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Experimental development and evaluation of a shop safety attitude scale

by

Mervin Dale Bettis

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of The Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major: Agricultural Education

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For the Graduate College

Iowa State University
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Ames, Iowa

1972

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INTRODUCTION

For centuries accidents have plagued man. Family goals and aspirations are interrupted when human resources are destroyed or disabled so as to be nonproductive. The costs of accidents are rising tremendously. According to the National Safety Council (1971) the cost of accidents in the United States during 1970 was $27,000,000,000. This included wages lost, medical fees, insurance settlements, property damaged and property lost by fire. There was a 16% increase in death rates due to accidents in agricultural industries between 1960 and 1970.

There is a great need for ways to predict accidents. Probably still the best predictor of accidents is the amount of time the individual is exposed to the hazard; however, it is detrimental to wait until accidents occur and then determine the cause.

"... we do not die, nor are we hurt, primarily because of machine fault" (Heinrich, 1959, p. 22). Research has often times placed the blame of accidents upon the individual's safety attitude. The human factor is becoming the more important contributor to accidents as machines are being built with greater safety features to reduce hazards and working conditions have improved considerably over the past 30-50 years.

In 1956, 40,000 men, women, and children were killed and 1,400,000 were injured in motor-vehicle accidents. There were 14,300 work fatalities and 28,000 deaths in homes. Neither machine nor mechanical devices can be
blamed for the great majority of these deaths (Heinrich, 1959, p. 22).

Research revealed that personal characteristics which cause accidents can be inherited while others are learned early and these characteristics do play an important part in accidents. Some characteristics are physical such as poor hearing, eyesight, and nervousness. Others may be attitudes of recklessness, stubbornness, irritation, violent temper, excitability, inattention, inconsiderativeness and other undesirable traits.

Williams (1963, p. 63) cited the following to support the claim that a considerable proportion of all accidents are due to faulty attitude.

1. In cooperation with the Cleveland Railway Company, the Metropolitan Life Insurance Company made a study of some of the human factors in accidents. They found that faulty attitude was the single largest contributor (14%) to all accidents attributed to human causes.

2. The National Safety Council recognizes in their analysis of accident causation three main divisions including: Unsafe Act, Personal Cause, and Mechanical Cause. Included in the factors comprising Personal Cause are (a) improper attitude, (b) lack of knowledge or skill, and (c) bodily (physical or mental) defects. The Council reports that for all accidents attributable to personal causes, an average of 50% was due to improper attitude of the worker.

3. Hannaford reports "studies have shown that, as the industrial safety attitude of male employees worsens, so does actual accident performance."

It would seem that it would be of help if attitudes could be tested or measured to see if they would predict whether one student may be prone to have more accidents than another student.
If it were possible for an instructor to give an available attitude test to students at the beginning of a shop class, the instructor could be alerted to possible problems for students and thus be able to take early action to prevent accidents by giving individual help and additional instruction on safety attitudes. This test, as a preventative measure, would be only a first step in the overall attempt to reduce accidents in the shop. In addition safe equipment, safe working conditions and safety educational instruction must be present or provided for total shop safety.

Nichols (1972) believed that much more research has been conducted on accident prevention in industry than in educational laboratories where students participate in new and varied activities rather than performing the same task day after day. The instructor often has new students with whom he must develop attitudes, skills and abilities so he must continue to discover and develop new methods of attacking the problem of preventing accidents. One way to attain the best safety performance, according to Nichols, was by maximizing safe student behavior. One of the factors listed was safety attitude.

Those interested with the responsibility of safety education, should assume the full responsibility of their jobs and they must dig below the surface causes of each accident . . . . Getting to the source of accidents is the best way of eradicating them (Shuman, 1938, p. 49)

The author's interest in shop safety led to research on the experimental evaluation of the effectiveness of safety units.
in teaching the safe use of power equipment (Bettis, 1971). It seemed feasible to go one step ahead of the instruction to further attempt to prevent accidents, that is to look for possible ways to measure safety attitude.

The main purpose of this study was to develop and evaluate a shop safety attitude scale to be administered at the beginning of the shop class. On this basis the instructor would be able to identify students who may be more prone to have accidents in the school shop.

The secondary purposes of the study were:

1. To determine the relationship between mechanical aptitude test score and accident experience.
2. To determine the relationship between social desirability test score and accident experience.
3. To determine the relationship between high school rank, cumulative college grade-point average and ACT score and accident experience.
4. To determine the relationship between course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and accident experience.
5. To determine the relationship between age and accident experience.
REVIEW OF LITERATURE

In reviewing literature related to this study, research was found that gave background information of attitudes and their effect upon performance and the need for more research in the area. A number of different tests were found as a means of measuring attitudes. The research of attitudes covered a broad area. Only those concerned with accidents will be cited here as a sample of continued work in the field. The author found no study which employed the Semantic Differential Scale to predict accidents in the school shop as used in this study.

Means of Measuring Attitudes

Thurstone and Chave (1929) were early researchers in the field of measurement of attitudes. They attempted to devise a method whereby the distribution of attitudes of a group on a specific issue could be represented in the form of a frequency distribution. The baseline ran from the extreme attitude in favor of through neutral and to the extreme attitude against. Judges sorted the items and put them on a continuum. They attempted to measure people's attitudes concerning selected issues such as attitudes toward the church and militarism. One hundred thirty opinions about the church were prepared to express as far as possible all graduations of attitude from one end of the scale to the other. They tried to select opinions that would appear at equal intervals along the scale between two
extremes. Special attention was given to neutral statements to keep the scale from breaking into two parts. Their experimental scale was tested for reliability by dividing it into two parts. The two sets of scores yielded a correlation of 0.848. When this correlation was interpreted by means of the Spearman-Brown formula, the estimated reliability of the whole scale was 0.92.

Edwards, in 1957, developed a Social Desirability (SD) Scale based upon 79 items in the Minnesota Multiphasic Personality Inventory. First a 150-item scale was submitted to ten judges who were asked to respond to each one in a socially desirable fashion, to give socially desirable responses. The judges found perfect agreement for 79 of the 150 items. The 79 items then became the first SD scale. After analyzing the 79-item scale, 39 items were selected which showed the greatest differentiation. This 39-item scale was used in later research. Nine items were keyed for true responses and 30 items were keyed for false responses. Edwards (1970, p. 108) made the following statement regarding his scale.

When an individual gives an SD response to an item, he is either attributing to himself a characteristic that is judged by the average person as desirable or he is denying a characteristic that is judged by the average person as undesirable. Similarly, when an individual gives an SUD response to an item, he is either denying a characteristic that the average person considers desirable or attributing to himself a characteristic that the average person considers undesirable.

Osgood et al. (1964) defines the semantic differential "as essentially a combination of controlled association and scaling
The instrument consists of carefully selected concepts or stimulus words followed by descriptive polar terms. These polar terms are usually opposing adjectives connected by a scale on which the subject is to indicate his response.

Osgood found some valuable test-retest correlation data as part of his first factor analytic study. He summarized his research as (pp. 126-127):

... 40 items sampled from the total 1000 items were repeated on a single page at the end of the form; this sample included 40 different scales (of 50 used in the experiment) and all 20 concepts, each appearing twice. None of the 100 subjects gave any indication of having noticed that certain items were repeated (presumably because they had been judging so many similar items). Test and retest were correlated across the 100 subjects and 40 items, producing an N of 4000. The resulting coefficient was .85.

In 1965 Heise formulated semantic differential profiles for 1,000 most frequently used English words. Along with the 1,000 word dictionary are factor scores on the evaluation, activity and potency dimensions.

The 1,000 word dictionary was assembled to facilitate another research study. He excluded functional words (e.g., the, and, he, is, to) from the 1,000 word dictionary since his pilot studies indicated their semantic differential profiles all tended to be neutral. Further, in some cases words have more than one meaning. Therefore the concepts (words plus their definition) were listed in the dictionary.

The dictionary contained semantic differential information such as the standardized factor scores for the evaluative,
activity and potency dimensions. It also included the stimulus words' polarization or distance from neutrality in the semantic space which was arrived at by squaring and adding the above factor scores and taking the square root of the sum.

Keise summarized the semantic differential methodology as follows: (p. 1)

1. Ratings on bipolar adjective scales - whatever the number and variety of scales used - are largely a function of a few dimensions of judgement.
2. These dimensions or factors are meaningfully related to affect.
3. A few appropriate scales can be used to obtain reliable measurements on any one dimension.
4. Measurements made on a given dimension are comparable for stimuli of greatly different character (words, colors, sounds, etc.).

A sample study using the semantic differential was done by Zax in 1964 wherein he studies three pairs of groups each consisting of "adjusted" and "maladjusted" groups. He compared them on their tendency to use the extreme, neutral and intermediate points. The first group of 30 male chronic schizophrenics who had been hospitalized an average of 10.27 years were compared with 30 male attendents from the same hospital. Subjects for the second group were 15 female undergraduates designated by the dean as being particularly maladjusted to campus life paired with 15 other female undergraduates who were regarded as particularly well adjusted. The third group consisted of 38 children hospitalized for emotional disorders compared to 42 children who had no history of treatment for emotional disturbances.
The first two groups used semantic differential ratings with 21 scales to rate 10 Rorschach inkblots as stimuli. The third group was subjected to the stimuli consisting of four characters of the Blacky test which were rated on 15 semantic differential scales.

The analysis was made by adding up the number of times each subject made an extreme rating by using one or seven on a seven-point scale between two opposing terms. His intermediate score was the number of times he used positions two, three, five or six and his neutral score was the number of times he used a rating of four.

Zax found that the maladjusted groups used the one or seven positions on the scale significantly more and used the two, three, five and six positions significantly less than did the adjusted groups.

Tittle and Hill, in 1967, compared four attitude measuring techniques. These were: (1) Thurstone's successive-interval technique, (2) a semantic differential procedure, (3) a summated-rating (Likert) technique and (4) a Guttman type scale. After the four instruments were constructed, they were incorporated into a questionnaire which was administered to 301 upper-class students who were enrolled in a course in marriage and the family.

The split-half reliability coefficients using the Spearman-Brown correction formula were as follows: the Likert scale, .95; the semantic differential measure, .87; the Guttman scale,
.80 and the Thurstone scale, .67.

Accident Prediction

Some studies have been done comparing the relationship of attitude to automobile accidents. Shaw, in 1965, reported on a study that had been done in South Africa to test and identify safe drivers for a bus line. When the projective tests, Thematic Apperception Test and Social Relations Test, were employed, the drivers hired produced a decline in number of accidents. The eight TAT cards consisted of touched up photographs presented to a subject who would in turn write a one-page story about the picture telling what has happened, what was happening and what will happen. In the SRT test the subject was given eight cartoon type pictures and asked to write a paragraph of about ten lines to tell what has happened, what was happening and what will happen. Findings from the study Shaw described provided: (p. 70)

concrete evidence that, in a practical situation, and in the hands of experienced operators, projective techniques of the TAT type have considerable merit as accident predictors

that the tests, applied diagnostically, . . . can indicate, with a high degree of accuracy, the subject who, at the time of testing should have been regarded as unsafe accident risks and about whom some sort of remedial or preventative action should have been taken.

In 1961 Schuster did an extensive study in southern California in developing attitude scales to predict problem
drivers. The 395-item instrument was administered to over 2,000 subjects from several different groups or organizations. These included the local Department of Motor Vehicles, Personal Traffic Safety classes, several insurance companies, military bases, local industries and the University of California.

The drivers were placed in two groups, better than average and problem drivers. Those drivers with an intermediate number of violations were omitted. Problem drivers were divided into three accident types and/or four violator types depending upon severity.

When using the 395-item instrument, Schuster (p. 78) stated:

... the various accident attitude scales resulted in 75 to 84 per cent correct classification of the criterion group drivers. The various violation attitude scales correspondingly gave figures from 74 to 88 per cent correct classifications.

Schuster felt that if a person was interested primarily in picking out problem drivers from the better than average group, one would want a shorter attitude scale comprised primarily of discriminating items with the irrelevant items excluded. Therefore a shorter revised scale consisting of 100 items was constructed and was found to discriminate approximately the same as the 395-item format. "The predictive efficiency was approximately 65 per cent for accidents, and approximately 70 per cent or somewhat better in the case of violations." (p. 97)

Schulz (1970) constructed an attitude scale for male
adolescents with which to determine if there was any differences between traffic offenders and nonoffenders. Statements for the attitude scale were developed from data collected from 547 male adolescents through group discussion-decision sessions. The attitude statements were developed from the discussion data and scaled by a panel of 20 judges.

