126	20	30	6	6	6	0	0	3	1	34.26	30
02	07	8	90	140	15	18	4	5	4	1	0	2	1	34.26	41
02	08	6	77	129	20	25	8	5	4	4	0	4	1	34.26	40
02	09	1	98	121	25	60	7	9	7	0	0	23	1	34.26	23

02	10	6	106	142	20	25	4	5	4	0	0	2	1	34.26	29
04	01	4	84	120	25	36	11	15	8	3	0	9	1	-	-
04	02	7	96	139	20	22	15	16	7	8	1	6	1	-	-
04	03	1	69	107	25	40	18	16	13	5	0	20	1	-	-
04	04	2	98	125	30	37	6	14	5	1	0	10	1	-	-
04	05													26.04	-
04	06	6	92	141	20	30	8	6	7	1	0	4	1	26.04	48
04	09	9	71	139	20	24	7	8	6	1	0	3	1	26.04	50
04	08	6	85	127	20	27	5	8	4	1	0	2	1	26.04	48
04	07	3	74	116	20	30	6	6	6	0	0	4	1	26.04	44
04	10	6	82	129	20	32	8	6	7	1	0	4	1	26.04	46
05	01	5	85	131	25	36	7	2	7	0	0	7	2	-	-
05	02	8	106	139	20	28	10	5	6	4	4	4	2	-	-
05	03	9	83	130	17	12	8	3	5	3	3	3	2	-	-
05	04	2	82	98	30	32	3	4	3	0	0	5	2	-	-
05	05													34.80	-
05	06	6	71	124	20	29	3	4	2	1	0	2	2	34.80	29
05	07	3	74	105	20	34	5	5	5	0	0	6	2	34.80	23
05	08	6	78	116	20	31	5	5	5	0	0	3	2	34.80	32
05	09	4	73	103	20	34	4	7	3	1	0	3	2	34.80	24
05	10	6	76	111	20	27	5	3	4	1	0	3	2	34.80	24
06	01	4	67	122	25	76	11	3	11	0	0	9	2	-	-
06	02	7	74	120	25	52	6	1	6	0	0	3	2	-	-
06	03	1	-	107	30	49	1	2	1	0	0	2	2	-	-
06	04	9	68	124	20	49	9	2	7	2	0	2	2	-	-

08	10	6	94	138	20	22	1	9	1	0	0	1	2	35.14	36
09	01	7	75	130	20	34	5	12	3	2	0	3	1	-	-
09	02	2	63	99	25	42	6	9	6	0	0	10	1	-	-
09	03	5	66	105	20	32	4	3	3	1	0	3	1	-	-
09	04	1	72	98	25	44	2	6	2	0	0	7	1	-	-
09	05													39.99	-
09	06	6	58	126	20	49	5	3	5	0	0	3	1	39.99	38
09	07	3	63	114	20	48	5	7	5	0	0	6	1	39.99	28
09	08	6	68	147	20	46	5	2	5	0	0	3	1	39.99	42
09	09	9	51	139	20	42	4	4	4	0	0	2	1	39.99	51
09	10	6	65	129	20	43	6	3	6	0	0	3	1	39.99	39
10	01	4	69	103	25	34	4	1	3	4	0	3	2	-	-
10	02	7	98	142	20	34	4	17	4	0	0	2	2	-	-
10	03	1	86	112	25	44	7	14	6	1	0	23	2	-	-
10	04	5	92	127	20	37	6	8	5	1	0	4	2	-	-
10	05													30.94	-
10	06	6	69	132	20	40	7	3	7	0	0	4	2	30.94	37
10	07	2	73	118	20	62	8	12	7	1	0	20	2	30.94	25
10	08	6	82	130	20	50	7	11	7	0	0	12	2	30.94	44
10	09	8	86	132	20	34	11	8	7	4	4	5	2	30.94	42
10	10	6	78	120	20	42	5	4	5	0	0	3	2	30.94	39
11	01	9	64	125	20	16	6	4	3	3	0	2	2	-	-
11	02	8	83	127	20	16	6	4	0	6	0	3	2	-	-
11	03	3	80	116	20	19	2	3	1	1	0	2	2	-	-
11	04	5	70	115	20	19	1	2	0	1	0	1	2	-	-

11 05												29.93 -
11 06 6	76	112	20	24	1	1	1	0	0	1	2	29.93 34
11 07 7	77	119	20	22	4	1	3	1	0	2	2	29.93 38
11 08 6	81	114	20	20	0	2	0	0	0	0	2	29.93 35
11 09 1	88	108	20	29	4	4	4	0	0	13	2	29.93 18
11 10 6	84	124	20	23	2	1	2	0	0	1	2	29.93 36
12 01 8	74	147	20	16	12	11	3	9	9	20	1	- -
12 02 4	98	127	20	26	9	-	7	2	1	8	1	- -
12 03 3	65	122	20	36	6	13	6	0	0	7	1	- -
12 04 2	81	111	20	34	4	9	4	0	0	7	1	- -
12 05												30.61 -
12 06 6	93	134	20	30	4	3	4	0	0	2	1	30.61 43
12 07 7	74	134	20	30	5	5	4	1	6	2	1	30.61 48
12 08 6	73	120	20	26	4	5	4	0	0	2	1	30.61 36
12 09 5	76	138	20	28	2	3	2	0	0	1	1	30.61 41
12 10 6	72	135	20	34	3	2	3	0	0	2	1	30.61 44
13 01 3	71	115	20	57	9	22	9	0	0	10	2	- -
13 02 8	69	147	20	46	15	14	8	7	3	6	2	- -
13 03 9	72	130	20	31	5	12	4	1	0	2	2	- -
13 04 4	69	117	20	46	8	15	8	0	0	7	2	- -
13 05												32.25 -
13 06 6	69	119	20	37	8	10	7	1	0	4	2	32.25 39
13 07 7	71	118	20	33	6	9	4	2	0	3	2	32.35 39
13 08 6	68	112	20	36	5	7	5	0	0	3	2	32.35 37
13 09 1	63	95	20	60	6	14	5	1	0	20	2	32.35 21

13	10	6	90	114	20	35	3	10	3	0	0	2	2	32.35	34
14	01	5	84	144	20	58	3	2	3	0	0	2	1	-	-
14	02	8	88	148	20	46	4	1	4	0	0	2	1	-	-
14	03	9	68	139	20	36	13	12	5	8	8	5	1	-	-
14	04	2	88	126	20	50	3	3	3	0	0	5	1	-	-
14	05													30.42	-
14	06	6	74	132	20	56	2	1	2	0	0	1	1	30.42	43
14	07	3	73	120	20	50	3	2	3	0	0	3	1	30.42	31
14	08	6	60	128	20	48	6	1	6	0	0	3	1	30.42	39
14	09	4	83	125	20	51	3	2	3	0	0	3	1	30.42	38
14	10	6	83	132	20	51	4	1	3	1	0	2	1	30.42	42
15	01	4	95	144	20	45	9	3	7	2	2	8	1	-	-
15	02	7	85	143	20	25	6	4	5	1	0	3	1	-	-
15	03	1	87	107	20	71	10	9	10	0	0	33	1	-	-
15	04	9	81	147	20	26	6	2	6	0	0	2	1	-	-
15	05													36.96	-
15	06	6	93	133	20	26	4	2	4	0	0	2	1	36.96	41
15	07	8	87	137	20	26	5	2	5	0	0	2	1	36.96	43
15	08	6	83	136	20	28	6	2	6	0	0	3	1	36.96	43
15	09	2	94	126	20	46	5	4	5	0	0	8	1	36.96	25
15	10	6	95	128	20	26	9	3	8	1	0	5	1	36.96	41
16	01	7	93	143	20	40	13	11	9	4	0	6	2	-	-
16	02	1	77	99	20	63	13	17	13	0	0	43	2	-	-
16	03	4	96	133	20	58	23	19	20	3	0	19	2	-	-
16	04	8	79	126	20	44	12	22	11	1	0	5	2	-	-

16	05												34.05	-
16	06	6	80	124	20	51	11	25	11	0	0	6	2	34.05 40
16	07	3	83	111	20	63	17	21	17	0	0	19	2	34.05 27
16	08	6	80	119	20	47	13	18	11	2	0	7	2	34.05 36
16	09	5	83	117	20	50	13	24	13	0	0	9	2	34.05 31
16	10	6	84	124	20	47	12	26	12	0	0	7	2	34.05 37
17	01	3	95	126	20	45	9	11	9	0	0	10	2	- -
17	02	5	83	148	20	34	11	10	8	3	1	7	2	- -
17	03	2	110	116	20	39	9	16	8	1	0	15	2	- -
17	04	9	87	140	20	23	15	19	7	8	3	6	2	- -
17	05													41.84 -
17	06	6	80	142	20	24	9	7	5	4	0	5	2	41.84 44
17	07	8	71	135	20	23	10	12	5	5	0	4	2	41.84 41
17	08	6	81	130	20	22	10	9	5	5	0	6	2	41.84 34
17	09	1	97	118	20	38	6	13	5	1	0	20	2	41.84 18
17	10	6	71	144	20	29	8	7	6	2	0	4	2	41.84 47
18	01	3	102	138	20	63	6	3	5	1	0	7	2	- -
18	02	7	83	146	20	53	9	3	7	2	0	4	2	- -
18	03	4	89	121	20	40	4	3	4	0	0	3	2	- -
18	04	8	110	136	20	36	3	2	3	0	0	1	2	- -
18	05													33.97 -
18	06	6	88	133	20	27	6	5	2	4	0	3	2	33.97 39
18	07	5	73	114	20	37	6	5	4	2	0	4	2	33.97 37
18	08	6	82	122	20	31	4	5	3	1	0	2	2	33.97 34
18	09	2	99	122	20	35	4	4	4	0	0	7	2	33.97 22