He tested the reliability of the 25-item, "equal-appearing intervals", type test by administering it to 138 male adolescents. He found it had a Pearson "product moment" reliability coefficient of .81 in a 14-day "test-retest" interval.

The predictive validity of the attitude scale was tested by administering the instrument to 56 traffic offenders and 56 nonoffenders during the first year of their licensed driving. He found no significant relationship between the adolescents' attitude scale scores and records of traffic violations. The Chi Square statistic revealed no significant relationships between responses of offenders and nonoffenders to individual statements on the attitude scale.

Bracy (1971) conducted a study to compare the personality characteristics of students who had had automobile accidents with those students who had not, and to identify those items in the personality instruments that discriminated between the two groups.

The subjects involved in this study were undergraduates at the University of Southern Mississippi and William Carey College in Hattiesburg, Mississippi. The subjects were selected accord-
ing to their reported involvement in automobile accidents. The accident group consisted of forty students who indicated they had had two or more traffic accidents in which they were charged with responsibility for the accidents. The nonaccident group was forty students who indicated they had never been involved in any automobile accidents while driving.

Bracy employed the Sixteen Personality Factor Questionnaire Forms A and B and the Impulsiveness Scale of the How Well Do You Know Yourself to measure personality characteristics. The accident group scored significantly higher than the nonaccident group in the following factors: reserved vs. outgoing, sober vs. happy-go-lucky and self assured vs. apprehensive. The non-accident group scored significantly higher than the accident group on the factor of group dependency vs. self-sufficiency. A regression equation predicted approximately one-third of the variance of the accident group.

Kraus et al. (1971) compared interview data on background characteristics between an experimental group consisting of 205 drivers under the age of 21 who were recently involved in accidents to matched controls. Kraus summarized the factors which were found to be significantly more frequent in the accident group as: (p. 1196)

(a) failed one or more grades in or before grade 8, or had been in a vocational high school course; (b) became a regular cigarette smoker at or before age 16; (c) had full-time employment exclusive of school vacation time at or before age 17 and before obtaining a driving license; and (d) had been charged with a criminal offense.
Subjects who had been in a one-vehicle accident showed still higher frequencies of these factors. The frequency of probable responsibility for a first accident within six months of receiving a drivers license was strikingly higher in those with these risk factors than in other accident cases, but these two groups had similar proportions with two or more accidents.

Need for Safety Education

As early as 1932 Judy suggested the need for more safety education in the industrial arts shops in Iowa and for instruction relative to the safe use of tools. He felt that safety methods and devices employed at that time were not adequate or there would not have been such a high accident rate.

Accident rates remain high which indicate to this author further need for research for better safety education.

Hannaford (1958) investigated the relationship between safety attitude of industrial workers on the job. There were two stages in the study. One was concerned with rating scales for male workers and for male supervisors. The next stage was the determination of the significance of industrial safety attitudes of male workers and of male supervisors as these attitudes related to the actual accident experience of the workers themselves. These scales were developed according to the procedures used by L. L. Thurstone and E. J. Chave as described in "The Measurement of Attitudes", 1929.
Hannaford found a positive correlation of .32 between male employee industrial safety attitude and accident experience of employees with one or more disabling injuries during the five-year period studied. Those with two or more disabling injuries had a correlation of .43. He found, "the differences in means for the accident free male employees and those with one or more and also those with two or more disabling injuries were significant and real at the .01 and .05 levels of significance." He felt his scales would serve to indicate the need for safety education to offset potential accidents.

In 1948 Birnbach attempted to determine and compare the psycho-physical qualities of the accident-repeater and the accident-free pupil. It was anticipated that the availability of such information would be helpful in identifying the accident personality that might be present in a school child and assist in bringing about adjustments that would lead to safe behavior.

The study involved 103 pupils from Hawthorne Junior High School of Yonkers. Forty-eight were in the accident-free group and 55 were selected as accident-repeaters. They were tested for strength, physical fitness, knowledge of safety, gymnastics, and for personal adjustment in the areas of health, home, social and emotional stability. He also examined the health, medical and scholastic records. The pupils were tested in their customary classes in the school.

Safety knowledge was the most significant of the 43 variables compared with accident experience. This was shown by the
fact that 41.3 per cent of the accident-repeaters failed the knowledge of safety test whereas none of the accident-free pupils failed this test.

Birnbach (p. 45) concluded that:

(1) Children who are well adjusted emotionally and in the area of the home have fewer accidents. (2) Possessing adequate safety knowledge is an accident deterrent providing the individual does not suffer from any serious personality maladjustments or serious physical defects. (3) Intelligence as a factor is not to be regarded as an important requisite in accident prevention. (4) When thwarted, the typical defenses of the repeater is his attempt to dominate by physical means, recklessness, bravado and evasion. These are his springboards to accidents. (5) Accidents are produced usually as the result of a combination of factors rather than any one factor.

Teaching Accident Prevention

Attitudes can be formed at the time the student is learning the knowledge and skills of operating machines. Attitudes are difficult to change once they are learned. Therefore it is imperative that the safe as well as correct way to perform a task be taught the first time the student is introduced to the learning experience. Safe working conditions and safe tools plus rules and regulations must also be present.

Stone, in 1953, investigated 126 shops in Iowa during the academic year. Stone found that of 248 accidents, 51 per cent were caused by hand tools, while power tools were involved in 27.5 per cent of the accidents, handling material caused 18 per cent, and falls and other causes resulted in three and one-half
per cent of the accidents reported. The first seven power
tools in order of number of accidents were: circular saw,
metal lathe, band saw, grinder, drill press, arc welder and
jointer.

In his discussion (p. 38) Stone stated:

It would seem, from comments and letters sent in by
instructors regarding this accident-reporting pro-
gram, that many instructors are not cognizant of their
responsibility in regard to the matter of instilling
safe habits in the minds of their students. Several
instructors have listed student carelessness as the
cause of an accident and apparently did not look any
further into the matter. However, carelessness in
itself is not a cause for an accident. Rather, it is
a result, in many instances, of an instructor's
failure to properly instruct his students in safe
work-habits.

Also in the discussion he stated:

... there is an urgent need for more safety edu-
cation not only for the student, but also for the
instructor. Responsibility for providing a safe
place in which to work rests squarely upon the
instructors' shoulders, and one of his primary
obligations to society is to turn out individuals
who have an abiding faith in the value of safe work
habits which will carry over into everyday life.

As a result of his study, Stone recommended: (1) that
safety instruction should not be treated as something separate
and apart from the teaching of industrial art skills but rather
as a part of the step-by-step instruction in those skills,
(2) that the instructor must be as diligent in observing safe
practices as he expects his pupils to be, (3) that certain safe
practices which are common to most individuals and many life
situations should be incorporated in every school shop safety
instruction program, (4) that a common code of safety rules or
regulations should be developed for each type of shop for a
general understanding of the requirements by all students and
instructors, (5) that safety instruction should be active and
whenever possible should involve real problems, (6) that safety
instruction should constantly be interpreted in terms of school
and common industrial activities, (?), that supplementary
materials such as posters and pamphlets are essential to sustain
interest in the safety program but should be changed often,
and (8) that adequate and constant supervision of student safety
activities by instructors is fundamental to successful safety
instruction.

McAllister, in 1941, used a check list to study accidents
in 35 shops in Northern Illinois. Power equipment was used by
1,031 boys. Carelessness of pupils accounted for 67 out of a
possible 410 accidents. Other causes were: anger accounted
for 25 accidents, pupils clothing 23, crowded conditions 21,
improperly guarded machines 21, hasty work 20, disobedience of
rules 16 accidents, working after school hours 15, lack of
instruction 11, worry 9, improper shop arrangements 9, improper
light 6, jig and fixtures 3, slippery floors 3, falling objects
1, and one was caused by the pupil being mentally retarded.

McAllister also showed in his study the safety methods and
number of schools using each. These, ranked according to use,
were: accident posters. safety talks. safety bulletin boards.
safety rules, safety assignments and student safety council.

Bettis, in 1971, conducted a study to compare the effec-
tiveness of two methods of teaching the safe use of power woodworking tools. The results of the study were based on data collected and tested from 46 students in a course in carpentry at Iowa State University. Two laboratory sections (24 students) comprised the treatment group and the remaining two laboratory sections (22 students) were in the control group. There was only one lecture period for all the students taking the course. All the students were given a pretest and post-test during the lecture. The same 66 true-false questions were used for both the pretest and post-test. The test was designed to measure the student's knowledge of power tools as well as their safe use.

A mechanical aptitude test was administered to all students at the beginning of the experiment. A study guide for each power tool was developed by Dr. Thomas A. Hoerner and Bettis which included: (1) Nomenclature or part identification, (2) Safe operational procedures, (3) General safety practices, (4) Completion questions and (5) References. The study guides were given to the treatment group in their laboratory classes. The control group was taught in the conventional manner without the use of the study guides.

At the end of the experiment all students were given a laboratory practicum. The students were instructed to use eight different power tools to make various cuts on a board in the presence of expert judges stationed at each power tool. Each student's high school rank and cumulative college grade-point average were collected from student records in the Office
of the Registrar at Iowa State University

Results on the safety scores were in favor of the treatment group for six out of the eight power tools. A correlation of +.59 significant at the .01 level was found for the treatment group when college grade point was correlated with the total laboratory score. Bettis (p. 74) concluded, "This would tend to indicate that students with higher college grade-point averages more effectively used the prepared study guides."

Nichols, in 1972, conducted a study to analyze the relationship between unsafe student behavior in the laboratory and selected psychological factors which may cause such unsafe behavior. The participants in the research were thirty-four students enrolled in a course, Introduction to Metal Processes. Instruments were developed to measure the student's ability to perceive hazards, aspiration to behave safely, knowledge of metal working safety and achievement in metalworking. The criteria representing unsafe behavior in the laboratory were based on the number of accidents, minor injuries and unsafe acts which were accumulated on video tapes. Nichols plotted the incidents of unsafe acts on a floor plan of the shop and found most of the incidents occurred in the hot metals and machinery areas of the laboratory. He suggested (p. 84),

that as a student's knowledge of metal working increases, he is more likely to perform metalworking activities in a safe manner. . . . Students with high achievement in metalworking appear to have a greater desire to perform in a safe manner than students with low achievement.

Anderson (1967) used safety as a major emphasis when he
employed the use of caricature booklets to supplement conventional machine woodworking safety instruction. Safety booklets and testing instruments were devised for the instruction and measurement of band saw, circular saw, drill press, jointer, surfacer and woodlathe safety units.

The study was administered in two Texas cities by nine participating teachers, each teaching an experimental and a control group. Data compiled from a total of 291 students were used for statistical comparisons. The teachers presented conventional safety instruction to each group, supplemented the instruction to the experimental group with caricature safety booklets, and administered a unit safety test following each unit presentation. A pretest was administered at the beginning of the semester, and a retest was administered three weeks after the last safety unit was presented.

The findings indicated that the experimental method was significantly better for three of the safety units and that there was significant difference among teachers as measured by initial learning. Similar findings were revealed when tests of retention were used as a criterion measure. It was, therefore, concluded that while safety instruction is largely dependent upon the teacher's mode of presentation, safety booklets could result in greater initial learning and retention of safety instruction than the conventional method.

Lulow (1933, p. 4) seemed to summarize the teaching of safety when he stated that:
In the case of hazardous operations, an operation sheet serves a double purpose: it may be used to describe recommended trade practice, and at the same time, give the accepted safe methods. The responsibility for accident prevention rests squarely upon the teacher, and any device that will aid in accident prevention is deeply appreciated.
METHOD OF PROCEDURE

Statement of the Problem

The review of literature revealed that researchers have been trying for many years to develop a testing instrument that could be used to predict accident experience. Some have had limited success but findings indicate that more research in the area of accident prediction was definitely needed.

The purpose of this study was to develop and evaluate a shop safety attitude scale.

Hypotheses

The following null hypotheses were tested:

\( H_0 \) 1. Accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by a combination of two or more independent variables including a semantic differential attitude scale score, mechanical aptitude test score, social desirability test score, high school rank, cumulative college grade-point average, ACT score, course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and age.