18	10	6	94	139	20	44	3	2	3	0	0	2	2	33.97	46
19	01	5	76	143	20	58	7	9	7	0	0	5	1	-	-
19	02	4	88	124	20	49	5	3	5	0	0	4	1	-	-
19	03	8	81	138	20	52	2	3	2	0	0	1	1	-	-
19	04	3	81	100	20	47	4	4	4	0	0	3	1	-	-
19	05													42.84	-
19	06	6	84	120	20	51	4	2	4	0	0	2	1	42.84	33
19	07	2	79	107	20	49	4	5	3	1	0	7	1	42.84	17
19	08	6	84	121	20	44	5	2	4	1	0	3	1	42.84	28
19	09	9	86	134	20	42	6	3	6	0	0	2	1	42.84	37
19	10	6	84	117	20	45	3	1	3	0	0	2	1	42.84	29
20	01	4	84	106	20	17	2	12	0	2	0	2	2	-	-
20	02	7	91	136	20	16	-	14	-	-	-	-	2	-	-
20	03	1	83	85	20	36	3	7	3	0	0	10	2	-	-
20	04	2	79	89	20	34	4	7	3	1	0	7	2	-	-
20	05													43.29	-
20	06	6	73	107	20	34	4	1	4	0	0	2	2	43.29	25
20	07	3	69	99	20	36	4	3	4	0	0	4	2	43.29	18
20	08	6	80	106	20	23	4	6	2	2	0	2	2	43.29	24
20	09	9	65	113	20	16	6	3	0	6	0	2	2	43.29	26
20	10	6	86	114	20	21	1	2	1	0	0	1	2	43.29	25
23	01	5	74	146	20	86	5	11	5	0	0	3	1	-	-
23	02	8	52	144	20	72	18	8	15	3	0	8	1	-	-
23	03	3	68	124	20	98	13	6	13	0	0	14	1	-	-
23	04	9	67	146	20	73	14	5	14	0	0	5	1	-	-

23	05												37.45	-
23	06	6	61	135	30	97	12	6	12	0	0	7	1	37.45 47
23	07	7	70	145	30	85	10	3	10	0	0	5	1	37.45 43
23	08	6	63	140	25	89	12	5	12	0	0	7	1	37.45 40
23	09	1	59	93	40	109	5	6	5	0	0	17	1	37.45 17
23	10	6	50	145	25	95	17	5	17	0	0	9	1	37.45 47
24	01	9	79	147	20	43	5	2	4	1	0	2	2	- -
24	02	5	83	137	20	46	4	5	4	0	0	3	2	- -
24	03	7	68	125	20	42	5	2	5	0	0	2	2	- -
24	04	4	75	120	20	46	3	2	3	0	0	3	2	- -
24	05													31.58 -
24	06	6	74	140	20	45	2	1	2	0	0	1	2	31.58 41
24	07	1	77	109	20	61	3	4	3	0	0	10	2	31.58 19
24	08	6	92	142	20	42	2	1	2	0	0	1	2	31.58 36
24	09	8	88	132	20	35	5	2	3	2	0	2	2	31.58 38
24	10	6	72	118	20	37	3	1	3	0	0	2	2	31.58 34
25	01	9	87	148	20	50	6	1	4	2	2	2	1	- -
25	02	5	79	144	20	69	4	1	4	0	0	3	1	- -
25	03	7	83	146	20	45	9	3	7	2	2	4	1	- -
25	04	4	93	141	20	57	3	1	3	0	0	3	1	- -
25	05													47.98 -
25	06	6	81	148	20	50	2	1	2	0	0	1	1	47.98 41
25	07	1	79	121	20	59	2	3	2	0	0	7	1	47.98 16
25	08	6	86	147	20	48	3	1	3	0	0	2	1	47.98 36
25	09	8	97	146	20	46	7	3	6	1	0	3	1	47.98 48

25	10	6	78	137	20	59	3	1	3	0	0	2	1	47.98	42
26	01	3	77	115	20	65	11	7	11	0	0	2	1	-	-
26	02	7	72	134	20	47	-	9	-	-	-	-	1	-	-
26	03	4	60	123	20	58	11	4	11	0	0	9	1	-	-
26	04	8	84	133	20	49	7	2	7	0	0	3	1	-	-
26	05													40.67	-
26	06	6	62	142	20	69	6	7	6	0	0	3	1	40.67	47
26	07	5	80	125	20	49	5	6	5	0	0	3	1	40.67	34
26	08	6	67	129	20	51	10	3	10	0	0	6	1	40.67	38
26	09	2	78	109	20	65	4	2	4	0	0	7	1	40.67	21
26	10	6	73	130	20	56	6	1	6	0	0	3	1	40.67	41
22	01	5	91	143	20	30	26	16	17	9	2	7	2	-	-
22	02	1	80	108	20	33	9	20	9	0	0	30	2	-	-
22	03	2	82	127	20	28	2	9	2	0	0	3	2	-	-
22	04	7	72	144	20	27	25	12	16	9	0	11	2	-	-
22	05													31.34	-
22	06	6	81	131	20	22	4	9	3	1	0	3	2	31.34	31
22	07	4	89	128	20	21	8	10	3	5	0	7	2	31.34	30
22	08	6	82	138	20	23	11	10	8	3	0	6	2	31.34	43
22	09	9	83	141	20	18	3	9	1	2	0	1	2	31.34	36
22	10	6	75	136	20	21	11	-	9	2	0	1	2	31.34	36
21	01	5	79	110	20	27	9	22	4	5	0	6	2	-	-
21	02	4	68	102	20	33	4	7	3	1	0	3	2	-	-
21	03	8	71	125	20	26	2	5	1	1	0	1	2	-	-
21	04	3	68	98	20	29	5	5	3	2	0	6	2	-	-

21 05												32.17 -
21 06 6	89	127	20	32	4	6	4	0	0	2	2	32.17 28
21 07 2	85	113	20	29	3	5	2	1	0	5	2	32.17 17
21 08 6	83	112	20	24	4	10	3	1	0	2	2	32.17 23
21 09 9	85	124	20	24	2	2	2	0	0	1	2	32.17 29
21 10 6	68	114	20	27	4	2	4	0	0	2	2	32.17 30
32 01 8	56	133	20	39	3	7	3	0	0	1	2	- -
32 02 4	65	121	20	65	10	6	8	2	0	8	2	- -
32 03 3	56	117	20	54	6	8	6	0	0	7	2	- -
32 04 2	68	131	20	92	4	8	4	0	0	7	2	- -
32 05												41.35 -
32 06 6	52	135	20	51	4	4	4	0	0	2	2	41.35 48
32 07 7	68	120	20	38	5	4	4	1	0	2	2	41.35 39
32 08 6	60	123	20	45	5	5	5	0	0	3	2	41.35 38
32 09 5	64	113	20	42	4	5	4	0	0	3	2	41.35 31
32 10 6	59	129	20	50	4	3	4	0	0	2	2	41.35 45
28 01 7	78	144	20	41	21	6	20	2	2	10	1	- -
28 02 8	75	144	20	39	12	4	8	4	0	5	1	- -
28 03 1	68	117	25	35	5	8	5	0	0	13	1	- -
28 04 2	76	119	20	39	6	5	6	0	0	10	1	- -
28 05												36.80 -
28 06 6	87	145	20	39	3	-	3	0	0	2	1	36.80 41
28 07 5	83	142	20	42	7	3	6	1	0	5	1	36.80 38
28 08 6	68	141	20	35	12	3	10	2	0	7	1	36.80 36
28 09 4	73	124	20	32	8	4	6	2	0	7	1	36.80 32

29	06	6	57	129	20	41	2	1	2	0	0	1	2	47.29	26
29	07	5	64	113	20	42	6	2	5	1	0	4	2	47.29	24
29	08	6	59	117	20	39	4	1	3	1	0	2	2	47.29	26
29	09	4	53	110	20	42	3	1	3	0	0	3	2	47.29	20
29	10	6	59	129	20	42	3	1	3	0	0	2	2	47.29	29