\( H_0 \) 2. Accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by means of a written semantic
differential attitude scale.

**Ho 3.** There is no significant relationship between mechanical aptitude test score, as measured by the Bennett Mechanical Aptitude test, and accident experience, as measured by the number of accidents involved in during a three-year period.

**Ho 4.** There is no significant relationship between social desirability, as measured by Edward's Social Desirability scale, and accident experience, as measured by the number of accidents involved in during a three-year period.

**Ho 5.** There is no significant relationship between high school rank and accident experience, as measured by the number of accidents involved in during a three-year period.

**Ho 6.** There is no significant relationship between cumulative college grade-point average and accident experience, as measured by the number of accidents involved in during a three-year period.

**Ho 7.** There is no significant relationship between ACT score and accident experience, as measured by the number of accidents involved in during a three-year period.

**Ho 8.** There is no significant relationship between course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and accident experi-
Ho 9. There is no significant relationship between age and accident experience, as measured by number of accidents involved in during a three-year period.

Selection of Materials

The experiment was designed to evaluate the effectiveness of an attitude scale in predicting accidents. The population consisted of 125 students who were enrolled in Agricultural Engineering 254 and Agricultural Engineering 255 at Iowa State University of Science and Technology during the spring quarter, 1972.

The attitude scale used in this experiment (see appendix) was developed by the author employing the Semantic Differential Technique which was originated by Osgood et al. (1964). The scale consists of six stimulus words with 16 opposing adjectives divided by a nine-point scale to which the students were asked to respond. The same 16 opposing adjectives were employed following each stimulus word. The six stimulus words used were: war, iron, love, death, violence and me. Five pairs of opposing adjectives representing the evaluative factor were: good-bad, clean-dirty, kind-cruel, ugly-beautiful and fair-unfair. Four adjective pairs representing the activity factor were: active-passive, fast-slow, hot-cold and sharp-dull.
The potency factor was represented by strong-weak, heavy-light, large-small and rugged-delicate. Tame-wild, sober-drunk and sane-insane represented the stability factor. The adjective pairs were those found to have high loadings in the factorial work as described in Osgood et al. (1964) and applicable to this investigation.

Arrangement of the different sections in the semantic differential attitude test was at random with the exception of the adjective pairs. Care was taken to insure that one adjective pair did not follow another adjective pair that represented the same factor in the progression of the test. This was to prevent carry over from one adjective pair to the next within factors.

Tests

Three tests were administered to 125 students during their regular one hour class periods. An accident survey was completed by each student after completion of the tests. (See appendix) The first test administered was the attitude scale consisting of the 96 responses to six stimulus words as described in the section, Selection of Materials. The second test was Edwards' (1957) Social Desirability Scale, a 39-item true-false questionnaire. The statements on this instrument, taken from the Minnesota Multiphasic Personality Inventory, described personal feelings. The mechanical aptitude test used
was the same as the one given to incoming freshmen in the College of Engineering at Iowa State University of Science and Technology. It has been standardized with senior boys in high school and scored on a percentile basis.

The cumulative college grade-point average, high school rank and ACT test scores were obtained from student records in the Office of the Registrar at Iowa State University of Science and Technology.

Design of the Experiment

Students involved in this study were informed that they were participating in a research project and were found to be very cooperative in completing the instruments. The instruments were administered during a regular Agricultural Engineering one hour class period. Each instrument required ten to fifteen minutes for completion. The directions for the first instrument were given at the beginning and instructions for the succeeding instruments were given as the students completed the preceding one. Students were not limited in their time and were allowed to leave when they had completed all four instruments.

Information from the semantic differential type attitude scale was combined to develop 12 of the 20 independent variables. The responses for the four stimulus words (war, iron, violence and death) were added together along each of the four factors (evaluative, activity, potency and stability) to make up four
independent variables. The stimulus words, love and me were kept separate but the responses along each of the four factors were added together for each of these stimulus words to bring about eight other variables, four for love and four for me.

Eight other independent variables were: mechanical aptitude test score, social desirability response score, American college test score, high school rank, cumulative college grade-point average, year at Iowa State University, course (Agricultural Engineering 254 or Agricultural Engineering 255) and age.

Pilot Study

After reviewing the literature the author decided to try to adapt the semantic differential, developed by Osgood, to this study. The scales could be set up with five or more spaces to provide the respondent with semantic space in which to place his reaction to the concept under investigation. The Osgood technique might be summarized as a combination of controlled responses plus a scaling technique for evaluating attitudes toward specific concepts.

During the spring quarter of 1971 the author attempted to develop and test a semantic differential type attitude scale as a pilot study for this research. The test used 19 stimulus words or concepts and 9 opposing adjectives for each stimulus word. Some of the words chosen for stimulus words were those
that would ordinarily be thought of or emitted around a hazardous situation such as machinery, danger, car race, blood and revolt. The words father and laws represented authority and words representing a more inactive or reserved concept were church, security, grandmother and piano. The remaining stimulus words were arbitrarily chosen in an effort to find concepts that would correlate highly with the criterion.

The nine pair of opposing adjectives represented the evaluative, activity and potency factors. Adjectives, good-bad, clean-dirty and beautiful-ugly, were used for the evaluative factor. Active-passive, fast-slow and sharp-dull were used for the activity factor and the potency factor was represented by the adjectives rugged-delicacy, large-small and strong-weak.

An instruction sheet was attached to the front of the instrument which listed the procedure for completing the semantic differential type test. An accident survey attached to the back of the attitude scale included questions concerning accident experience during the past five years.

This first test was then administered to a small group of students to determine how they would react to this type of test and to obtain direction or indication of ways to improve the next test. The author speculated that those students with high accident experience would use extreme responses on the scale. The number of extreme responses were counted and this variable was included in the correlation matrix. There were no significant correlations found between the criterion variables
and the number of extreme responses, therefore, the extreme
response variable was not considered in subsequent tests.

After the data were tested with an intercorrelation matrix,
it was evident that the stimulus words having a controversial
or emotional connotation correlated significantly with accident
experience.

During the fall quarter of 1971 a second semantic differ­
ential type attitude scale was constructed and administered to
262 students in several agricultural engineering classes. This
test was an effort to improve upon the first test administered
the previous spring. Stimulus words that did not have a
significant correlation with criterion variables were elimi­
nated. The second scale contained mostly stimulus words that
were of a controversial or emotional nature. Five words were
the same as the first test; blood, car races, war, revolt and
teacher. Five additional words; me, fire, dope, motorcycle,
and violence, were thought by the author to perhaps have a
similar controversial or emotional nature and might correlate
similarly with accident experience and were therefore chosen
to complete the ten stimulus words. Six opposing adjectives
were used with each stimulus word. Good-bad and beautiful-ugly
were used for the evaluative factor, active-passive and fast­
slow were used for the activity factor and large-small and
strong-weak were used for the potency factor.

An instruction sheet attached to the front of the instru­
ment included an example semantic differential scale. The
instructions were read to the class at the beginning of the testing period. An accident survey attached to the instrument included questions concerning the student's accident experience during the last three years. Students were very cooperative and completed each instrument within 15 minutes time even though no time limit was set.

Results of the second test were similar to the first test. Stimulus words with a controversial or emotional connotation were significantly correlated with accident experience. The word violence, teamed with the evaluative factor, produced the highest correlation.

Two tests were developed and administered during the pilot study. The first test was given to 34 students in agricultural engineering classes during spring quarter of 1971. Experience with the first test led to the development of the second test which was administered to 262 students in agricultural engineering during fall quarter of 1971. The construction and administration of the final test was influenced by the findings and experience with the pilot study. The final test used three stimulus words: war, violence and me, from the pilot study because these words correlated significantly with accident experience. Iron, love and death were added to make up the six stimulus words for the final test. Iron, love, death and war were found in Heise's (1965, pp. 1-31) dictionary of 1,000 most frequently used English words as words which showed more polarization or distance from neutrality in the semantic space.
They were chosen by the author because they were also applicable to this study.

The final study used five pair of adjectives to represent the evaluative factor. These were: good-bad, clean-dirty, beautiful-ugly, fair-unfair, and kind-cruel. Good-bad, beautiful-ugly, and clean-dirty had been included in the first test of the pilot study. Good-bad and beautiful-ugly had also been in the second test of the pilot study.

Four pair of adjectives were employed to represent the potency factor. These were: large-small, heavy-light, strong-weak and rugged-delicate. Large-small, strong-weak and rugged-delicate had been used in the first test and large-small and strong-weak were also used in the second test of the pilot study.

Active-passive, fast-slow, sharp-dull and hot-cold were the adjectives employed to represent the activity factor. Active-passive, fast-slow and sharp-dull had been in the first test and active-passive and fast-slow were also in the second test.

Review of literature revealed that stability or lack of stability seemed to be associated with accident experience. For this reason stability factor was included in the final test. Adjectives, tame-wild, sober-drunk and sane-insane, represented the stability factor.

The final test included these four factors, evaluative, potency, activity and stability, because they had the highest loadings in studies conducted by Osgood et al. (1964) and Heise
(1965). The evaluative factor was clearly identifiable in Osgood's study, the potency and activity factors fairly well identified themselves, while the stability factor was more difficult to identify but was recognized as a fourth factor.

Definition of Terms

The following terms are defined as interpreted by the author and used in this study.

attitude - the total of a person's inclinations, feelings, prejudices, biases, preconceived notions, ideas, fears, threats and convictions about any specific topic

accident - an unplanned event in which the action or reaction of a person results in personal injury or property damaged or destroyed

safety attitude - an indication of a person's probable reaction to a dangerous situation

semantic differential - a testing instrument using stimulus words followed by scales connecting two opposing adjectives on which the subjects designate their responses

accident survey - a list of questions concerning the subject's involvement in accidents during a specific period of time

accident experience - the subject's involvement in accidents
during a specific period of time
evaluative factor - denotes the value judgement variable which was developed through addition of the response scores to adjectives; good-bad, clean-dirty, beautiful-ugly, fair-unfair and kind-cruel
potency factor - denotes the athletic type variable which was developed through addition of the response scores to adjectives; large-small, rugged-delicate, heavy-light and strong-weak
activity factor - denotes the action variable which was developed through addition of the response scores to adjectives; active-passive, fast-slow, sharp-dull and hot-cold
stability factor - denotes the anxiety variable which was developed through addition of the response scores to adjectives; sane-insane, sober-drunk and tame-wild
year at Iowa State University - the student's status is as classified in the Office of the Registrar, Iowa State University of Science and Technology
concept or stimulus word - are used synonymously in this study. They represent the word and its impression upon the student

Delimitations

The study was limited to 125 students who were enrolled in Agricultural Engineering 254 and Agricultural Engineering 255
during the spring quarter of 1972. Accident data were limited to the questions answered by the students concerning their accident experience during the three-year period before testing. Each student had an equal opportunity to respond based on his experiences and background.

During this investigation it was impossible to wait for accident experience to occur so an accident survey was employed to record the student's accident experience during the three-year period prior to the time the tests were administered. It was assumed that the accident experience of the subjects did not affect their scores on the various instruments. It was also assumed that the students correctly answered the accident survey.

Statistical Treatment of the Data

Data obtained in this study consisted of the semantic differential attitude scale score, mechanical aptitude test score, social desirability test score, American College Test score, high school rank, cumulative college grade-point average, year at Iowa State University, course (Agricultural Engineering 254 or Agricultural Engineering 255), age and accident experience. These data were recorded on International Business Machine (IBM) cards.

Data from the semantic differential attitude scale were
combined into four factor areas; evaluative, activity, potency and stability. These made up twelve of the twenty independent variables as shown in Table 1. Information concerning accident experience was combined into 24 dependent variables. The data were then processed through the electronic computer to obtain intercorrelations among all 44 variables.

The Mouflon step-wise regression technique, quoted from the Mouflon Reference Manual (Hanson, 1969, pp. 9-11), was used in selecting the best predictors of the dependent variables. In this procedure the computer first selected the best independent variable which was also significantly correlated with the dependent variable to predict the dependent variable. After one variable had been removed the partial correlations of the remaining variables were scanned by the computer for the next best X variable, which also had the highest F level, to predict the Y variable. The third best X variable was selected in the same manner and the process continued until no further F values of the partial correlations of the remaining variables reached the preset F level to enter the regression equation. If at any time during the procedure any previously selected X variable could have been eliminated without losing a significant amount of predictability then that variable was eliminated from the equation.

The Mouflon step-wise regression procedure was used with each of the 24 Y variables. For each Y variable an equation was originated giving coefficients to be multiplied by selected
X variables and added to a constant thus producing a predicted number of accident experiences for an individual subject during a three-year period of time.

The basic regression model is:

\[ \hat{y}_{ij} = b_0 + b_1 x_{1j} + b_2 x_{2j} + \cdots + b_n x_{nj} + \epsilon_{ij} \]

\( \hat{y}_{ij} \) = ith dependent variable to be predicted for the jth person
\( b_0, b_1, b_2 \ldots b_n \) = constants derived from least squares application
\( x_{ij} \ldots x_{nj} \) = nth predictor variable for the jth person
\( \epsilon_{ij} \) = error associated with the prediction of ith dependent variable of jth person

i = 1 \ldots 24
n = 1 \ldots 20
j = 1 \ldots 125

The following information explains the Mouflon step-wise regression technique and is taken from the Mouflon Reference Manual.

E. Stepwise Regression

Before we look at the stepwise procedure (see reference 2) let us consider a general case. First, let \( X_1 \) denote the set of variates \( x_1, \ldots, x_p \) which are currently in the model and let \( X_2 \) denote the set of variates \( x_{p+1}, \ldots, x_k \).

Next, define the sample partial correlation coefficient of the dependent variable \( y \) and one of the independent variates from the set \( X_2 \), (say \( x_{p+i} \)), to be the simple correlation coefficient of \( y^* \) and \( x_{p+i}^* \). \( y^* \) is the set of residuals resulting from the regression of \( y \) on \( x_1, x_2, \ldots, x_p \) and \( x_{p+i}^* \) is the
set of residuals resulting from the regression of \( x_{p+1} \) on \( x_1, x_2, \ldots, x_p \). Let the sample partial correlation coefficient of \( y \) and \( x_{p+1} \) be denoted by \( r_{p+j} \).

Now consider the case of transferring one of the variates, \( x_{p+j} \), from set \( X_2 \) to set \( X_1 \), (i.e. including \( x_{p+j} \) in the regression equation). Let \( \text{RSS}_{p+j} \) denote the residual sum of squares for the regression of \( y \) on \( x_1, x_2, \ldots, x_p, x_{p+j} \). Note that the value of \( j \) can be \( 1, 2, \ldots, k-p \).

Let \( x_{p+i} \) be 'the' variable transferred to the set \( X_1 \) where \( i \) satisfies

\[
\text{RSS}_{p+i} \leq \text{RSS}_{p+j} \quad j = 1, 2, \ldots, k-p.
\]

This is equivalent to

\[
r^2_{p+i} \geq r^2_{p+j} \quad j = 1, 2, \ldots, k-p
\]

since it can be shown that

\[
\text{RSS}_{p+j} = \text{RSS}_p (1 - r^2_{p+j}).
\]

Thus, the selection of the largest \( r^2_{p+j} \) for \( j = 1, 2, \ldots, k-p \), minimizes \( \text{RSS}_{p+j} \).

Now consider the case of transferring one of the independent variables \( x_j \) from the set \( X_1 \) to the set \( X_2 \) (i.e. removing it from the regression). Let \( \text{RSS}_j \) denote the residual sum of squares for the regression of \( y \) on \( x_1, x_2, \ldots, x_{j-1}, x_{j+1} \ldots x_p \).

It can be shown that

\[
\text{RSS}_j = \text{RSS}_p + \frac{\hat{\beta}_j^2}{c_{jj}}.
\]

Let \( x_i \) be 'the' variable transferred to the set \( X_2 \) where \( i \) satisfies

\[
\frac{\hat{\beta}_i^2}{c_{ii}} \leq \frac{\hat{\beta}_j^2}{c_{jj}} \quad j = 1, 2, \ldots, p
\]

or

\[
(t^2_c)_i \leq (t^2_c)_j \quad j = 1, 2, \ldots, p.
\]

where \( (t^2_c)_i = \frac{\hat{\beta}_i^2/c_{ii}}{\text{RMS}} \). Thus, the selection of the smallest \( (t^2_c)_j \) for \( j = 1, 2, \ldots, p \) minimizes \( \text{RSS}_j \).
The above considerations give way to the step-wise regression procedure, which consists of two alternating steps and examination of termination criteria after each step. The procedure terminates when any one of the following criteria is encountered.

1) There is no variable to enter and no variable to remove.
2) The procedure dictates that the same variable be entered and removed successively. This can be corrected by changing the F levels if the user so wishes.
3) The total number of steps executed reaches the maximum number of steps specified by the user.

The procedure begins with Step 1 and no variables entered in the model.

**Step 1** Enter variable i into the regression if i satisfies
\[ r_{p+1}^2 \geq r_p^2 + j \quad j = 1, 2, \ldots, k-p \text{ and } \frac{(t_c^2)_{p+1}}{(n-p-2)r_{p+1}^2} \geq F_{\text{in}}. \]

Here, F_{\text{in}} is the F level to enter a variable and is specified by the user.

The termination criteria are now checked. If any one of the three criteria are satisfied, STOP. If none of the criteria are satisfied, GO TO STEP 2.

**Step 2** Remove variable i from the regression if i satisfies \((t_c^2)_i \leq (t_c^2)_j \quad j = 1, 2, \ldots, p \text{ and } (t_c^2)_i \leq F_{\text{out}}.\)

Here, F_{\text{out}} is the F level to remove a variable and is specified by the user.

The termination criteria are now checked. If any one of the three criteria are satisfied, STOP. If none of the criteria are satisfied, GO TO STEP 1.
FINDINGS

Introduction

The findings of this investigation are based upon results of data collected from 125 students in Agricultural Engineering 254 and Agricultural Engineering 255, courses in metal-working and carpentry at Iowa State University of Science and Technology during spring quarter 1972. Sixty-three students were in Agricultural Engineering 254 and 62 students were in Agricultural Engineering 255.

Summary of Population

The background of the 125 students enrolled in Agricultural Engineering 254 and Agricultural Engineering 255 was almost entirely rural. Most of the students were enrolled in the College of Agriculture with the majority majoring in Farm Operation. Others from the College of Agriculture were enrolled in Agricultural Education, Animal Science, Agronomy, Agricultural Business, Dairy Science, Agriculture, Pre-Veterinary Medicine, Fisheries and Wildlife Biology and Horticulture. Very few students were enrolled from other colleges. Of those who were from other colleges, their majors were: Physics, Engineering Operations, Aerospace Engineering, Computer Science, Industrial Administration, Mechanical Technology and Mechanical Engineering.
Forty-eight freshmen, thirty-seven sophomores, eighteen juniors and twenty-two seniors participated in this research. Information in Table 1 shows that the mean year of enrollment at Iowa State University for the sample was 2.11. This indicates that a majority (or 68 per cent) of the students were in their first two years of college. The standard deviation for the year at Iowa State University was 1.10.

Data in Table 1 reveal that the average age of the students was 20.03 years with a standard deviation of 1.89. Twenty-seven were eighteen years old, thirty-four were nineteen, twenty-two were twenty, twenty-two were twenty-one, six were twenty-two, six were twenty-three, three were twenty-four, two were twenty-five and three were twenty-six. This reveals that 80.4 per cent of the students were 18 through 21 years of age.

High school rank was computed on the basis of the higher the rank the lower the percentile score which means that if a student was at the top of his high school class he would have a percentile score of one. Further information in Table 1 reveals that the mean of the percentile scores for high school rank was 32.15 for those in this study with a standard deviation of 19.25. This indicates that most of the students were in the upper half of their high school classes although the range was from the 1st to the 82nd percentile.

Data in Table 1 reveal that the mean ACT score was 24.06 with a standard deviation of 3.24. The range was from 15 to 32 points.
The lowest cumulative college grade-point average was 1.21 and the highest average was 3.82 with the mean being 2.39 and a standard deviation of 0.59 as shown in Table 1. The grade-point average for the freshmen was based on only one or two quarters of work at Iowa State University of Science and Technology.

Data in Table 1 also reveal that the mechanical aptitude mean percentile score was 52.9 with a standard deviation of 8.17. The range of the mechanical aptitude scores was from the 18th to the 68th percentile which indicated that these students had average mechanical ability.

Relationships between selected independent variables as revealed in the correlation matrix in Table 3 are shown in the following tables.

Data in Table 4 reveal a correlation coefficient of 0.73, significant at the .01 level, between age of the students and their year at Iowa State University. A correlation coefficient of 0.20 and significant at the .05 level was found between age and the social desirability test score.

The correlation coefficients comparing year at Iowa State University with selected variables are revealed in Table 5. There were no significant correlation coefficients between year at Iowa State University and the other variables as shown in Table 5.

ACT score was significantly correlated at the .01 level with three other independent variables as revealed in Table 6. The correlation coefficient between ACT score and high school
Table 1. Means and standard deviations for selected independent variables for the 125 students in safety attitude study

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$ Mechanical aptitude test score</td>
<td>52.90</td>
<td>8.17</td>
</tr>
<tr>
<td>$X_2$ Social desirability test score</td>
<td>30.46</td>
<td>4.47</td>
</tr>
<tr>
<td>$X_3$ American college test score</td>
<td>24.06</td>
<td>3.24</td>
</tr>
<tr>
<td>$X_4$ High school rank</td>
<td>32.15</td>
<td>19.25</td>
</tr>
<tr>
<td>$X_5$ Cumulative college grade-point average</td>
<td>2.39</td>
<td>0.59</td>
</tr>
<tr>
<td>$X_6$ Year at Iowa State University</td>
<td>2.11</td>
<td>1.10</td>
</tr>
<tr>
<td>$X_7$ Course A. E. 254 or A. E. 255</td>
<td>1.50</td>
<td>0.50</td>
</tr>
<tr>
<td>$X_8$ Age</td>
<td>20.03</td>
<td>1.89</td>
</tr>
<tr>
<td>$X_9$ Evaluative factor with the concepts war, iron, violence and death</td>
<td>72.36</td>
<td>16.40</td>
</tr>
<tr>
<td>$X_{10}$ Potency factor with the concepts war, iron, violence and death</td>
<td>112.57</td>
<td>10.23</td>
</tr>
<tr>
<td>$X_{11}$ Activity factor with the concepts war, iron, violence and death</td>
<td>90.70</td>
<td>12.33</td>
</tr>
<tr>
<td>$X_{12}$ Stability factor with the concepts war, iron, violence and death</td>
<td>52.02</td>
<td>7.28</td>
</tr>
<tr>
<td>$X_{13}$ Evaluative factor with the concept love</td>
<td>39.08</td>
<td>4.61</td>
</tr>
<tr>
<td>$X_{14}$ Potency factor with the concept love</td>
<td>21.39</td>
<td>4.93</td>
</tr>
<tr>
<td>$X_{15}$ Activity factor with the concept love</td>
<td>27.36</td>
<td>4.37</td>
</tr>
<tr>
<td>$X_{16}$ Stability factor with the concept love</td>
<td>18.01</td>
<td>4.63</td>
</tr>
<tr>
<td>$X_{17}$ Evaluative factor with the concept me</td>
<td>34.65</td>
<td>4.35</td>
</tr>
<tr>
<td>$X_{18}$ Potency factor with the concept me</td>
<td>24.30</td>
<td>4.25</td>
</tr>
<tr>
<td>$X_{19}$ Activity factor with the concept me</td>
<td>24.97</td>
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<td>$X_{20}$ Stability factor with the concept me</td>
<td>19.34</td>
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Table 2. Means and standard deviations for dependent variables for 125 students in safety attitude study

<table>
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<tr>
<th>Dependent variable</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_1$ Number of injuries to self requiring a doctor's treatment</td>
<td>1.06</td>
<td>1.45</td>
</tr>
<tr>
<td>$Y_2$ Number of self-blames for injuries to self requiring a doctor's treatment</td>
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<td>0.83</td>
</tr>
<tr>
<td>$Y_3$ Number of injuries to self requiring only first aid</td>
<td>5.23</td>
<td>10.48</td>
</tr>
<tr>
<td>$Y_4$ Number of self-blames for injuries to self requiring only first aid</td>
<td>3.94</td>
<td>8.12</td>
</tr>
<tr>
<td>$Y_5$ Number of accidents causing only damage to property</td>
<td>2.52</td>
<td>3.44</td>
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<tr>
<td>$Y_6$ Number of self-blames for accidents causing only damage to property</td>
<td>1.88</td>
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</tr>
<tr>
<td>$Y_7$ Number of accidents causing injury to other people</td>
<td>0.38</td>
<td>0.76</td>
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<tr>
<td>$Y_8$ Number of self-blames for accidents causing injury to other people</td>
<td>0.24</td>
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<tr>
<td>$Y_9$ Number of traffic accidents</td>
<td>1.02</td>
<td>2.03</td>
</tr>
<tr>
<td>$Y_{10}$ Number of farm shop accidents</td>
<td>2.46</td>
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</tr>
<tr>
<td>$Y_{11}$ Number of machinery accidents</td>
<td>2.76</td>
<td>4.32</td>
</tr>
<tr>
<td>$Y_{12}$ Number of livestock accidents</td>
<td>1.03</td>
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</tr>
<tr>
<td>$Y_{13}$ Number of school accidents</td>
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<tr>
<td>$Y_{14}$ Number of self-blames for traffic accidents</td>
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<tr>
<td>$Y_{15}$ Number of self-blames for farm shop accidents</td>
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<tr>
<td>$Y_{16}$ Number of self-blames for machinery accidents</td>
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<td>Independent variable</td>
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<td>Standard deviation</td>
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<tr>
<td>---------------------------------------------------------------</td>
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<tr>
<td>$Y_{17}$ Number of self-blames for livestock accidents</td>
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<td>$Y_{18}$ Number of self-blames for school accidents</td>
<td>0.46</td>
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<td>$Y_{19}$ Number of self-blame for other accidents</td>
<td>0.70</td>
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<td>$Y_{20}$ Number of other accidents</td>
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<td>$Y_{23}$ Total number of accidents</td>
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Table 3. Correlation coefficients comparing independent (X) variables

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<th>X₄</th>
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a Decimal points were omitted
b X variables are explained in Table 1
* .05 level of significance 125 d.f. = .174
** .01 level of significance 125 d.f. = .228
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<td>34**</td>
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</table>

* indicates significance at the 0.05 level.
** indicates significance at the 0.01 level.
Table 4. Correlation coefficients comparing age with selected variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
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<tbody>
<tr>
<td>Year at Iowa State University</td>
<td>0.73**</td>
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<tr>
<td>ACT score</td>
<td>-0.12</td>
</tr>
<tr>
<td>High school rank</td>
<td>0.15</td>
</tr>
<tr>
<td>Cumulative college grade-point average</td>
<td>-0.05</td>
</tr>
<tr>
<td>Mechanical aptitude test score</td>
<td>0.11</td>
</tr>
<tr>
<td>Social desirability test score</td>
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</tbody>
</table>

*.05 level of significance
**.01 level of significance

Table 5. Correlation coefficients comparing year at Iowa State University with selected variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
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<tbody>
<tr>
<td>ACT score</td>
<td>-0.03</td>
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<tr>
<td>High school rank</td>
<td>0.06</td>
</tr>
<tr>
<td>Cumulative college grade-point average</td>
<td>0.03</td>
</tr>
<tr>
<td>Mechanical aptitude test score</td>
<td>0.11</td>
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<tr>
<td>Social desirability test score</td>
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Table 6. Correlation coefficients comparing ACT score with selected variables

<table>
<thead>
<tr>
<th>Variables</th>
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<tbody>
<tr>
<td>High school rank</td>
<td>-0.60**</td>
</tr>
<tr>
<td>Cumulative college grade-point average</td>
<td>0.44**</td>
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<td>Mechanical aptitude test score</td>
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</tr>
<tr>
<td>Social desirability test score</td>
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</tbody>
</table>

**.01 level of significance

rank was -0.60. The negative correlation was due to high school rank being computed with the smallest percentile being the top of the class. ACT score yielded a correlation coefficient of 0.44 when compared with cumulative college grade-point average and a correlation coefficient of 0.23 with mechanical aptitude test score.

Data in Table 7 reveal a correlation coefficient of -0.56, significant at the .01 level, between high school rank and cumulative college grade-point average. The negative correlation was again due to the way high school rank was computed.

No significant correlations were revealed in Table 8 between cumulative college grade-point average and mechanical aptitude test score or social desirability test score.
Table 7. Correlation coefficients comparing high school rank with selected variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
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</thead>
<tbody>
<tr>
<td>Cumulative college grade-point average</td>
<td>-0.56**</td>
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<tr>
<td>Mechanical aptitude test score</td>
<td>-0.11</td>
</tr>
<tr>
<td>Social desirability test score</td>
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</tbody>
</table>

**.01 level of significance

Table 8. Correlation coefficients comparing cumulative college grade-point average with selected variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical aptitude test score</td>
<td>0.06</td>
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<tr>
<td>Social desirability test score</td>
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</tbody>
</table>
Analysis of Raw Data

Intercorrelations were run to reveal the relationship between individual independent and dependent variables. The independent variables consisted of individual test scores and combinations of factors from within the semantic differential attitude scale plus other information including high school rank, cumulative college grade-point average, year at Iowa State University, course (Agricultural Engineering 254 or Agricultural Engineering 255) and age. The twenty-four dependent variables were the result of individual questions answered on the accident survey form plus selected combinations of the answers. Information in Table 9 shows the magnitude of the correlations between dependent and independent variables.

Data in Table 9 reveal that variable $X_8$, age, was negatively correlated with all but one of the criterion variables. A similar situation was found when comparing variable $X_7$, course, with criterion variables. This shows that the students in Agricultural Engineering 255 had less accident experience than students in Agricultural Engineering 254. Another variable, with all but two of the correlations with the criterion negative, was $X_6$, year at Iowa State University, which indicated that students who had been enrolled at Iowa State University for a longer period of time had fewer accident experiences during the past three years. The relationship between these three independent variables, age, course and year at Iowa State University, and the criterion would be expected
to be similar since the students who were older would most likely have had more years at Iowa State University. Students usually enroll in Agricultural Engineering 254 before Agricultural Engineering 255.

As shown in Table 9 all correlations were negative between $X_{12}$, stability factor with the concepts war, iron, violence and death, and the criterion variables. That is, on the stability factor scale for the stimulus words; war, iron, violence and death, the students who made more responses toward the adjectives insane, drunk, and wild had more accident experience.

In comparing variable $X_{13}$, evaluative factor with the concept love, with the criterion variables, twenty-three of the twenty-four correlations were found to be positive. In other words, the students who responded more toward the adjectives good, clean, fair, kind and beautiful on the evaluative scale had more accident experiences.

When comparing $X_{20}$, stability factor with the stimulus word me, with the criterion variables, the data reveal several negative correlations. Three are significant at the .01 level. The three highly significant correlations are with $Y_3$, number of injuries to self requiring only first aid; $Y_{14}$, number of self-blames for traffic accidents; and $Y_{21}$, number of injuries to self requiring a doctor's treatment or first aid. This shows that on the scales using the stimulus word me the students responding toward the adjectives insane, drunk and wild had more accident experience.
Table 9. Correlation coefficients comparing independent (X) and dependent (Y) variables

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a Decimal points were omitted
b X and Y variables are defined in Tables 1 and 2
* .05 level of significance 125 d.f. = .174
** .01 level of significance 125 d.f. = .228
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The following is an expansion of the data given in Table 10 that was obtained by the Mouflon step-wise regression procedure. An F level of 4 was arbitrarily set as the lower limit for any independent variable to enter the regression equation because the F level of 4 with 1 and 123 degrees of freedom was approximately equal to a significance level of .05. The F level was lowered for selected dependent variables as shown in Table 10. Independent variable $X_{11}$, activity factor with the concepts war, iron, violence and death was the only variable selected to predict $\hat{Y}_1$, number of injuries to self requiring a doctor's treatment. The multiple $R^2$ was 0.0504.

Potency factor with the concept me, $X_{18}$, was the first variable selected to predict $\hat{Y}_2$, number of self-blames for injuries to self requiring a doctor's treatment, with a multiple $R^2$ of 0.0349. The multiple $R^2$ was increased to 0.0703 when $X_3$, ACT score, was included in the equation.

Stability factor with the concept me, $X_{20}$, the first variable selected to predict $\hat{Y}_3$, number of injuries to self requiring only first aid, produced a multiple $R^2$ of 0.0524. The only other variable selected was $X_{16}$, stability factor with the concept love, which raised the multiple $R^2$ to 0.1111.

Information in Table 10 reveals $X_{18}$, potency factor with the concept me, was the first variable selected to predict $\hat{Y}_4$, number of self-blames for injuries to self requiring only first aid. This produced a multiple $R^2$ of 0.0511. The second variable selected was $X_{20}$, stability factor with the concept me, which
raised the multiple $R^2$ to 0.0852. The addition of $X_{16}$, stability factor with the concept love, raised the multiple $R^2$ to 0.1404. When lowering the F level to enter the regression equation from 4 to 2 there were no additional predictors selected.

Age, $X_8$, the first variable selected to predict $\hat{Y}_5$, number of accidents causing only damage to property, produced a multiple $R^2$ of 0.0494. The only other variable selected was $X_{10}$, potency factor with the concepts war, iron, violence and death, which raised the multiple $R^2$ to 0.0801.

Independent variable $X_{10}$, potency factor with the concepts war, iron, violence and death, was the first variable selected to predict $\hat{Y}_6$, number of self-blames for accidents causing only damage to property. A multiple $R^2$ of 0.0502 was produced. The next variable selected was $X_8$, age, which raised the multiple $R^2$ to 0.0934. The addition of $X_3$, ACT score, raised the multiple $R^2$ to 0.1419. The fourth variable selected, $X_1$, mechanical aptitude test score, raised the multiple $R^2$ to 0.1767. The F level was then lowered to 2 after which $X_5$, cumulative college grade-point average, was added. This increased the multiple $R^2$ to 0.1994. The sixth variable, $X_{13}$, evaluative factor with the concept love, changed the multiple $R^2$ to 0.2149 and the last variable selected for $\hat{Y}_6$, evaluative factor with the concept me, $X_{17}$, brought the multiple $R^2$ to 0.2336.

As noted in Table 10 variable $X_{18}$, potency factor with the concept me, was the only variable selected to predict $\hat{Y}_7$, number
of accidents causing injury to other people. The multiple 
\( R^2 \) was 0.0400.

There was no variable selected for \( Y_8 \), number of self-blames for accidents causing injury to other people.

Only one variable, \( X_{15} \), activity factor with the concept love, was selected for \( Y_2 \), number of traffic accidents. This produced a multiple \( R^2 \) of 0.0707.

Potency factor with the concept me, \( X_{18} \), the only variable selected to predict \( Y_{10} \), number of farm shop accidents, produced a multiple \( R^2 \) of 0.0625. The F level was then lowered to 2 and \( X_{20} \), stability factor with the concept me, raised the multiple \( R^2 \) to 0.0896. With the addition of \( X_{16} \), stability factor with the concept love, the multiple \( R^2 \) was increased to 0.1130.

Only variable \( X_{13} \), evaluative factor with the concept love, was selected to predict \( Y_{11} \), number of machinery accidents, and a multiple \( R^2 \) of 0.0390 was produced.

Independent variable, \( X_{17} \), evaluative factor with the concept me, the only variable selected to predict \( Y_{12} \), number of livestock accidents, produced a multiple \( R^2 \) of 0.0334.

Only variable \( X_{11} \), activity factor with the concepts war, iron, violence and death, was selected to predict \( Y_{13} \), number of school accidents, producing a multiple \( R^2 \) of 0.0445.

As shown in Table 10, \( X_{20} \), stability factor with the concept me, was the first variable selected to predict \( Y_{14} \), number of self-blames for traffic accidents. This produced a multiple
R² of 0.0568. With the addition of X₉, evaluative factor with the concepts war, iron, violence and death, the multiple R² was raised to 0.1041.

Only variable X₁₈, potency factor with the concept me, was chosen to predict Y₁₅, number of self-blames for farm shop accidents giving a multiple R² of 0.0645.

Evaluative factor with the concept love, X₁₃, the first variable selected for Y₁₆, number of self-blames for machinery accidents, produced a multiple R² of 0.0419. The next variable selected, X₁₄, potency factor with the concept love, increased the multiple R² to 0.0742.

There were no variables selected for predicting Y₁₇, number of self-blames for livestock accidents as revealed in Table 10.

Evaluative factor with the concepts war, iron, violence and death, X₉, was first selected to predict Y₁₈, number of self-blames for school accidents. This produced a multiple R² of 0.0535 which was changed to 0.0844 with the addition of X₁₁, activity factor with the concepts war, iron, violence and death.

High school rank, X₄, the only variable selected to predict Y₁₉, number of self-blames for other accidents, produced a multiple R² of 0.0537.

High school rank, X₄, was also the only variable selected for Y₂₀, number of other accidents producing a multiple R² of 0.0407.
Two variables were selected to predict $\hat{Y}_{21}$, number of injuries to self requiring a doctor's treatment or first aid. $X_{20}$, stability factor with the concept me, produced a multiple $R^2$ of 0.0524 and $X_{16}$, stability factor with the concept love, raised the multiple $R^2$ to 0.1163. When the F level was lowered to 2 and $X_{11}$, activity factor with the concepts war, iron, violence and death was added, the multiple $R^2$ was changed to 0.1411. The next variable selected, $X_{14}$, potency factor with the concept love, increased the multiple $R^2$ to 0.1568.

As noted in Table 10, $X_{18}$, potency factor with the concept me, was the first variable selected to predict $\hat{Y}_{22}$, number of self-blames for injuries to self requiring a doctor's treatment or first aid. The multiple $R^2$ was 0.0583. The second variable selected, $X_{20}$, stability factor with the concept me raised the multiple $R^2$ to 0.0900. A third variable, $X_{16}$, stability factor with the concept love, increased the multiple $R^2$ to 0.1461. When the F level was lowered to 2 there were no other variables selected.

Independent variable $X_{20}$, stability factor with the concept me, first selected to predict $\hat{Y}_{23}$, total number of accidents, produced a multiple $R^2$ of 0.0390. With the addition of $X_{16}$, stability factor with the concept love, the multiple $R^2$ was raised to 0.0949. When the F level was lowered to 2 and $X_{11}$, activity factor with the concepts war, iron, violence and death was added, the multiple $R^2$ was 0.1179. Variable $X_7$, course (Agricultural Engineering 254 or Agricultural Engineering
 raised the multiple $R^2$ to 0.1325.

Potency factor with the concept me, $X_{18}$, was the only variable selected for $\hat{Y}_{24}$, total number of self-blames for all accidents. This produced a multiple $R^2$ of 0.0439 as revealed in Table 10.

**Testing Hypotheses**

The Mouflon step-wise regression procedure was used as a basis for rejecting or failing to reject the hypotheses. Results are shown in Tables 10 and 11.

**Hypothesis 1**, accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by a combination of two or more independent variables including a semantic differential attitude scale score, mechanical aptitude test score, social desirability test score, high school rank, cumulative college grade-point average, ACT score, course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and age, was rejected. Variable $\hat{Y}_6$, number of self-blames for accidents causing only damage to property, was predicted by seven variables in the regression formula. These variables were: $X_1$, mechanical aptitude; $X_3$, ACT score; $X_5$, cumulative college grade-point average; $X_8$, age; $X_{10}$, potency factor with the concepts war, iron, violence and death; $X_{12}$, evaluative factor with the concept love and $X_{17}$, evaluative factor with the concept me. The multiple $R^2$ was 0.2336.
Table 10. Combinations of independent (X) variables to predict dependent (Y) variables with the F level to enter the regression equation set at 4

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<tr>
<td>( Y_2 = 0.0373X_{18} - 0.0479X_9 + 0.7749 )</td>
<td>0.0703</td>
</tr>
<tr>
<td>( Y_3 = 0.6325X_{16} - 1.0415X_{20} + 13.9878 )</td>
<td>0.1111</td>
</tr>
<tr>
<td>( Y_4 = 0.4781X_{16} + 0.3435X_{18} - 0.7104X_{20} + 0.7281 )</td>
<td>0.1404</td>
</tr>
<tr>
<td>( Y_5 = 0.0590X_{10} - 0.3916X_8 + 3.7291 )</td>
<td>0.0801</td>
</tr>
<tr>
<td>( Y_6 = 0.0636X_1 - 0.2233X_3 - 0.3701X_8 + 0.0528X_{10} + 5.3570 )</td>
<td>0.1767</td>
</tr>
<tr>
<td>( Y_7 = -0.0355X_{18} + 1.2392 )</td>
<td>0.0400</td>
</tr>
<tr>
<td>( Y_8 = \text{NONE} )</td>
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<tr>
<td>( Y_9 = 0.1235X_{15} - 2.3539 )</td>
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<td>( Y_{10} = 0.3644X_{18} - 6.4000 )</td>
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<tr>
<td>( Y_{11} = 0.1852X_{13} - 4.4780 )</td>
<td>0.0390</td>
</tr>
<tr>
<td>( Y_{12} = 0.0965X_{17} + 4.3760 )</td>
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<tr>
<td>( Y_{13} = 0.0584X_{11} - 3.8776 )</td>
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<td>( Y_{14} = -0.0104X_9 - 0.0595X_{20} + 2.4006 )</td>
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<td>( Y_{15} = 0.3140X_{18} - 5.6226 )</td>
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<tr>
<td>( Y_{16} = 0.1584X_{13} + 0.1345X_{14} - 6.7324 )</td>
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<tr>
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<tr>
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\( a \) \( \hat{Y} \) = The predicted variable
Table 10. Continued

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<td>$\hat{y}<em>{22} = 0.4886x</em>{16} + 0.3793x_{18} - 0.7085x_{20} + 0.1599$</td>
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</tr>
<tr>
<td>$\hat{y}<em>{23} = 0.7327x</em>{16} - 1.1208x_{20} + 17.6791$</td>
<td>0.0949</td>
</tr>
<tr>
<td>$\hat{y}<em>{24} = 0.4625x</em>{18} - 4.6491$</td>
<td>0.0439</td>
</tr>
</tbody>
</table>

Table 11. Combination of independent ($X$) variables to predict dependent ($\hat{Y}$) variables with the $F$ level to enter the regression equation set at 2

<table>
<thead>
<tr>
<th>Variables</th>
<th>Multiple $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{y}<em>{21} = a \cdot 0.1198x</em>{11} + 0.2815x_{14} + 0.6777x_{16} - 1.0572x_{20}$</td>
<td>0.1568</td>
</tr>
<tr>
<td>$\hat{y}<em>{22} = 0.4886x</em>{16} + 0.3793x_{18} - 0.7085x_{20} + 0.1599$</td>
<td>0.1461</td>
</tr>
<tr>
<td>$\hat{y}<em>{23} = -3.0713x_7 + 0.1702x</em>{11} + 0.7482x_{16} - 1.1011x_{20}$</td>
<td>0.1325</td>
</tr>
<tr>
<td>$\hat{y}<em>{24} = 0.4781x</em>{16} + 0.3435x_{18} - 0.7104x_{20} + 0.7282$</td>
<td>0.1404</td>
</tr>
<tr>
<td>$\hat{y}_{25} = 0.0674x_1 - 0.2853x_3 + 0.87x_5 - 0.3496x_8$</td>
<td>0.2336</td>
</tr>
<tr>
<td>$+ 0.0525x_{10} + 0.0920x_{13} - 0.0927x_{17} + 3.7917$</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\hat{Y} = \) The predicted variable
Hypothesis 2, accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by means of a written semantic differential attitude scale, was rejected. As indicated by Table 11, $\hat{\theta}_{21}$, number of injuries to self requiring a doctor's treatment or first aid during a three-year period of time, can be predicted from the regression equation by including the variables $X_{11}$, activity factor with the concepts war, iron, violence and death; $X_{14}$, potency factor with the concept love; $X_{16}$, stability factor with the concept love and $X_{20}$, stability factor with the concept me. The multiple $R^2$ was 0.1568.

Hypothesis 3, there is no significant relationship between mechanical aptitude test score, as measured by the Bennett Mechanical Aptitude Test, and accident experience, as measured by the number of accidents involved in during a three-year period, was not rejected. Mechanical aptitude, $X_1$, was not selected alone as a predictor of accidents, therefore hypothesis 3 was not rejected.

Hypothesis 4, there is no significant relationship between social desirability test score, as measured by Edward's Social Desirability Scale, and accident experience, as measured by the number of accidents involved in during a three-year period, was not rejected. As shown in Table 10, $X_2$, social desirability test score was not selected alone or in any combination with other variables as a predictor of accidents.

Hypothesis 5, there is no significant relationship between
high school rank and accident experience, as measured by the number of accidents involved in during a three-year period, was rejected. Using the step-wise regression procedure high school rank was selected as an only predictor of accidents for \( \hat{Y}_{20} \), number of other accidents, and \( \hat{Y}_{19} \), number of self blames for other accidents. The multiple \( R^2 \) for \( \hat{Y}_{20} \) was 0.0407 and the multiple \( R^2 \) for \( \hat{Y}_{19} \) was 0.0537.

Hypothesis 6, there is no significant relationship between cumulative college grade-point average and accident experience, as measured by the number of accidents involved in during a three-year period, was not rejected. This variable was chosen only once in combination with six other variables as a predictor of accidents as based on results in Table 11.

Hypothesis 7, there is no significant relationship between ACT score and accident experience, as measured by the number of accidents involved in during a three-year period, was not rejected. This variable was chosen only two times using the Mouflon step-wise regression procedure and only with combinations of other variables.

Hypothesis 8, there is no significant relationship between course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and accident experience, as measured by number of accidents involved in during a three-year period, was not rejected. This variable was chosen only once and as the last variable in combination with three other variables.

Hypothesis 9, there is no significant relationship between
age and accident experience, as measured by number of accidents involved in during a three-year period, was not rejected. This variable was chosen only in combination with other variables as a predictor of accidents.
DISCUSSION

This research was an attempt to develop and evaluate a shop safety attitude scale. Throughout the pilot study care was taken to develop a testing instrument whereby the results could not be pre-determined by the student. It was assumed that if a student had interest in the outcome of a test he would try to make himself appear better than he actually was. During the review of literature, Osgood's (1964) semantic differential scale was examined. It seemed impossible for the subjects to intentionally fill out the semantic differential scale in a way that would make them appear to have a good or bad safety attitude. Therefore, the semantic differential type scale was adapted for this study.

Extensive evaluation was done during the pilot study to arrive at the best scale for the final study. High reliability had been found with several semantic differential experiments. Also extensive factor analysis work had been done by Osgood and his associates. Therefore, the author felt that the factors and their associated adjective pairs could be adapted to this study with confidence without additional factor analysis.

The two scales developed and administered during the pilot study showed significant correlations between accident experience and stimulus words along the evaluative factor. This provided direction for development of the final instrument. During the pilot study only evaluative, potency, and activity
factors were employed in the semantic differential. In reviewing literature, studies were found to reveal a relationship between the number of accidents and a student's emotional stability. In Osgood's factor analysis studies, the stability factor was difficult to isolate but it was identifiable as a fourth factor. It was decided by the author to try to sample an additional dimension of the semantic space by employing the stability factor, along with the three previously used factors, for the final instrument.

After interviewing other researchers, the author felt that additional information about the students may be significantly correlated with accident experience. Therefore additional instruments were selected to determine certain aspects of their personalities and abilities. Also other demographic information was collected from the students to determine its relationship to the student's accident experience.

Edward's Social Desirability Test was selected to measure personality factors that may be related to accident experience. The test did not prove to be of value either alone or in combination with other independent variables since it was not selected as a predictor, using the Moufлон step-wise regression technique. The Bennett Mechanical Aptitude Test was chosen to measure the student's mechanical ability and determine its relationship to accident experience. It was found to be only of value in combination with other independent variables as a predictor of accidents. An accident survey was developed by the
author to measure accident experience of the students during the three-year period of time preceding the completion of the survey.

When testing hypothesis 1, it was found that a combination of independent variables could be employed to predict accident experience. Those variables selected, using the step-wise regression procedure to formulate the regression equation, were taken from the semantic differential attitude scale, age of the student, ACT score, mechanical aptitude test score and cumulative college grade-point average.

If an instructor were interested only in the number of property damage accidents for which the student was to blame, he could use the above variables in the regression equation,

$$
\hat{Y}_6 = 3.792 + 0.067X_1 - 0.285X_3 + 0.009X_5 - 0.350X_8 + 0.053X_{10} + 0.092X_{13} - 0.093X_{17}.
$$

By using this equation, 23.36 per cent of the variance could be accounted for in predicting an individual student's accident experience concerning property damage accidents for which he was to blame during a three-year period.

Therefore, hypothesis 1, accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by a combination of two or more independent variables including a semantic differential attitude scale score, a mechanical aptitude test score, a social desirability test score, high school rank, cumulative college grade-point average, ACT score, course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and age, was rejected.
In reviewing the data in Table 9, it can be seen that $Y_6$, number of self-blames for accidents causing only damage to property, was significantly correlated with three independent variables. These three variables were: $X_7$, ACT score; $X_8$, age; and $X_{10}$, potency factor with the concepts war, iron, violence and death. These data indicate that those students who had a low ACT score and/or were the younger students had more accident experiences of the type measured by $Y_6$. Furthermore, those students who scored the potency factor more toward the adjectives; large, rugged, strong and heavy, had more of this type of accident experience.

Hypothesis 2, accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by means of a written semantic differential attitude scale, was also rejected.

If a shop instructor were interested in predicting the number of injuries to his students requiring a doctor's treatment or first aid during a three-year period, he could administer the semantic differential attitude scale described in this study. Individual student's scores that can be combined to be included in the regression equation, $\hat{Y}_{21} = -2.35 + 0.12X_{11} + 0.28X_{14} + 0.68X_{16} - 1.06X_{20}$, constitute the following four variables: the activity factor with the concepts war, iron, violence and death, the potency factor with the concept love, the stability factor with the concept love, and the stability factor with the concept me. By using this equation, 15.68 per
cent of the variance may be accounted for in predicting an individual student's accident experience concerning the injuries to himself requiring a doctor's treatment or first aid.

The first variable selected to predict \( \hat{Y}_{21} \), number of injuries to self requiring a doctor's treatment or first aid, was \( X_{20} \), stability factor with the concept, me. By reviewing Table 9, we can see that the correlation coefficient between these two variables was \(-0.23\). This revealed that those students who scored the stability factor more toward the adjectives, drunk, insane and wild, had more injuries to self requiring a doctor's treatment or first aid. This indicated that the students who may have low opinions of themselves tended to have more accidents. This observation was also observed by Kraus et al. (1971, p. 1196) as he described the accident group as:

(a) failed one or more grades in or before grade 8, or had been in a vocational high school course; (b) became a regular cigarette smoker at or before age 16; (c) had 1st full-time employment exclusive of school vacation time at or before age 17 and before obtaining a driving license; and (d) had been charged with a criminal offense.

Another study following this same reasoning was conducted by Birnbach (1948) in which he concluded that (p. 45):

"Children who are well adjusted emotionally and in the area of the home have fewer accidents."

Therefore the author concludes that there must be some relationship between a student's opinion of himself, his emotional stability or his level of adjustment to his environment and his accident experience.
The following examples will help to explain how the regression equation can be used to predict accident experience for individual students.

Student "number 001" reported very few accidents on the accident survey and none for $y_{21}$, number of injuries requiring a doctor's treatment or first aid during the past three years. The mean number of these types of accidents was 6.3 for all 125 students during a three-year period.

By taking selected scores provided by a student from the semantic differential attitude scale and inserting them into the regression equation, it is possible to predict his accident experience. Several individual scale scores were summed to be included in the four variables for each student.

The following key gives the item number of the semantic differential attitude scale to be scored from left to right, straight, and from right to left, reverse, for the four variables used in the regression equation.

Variable $X_{11}$, straight - 3, 14, 20, 23, 63, 65, 74, 79
reverse - 5, 10, 25, 28, 49, 55, 57, 68

Variable $X_{14}$, straight - none
reverse - 37, 39, 44, 47

Variable $X_{16}$, straight - 33
reverse - 38, 48

Variable $X_{20}$, straight - none
reverse - 82, 84, 87
Example No. 1. Scores for student "number 001" were:

<table>
<thead>
<tr>
<th>Variable $X_{11}$</th>
<th>Variable $X_{14}$</th>
<th>Variable $X_{16}$</th>
<th>Variable $X_{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S$</td>
<td>$R$</td>
<td>$S$</td>
<td>$R$</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>7</td>
<td>3</td>
</tr>
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<td>6</td>
<td>7</td>
<td>2</td>
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<td>3</td>
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<td>8</td>
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<td>2</td>
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<tr>
<td>9</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

$S = 8$ $R = 9$ $S + R = 17$ $R = 23$

$S = 39$ $R = 39$

$S + R = 78$

The regression equation to be used to predict injuries to self was: $\hat{Y}_{21} = -2.35 + 0.12X_{11} + 0.28X_{14} + 0.68X_{16} - 1.06X_{20}$

For student "number 001" the equation would be: $\hat{Y}_{21} = -2.35 + 0.12(78) + 0.28(25) + 0.68(17) - 1.06(23) = 1.24$

Therefore $\hat{Y}_{21} = 1.24$ injuries to himself requiring a doctor's treatment or first aid during a three-year period.

This example shows that the regression equation can be used to predict an individual's accident experience. Student "number 001" did not have this type of accident but the equation predicted him to have 1.24 injuries, while the mean of the total group was 6.3.
Example No. 2. Scores for student "number 007" were:

<table>
<thead>
<tr>
<th>Variable $X_{11}$</th>
<th>Variable $X_{14}$</th>
<th>Variable $X_{16}$</th>
<th>Variable $X_{20}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S$</td>
<td>$R$</td>
<td>$R$</td>
<td>$S$</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>5</td>
<td>$S=1$</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>9</td>
<td>$R=18$</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$S = 51 \quad R = 52$

$S + R = 103$

The regression equation to be used to predict injuries to self was:

$$\hat{Y}_{21} = -2.35 + 0.12X_{11} + 0.28X_{14} + 0.68X_{16} - 1.06X_{20}$$

For student "number 007" the equation would be:

$$\hat{Y}_{21} = -2.35 + 0.12(103) + 0.28(32) + 0.68(19) - 1.06(9) = 22.36$$

Therefore $\hat{Y}_{21} = 22.36$ injuries to himself requiring a doctor's treatment or first aid during a three-year period. Student "number 007" reported 100 accidents of this type which was the highest number of the 125 students in this study. The regression equation predicted him to have 22.36 injuries, while the mean of the total group was 6.3.

After comparing the semantic differential scale scores and
the number of accidents predicted for these two students, the instructor can see that student "number 007" needs additional attention to insure that he will not be involved in accidents. It appears that student "number 007" is headed for disaster if someone does not give him additional instruction in safety procedures. By identifying this student who is an accident repeater early in the shop course, the instructor could provide the necessary instruction.

Hypothesis 5, there is no significant relationship between high school rank and accident experience, as measured by the number of accidents involved in during a three-year period, was rejected and the percentage of variance accounted for was 5.37 per cent. Therefore, since the efficiency of high school rank as a lone predictor is quite low its use as a lone predictor would be questionable.

It was impossible to reject any of the other hypotheses since their rejection depended upon the selection of one variable alone as a predictor of accidents. That is, mechanical aptitude test score, social desirability test score, cumulative college grade-point average, ACT score, course enrolled in nor age were selected alone as a predictor of accidents. Some of these were selected to be used in combination with other variables. Probably the best reason for the inability to select a single variable as a predictor of accidents is stated in Birnbach's (1948, p. 45) conclusion: "Accidents are produced usually as the result of a combination of factors rather than
any one factor."

Before an instructor decides to use this semantic differential attitude scale alone or in combination with other variables he must weight its value as an accident prediction instrument. In this study the author at best was able to account for a little less than one-fourth of the variance. Other researchers have been able to develop somewhat more efficient accident predictors. Schuster (1961) and Bracy (1971) were able to predict approximately one-third of the variance with their respective testing procedures. Although the author was interested in predicting all types of accidents, especially those for the school shops, the results of this study were successful only in predicting accidents of a specific nature.

Based on the results of this study, it appears that accident experience of students in shop classes consisting of injuries to self or damage to property can be predicted with 15 to 23 per cent of the variance accounted for. Using the testing procedure described in the study, shop instructors could identify those students who may be involved in accidents. Students, once identified as being accident repeaters, could be given additional safety instruction or other attention as considered necessary by the instructor.
SUMMARY

Considerable research has been conducted in an attempt to develop a testing instrument to single out accident repeaters. Researchers have had only partial success with these studies. This investigation was an attempt to develop and evaluate a shop safety attitude scale that could be administered at the beginning of a shop class to determine if any student might be prone to have accidents.

The main purpose of this study was to develop and evaluate a shop safety attitude scale.

The secondary purposes of the study were:

1. To determine the relationship between mechanical aptitude test score and accident experience.
2. To determine the relationship between social desirability test score and accident experience.
3. To determine the relationship between high school rank, cumulative college grade-point average and ACT score and accident experience.
4. To determine the relationship between course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and accident experience.
5. To determine the relationship between age and accident experience.

The 125 students selected for this study were enrolled in Agricultural Engineering 254, metals and welding and Agricultural Engineering 255, carpentry and concrete, during spring
quarter of 1972. Approximately one-half of the students were in each course. Their mean age was 20.03 and their mean year at Iowa State University was 2.11. Most of them were from the upper half of their high school classes.

Information was obtained by administering an attitude scale, a social desirability test, a mechanical aptitude test and an accident survey. Other data were collected from student records in the Office of the Registrar at Iowa State University of Science and Technology. This information was then coded and transferred to IBM cards.

The following 44 variables were statistically treated to obtain intercorrelations among the variables. Variables 1-20 are independent and 21-44 are dependent variables.

1. mechanical aptitude test score
2. social desirability test score
3. American College Test (ACT) score
4. high school rank
5. cumulative college grade-point average
6. year at Iowa State University
7. course (Agricultural Engineering 254 or Agricultural Engineering 255)
8. age
9. evaluative factor with the concepts war, iron, violence and death
10. potency factor with the concepts war, iron, violence and death
11. activity factor with the concepts war, iron, violence and death
12. stability factor with the concepts war, iron, violence and death
13. evaluative factor with the concept love
14. potency factor with the concept love
15. activity factor with the concept love
16. stability factor with the concept love
17. evaluative factor with the concept me
18. potency factor with the concept me
19. activity factor with the concept me
20. stability factor with the concept me
21. number of injuries to self requiring doctor's treatment
22. number of self-blames for injuries to self requiring a doctor's treatment
23. number of injuries to self requiring only first aid
24. number of self-blames for injuries to self requiring only first aid
25. number of accidents causing only damage to property
26. number of self-blames for accidents causing only damage to property
27. number of accidents causing injury to other people
28. number of self-blames for accidents causing injury to other people
29. number of traffic accidents
30. number of farm shop accidents
31. number of machinery accidents
32. number of livestock accidents
33. number of school accidents
34. number of other accidents
35. number of self-blames for traffic accidents
36. number of self-blames for farm shop accidents
37. number of self-blames for machinery accidents
38. number of self-blames for livestock accidents
39. number of self-blames for school accidents
40. number of self-blames for other accidents
41. number of injuries to self requiring a doctor's treatment or first aid
42. number of self-blames for injuries to self requiring a doctor's treatment or first aid
43. total number of accidents
44. total number of self-blames for all accidents

The Mouflon step-wise regression technique was employed to select the best independent variable to predict each dependent variable.

In using the step-wise regression technique a combination of seven variables was selected to predict the number of self-blames for accidents causing only damage to property. The variables selected were: mechanical aptitude test score; ACT score; cumulative college grade-point average; age; the potency factor with the concepts war, iron, violence and death; the evaluative factor with the concept love and the evaluative
factor with the concept me. Therefore it was possible to reject hypothesis 1, accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by a combination of two or more independent variables including a semantic differential attitude scale score, mechanical aptitude test score, social desirability test score, high school rank, cumulative college grade-point average, ACT score, course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and age.

Four variables from the semantic differential attitude scale were selected to predict the number of injuries to self requiring a doctor's treatment or first aid during a three-year period. The four variables were: the activity factor with the concepts war, iron, violence and death; the potency factor with the concept love; the stability factor with the concept love and the stability factor with the concept me. Therefore, it was possible to reject hypothesis 2, accident experience, as measured by the number of accidents involved in during a three-year period, cannot be predicted by means of a written semantic differential attitude scale.

By using the Mouflon step-wise regression technique mechanical aptitude alone was not selected as a predictor of accidents. It was therefore impossible to reject hypothesis 3, there is no significant relationship between mechanical aptitude test score, as measured by the Bennett Mechanical Aptitude Test, and accident experience, as measured by the number of accidents involved in during a three-year period.
Social desirability test score was not selected alone or in any combination with other variables as a predictor of accidents. Thus, it was also impossible to reject hypothesis 4, there is no significant relationship between social desirability test score, as measured by Edward's Social Desirability Scale, and accident experience, as measured by the number of accidents involved in during a three-year period.

When employing the step-wise regression technique, high school rank as a lone predictor was selected for the two dependent variables; number of other accidents and the number of self-blames for other accidents. As a result, it was possible to reject hypothesis 5, there is no significant relationship between high school rank and accident experience, as measured by the number of accidents during a three-year period.

Cumulative college grade-point average was selected only in combination with other variables. Therefore, it was impossible to reject hypothesis 6, there is no significant relationship between cumulative college grade-point average and accident experience, as measured by the number of accidents involved in during a three-year period.

ACT score was not selected as a lone predictor of accidents. For this reason it was not possible to reject hypothesis 7, there is no significant relationship between ACT score and accident experience, as measured by the number of accidents involved in during a three-year period.

Course enrolled in (Agricultural Engineering 254 or
Agricultural Engineering 255) was not selected as an only predictor of accidents. It was therefore impossible to reject hypothesis 8, there is no significant relationship between course enrolled in (Agricultural Engineering 254 or Agricultural Engineering 255) and accident experience, as measured by the number of accidents involved in during a three-year period.

Age was not selected as an only predictor of accidents. Therefore, it was also impossible to reject hypothesis 9, there is no significant relationship between age and accident experience, as measured by the number of accidents involved in during a three-year period.

After testing the hypotheses, it was found that it was possible to develop a written shop safety attitude scale that can be used alone or in combination with other instruments to predict certain types of accident experience.
RECOMMENDATIONS

The following suggestions are recommended as ways to improve upon the semantic differential attitude scale developed in this study.

1. Cross-validate the semantic differential attitude scale.
2. Factor analyze the data to determine if the adjectives still have the same meaning today as found by Osgood in his studies.
3. Factor analyze all scores to determine the best score to be combined for each variable.
4. Replicate the study with a more heterogeneous population.
5. Test for non-linear relationships between independent and dependent variables.

The following recommendations may be helpful for those doing additional research in accident prediction.

1. Test the subjects first and collect the accident experience over a period of time following the testing to get more accurate accident information and also include the more serious accidents. By testing first, the accidents occurring after the testing would not affect the test results.
2. Check accident records instead of depending upon subjects for correct number and type of accidents.
3. Include more biographical information and determine its relationship to accident experience.
LITERATURE CITED


Shuman, John T. 1938. The basic causes of accidents. Industrial Arts and Vocational Education 27, No. 1: 49.


APPENDIX I: PILOT STUDY I
Pilot Study 1

You are to give your reaction to the underlined word or words at the beginning of each item by placing an X in the space between two opposing adjectives.

Example:
Communist

Good: ___: ___: ___: ___: Bad

The six spaces for a reaction are: (1) very good, (2) fairly good, (3) slightly good, (4) slightly bad, (5) fairly bad, (6) very bad.

Please put your X in the center of one of the six spaces provided. You may at times feel that the X should go between two spaces. In these situations choose the space that most nearly describes your reaction and put your X in this space.

Nine pair of opposing adjectives are included in each item. Please react to the word or words at the beginning of each item nine times and place your Xs in the appropriate spaces.

Work at a fairly fast rate. Your first impressions are usually the best. Be sure to concentrate on each item. Go to the first item and start working.
1. Slow traffic

strong___________weak
rugged___________delicate
good___________bad
passive___________active
dirty___________clean
small___________large
slow___________fast
sharp___________dull
beautiful________ugly

2. Danger

large___________small
active___________passive
beautiful________ugly
clean___________dirty
slow___________fast
good___________bad
sharp___________dull
rugged___________delicate
weak___________strong
3. Piano

slow__:__:_:_:_:__fast

good__:__:_:_:_:__bad

ugly__:__:_:_:_:__beautiful

dull__:__:_:_:_:__sharp

dirty__:__:_:_:_:__clean

delicate__:__:_:_:_:__rugged

large__:__:_:_:_:__small

weak__:__:_:_:_:__strong

passive__:__:_:_:_:__active

4. Blood

weak__:__:_:_:_:__strong

active__:__:_:_:_:__passive

bad__:__:_:_:_:__good

rugged__:__:_:_:_:__delicate

ugly__:__:_:_:_:__beautiful

sharp__:__:_:_:_:__dull

slow__:__:_:_:_:__fast

small__:__:_:_:_:__large

dirty__:__:_:_:_:__clean

5. Tests

ugly__:__:_:_:_:__beautiful

passive__:__:_:_:_:__active

weak__:__:_:_:_:__strong

large__:__:_:_:_:__small

slow__:__:_:_:_:__fast

bad__:__:_:_:_:__good

rugged__:__:_:_:_:__delicate

dirty__:__:_:_:_:__clean

sharp__:__:_:_:_:__dull
6. Pain

passive: active
delicate: rugged
small: large
fast: slow
ugly: beautiful
dirty: clean
strong: weak
good: bad
dull: sharp

7. War

bad: good
beautiful: ugly
large: small
slow: fast
strong: weak
dirty: clean
dull: sharp
active: passive
rugged: delicate

dull: sharp

8. Electricity

large: small
bad: good
passive: active
dull: sharp
beautiful: ugly
weak: strong
clean: dirty
slow: fast
rugged: delicate
9. Laws

delicate__:_:_:_:_:_:_:_rugged
dirty__:_:_:_:_:_:_:_clean
passive__:_:_:_:_:_:_:_active
slow__:_:_:_:_:_:_:_fast
dull__:_:_:_:_:_:_:_sharp
large__:_:_:_:_:_:_:_small
beautiful__:_:_:_:_:_:_:_ugly
strong__:_:_:_:_:_:_:_weak
good__:_:_:_:_:_:_:_bad

10. Thunder

rugged__:_:_:_:_:_:_:_delicate
active__:_:_:_:_:_:_:_passive
slow__:_:_:_:_:_:_:_fast
weak__:_:_:_:_:_:_:_strong
ugly__:_:_:_:_:_:_:_beautiful
sharp__:_:_:_:_:_:_:_dull
large__:_:_:_:_:_:_:_small
good__:_:_:_:_:_:_:_bad
clean__:_:_:_:_:_:_:_dirty

11. Father

good__:_:_:_:_:_:_:_bad
sharp__:_:_:_:_:_:_:_dull
passive__:_:_:_:_:_:_:_active
dirty__:_:_:_:_:_:_:_clean
beautiful__:_:_:_:_:_:_:_ugly
delicate__:_:_:_:_:_:_:_rugged
fast__:_:_:_:_:_:_:_slow
strong__:_:_:_:_:_:_:_weak
small__:_:_:_:_:_:_:_large
12. Grandmother

passive___:___:___:___:active
fast___:___:___:___:slow
good___:___:___:___:bad
clean___:___:___:___:dirty
dull___:___:___:___:sharp
ugly___:___:___:___:beautiful
rugged___:___:___:___:delicate
weak___:___:___:___:strong
small___:___:___:___:large

13. Security

clean___:___:___:___:dirty
bad___:___:___:___:good
ugly___:___:___:___:beautiful
dull___:___:___:___:sharp
rugged___:___:___:___:delicate
fast___:___:___:___:slow
small___:___:___:___:large
strong___:___:___:___:weak
active___:___:___:___:passive

14. Revolt

passive___:___:___:___:active
small___:___:___:___:large
ugly___:___:___:___:beautiful
weak___:___:___:___:strong
fast___:___:___:___:slow
clean___:___:___:___:dirty
good___:___:___:___:bad
rugged___:___:___:___:delicate
sharp___:___:___:___:dull
15. Teacher

weak____:____:____:____:____:____:strong
small____:____:____:____:____:____:large
delicate____:____:____:____:____:____:rugged
slow____:____:____:____:____:____:fast
dirty____:____:____:____:____:____:clean
bad____:____:____:____:____:____:good
passive____:____:____:____:____:____:active
sharp____:____:____:____:____:____:dull
ugly____:____:____:____:____:____:beautiful

16. Church

slow____:____:____:____:____:____:fast
rugged____:____:____:____:____:____:delicate
bad____:____:____:____:____:____:good
dull____:____:____:____:____:____:sharp
clean____:____:____:____:____:____:dirty
large____:____:____:____:____:____:small
active____:____:____:____:____:____:passive
ugly____:____:____:____:____:____:beautiful
weak____:____:____:____:____:____:strong

17. Car race

rugged____:____:____:____:____:____:delicate
fast____:____:____:____:____:____:slow
dirty____:____:____:____:____:____:clean
good____:____:____:____:____:____:bad
beautiful____:____:____:____:____:____:ugly
weak____:____:____:____:____:____:strong
active____:____:____:____:____:____:passive
large____:____:____:____:____:____:small
dull____:____:____:____:____:____:sharp
18. Invalid

passive__:_:__:__:__:__:active
slow__:_:__:__:__:__:fast
sharp__:_:__:__:__:__:dull
good__:_:__:__:__:__:bad
rugged__:_:__:__:__:__:delicate
weak__:_:__:__:__:__:strong
dirty__:_:__:__:__:__:clean
small__:_:__:__:__:__:large
beautiful__:__:__:__:__:ugly

19. Machine

small__:_:__:__:__:__:large
dirty__:_:__:__:__:__:clean
dull__:_:__:__:__:__:sharp
active__:_:__:__:__:__:passive
fast__:_:__:__:__:__:slow
rugged__:_:__:__:__:__:delicate
beautiful__:__:__:__:__:ugly
strong__:_:__:__:__:__:weak
good__:_:__:__:__:__:bad
Your involvement in accidents during the last 5 years

A. Accidental injuries to you requiring a doctor's treatment;

<table>
<thead>
<tr>
<th>Type (car, saw, etc.)</th>
<th>Part of body injured (hand, leg, etc.)</th>
<th>Were you at fault? (yes or no)</th>
<th>Place (school shop, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Accidental injuries to you requiring only first aid;

<table>
<thead>
<tr>
<th>Type</th>
<th>Part of body injured</th>
<th>Were you at fault?</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Accidents causing only damaged property;

<table>
<thead>
<tr>
<th>Type</th>
<th>Property damaged</th>
<th>Were you at fault?</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Accidents causing injuries to other people;

<table>
<thead>
<tr>
<th>Type</th>
<th>Part of body injured</th>
<th>Were you at fault?</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX II: PILOT STUDY II
Pilot Study II

The purpose of this exercise is to determine the relationships between reactions to certain stimuli.

You are to give your reaction to the underlined word or words at the beginning of each item by marking one space on the answer sheet corresponding to the space between two opposing adjectives. For example you will have six spaces for your reaction between the adjectives good and bad. These are; very good, fairly good, slightly good, slightly bad, fairly bad, and very bad. These may be in the reverse order.

Example:

Machines

<table>
<thead>
<tr>
<th>good</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>bad</th>
</tr>
</thead>
</table>

or

bad 1 2 3 4 5 6 good

You may at times feel that you should put your mark between two spaces. In this situation choose the space that most nearly describes your reaction and mark this space.

Six pairs of opposing adjectives are included in each item. Please react to the underlined word or words at the beginning of each item six times.

Work at a fairly fast rate. Your first reactions are usually the best. On the other hand, please do not be careless because we want your true reactions.

Copy the number found at the top of this sheet onto the top of your answer sheet. This number is for your use only. Remember it, if you want to compare your score with other students completing this exercise.

Please fill in the following blanks at the top of the answer sheet: age, major, grade or class (Fr., So., Jr., or Sr.).
### Blood

1. weak 1 2 3 4 5 6 strong
2. active 1 2 3 4 5 6 passive
3. bad 1 2 3 4 5 6 good
4. ugly 1 2 3 4 5 6 beautiful
5. slow 1 2 3 4 5 6 fast
6. small 1 2 3 4 5 6 large

### Teachers

7. weak 1 2 3 4 5 6 strong
8. small 1 2 3 4 5 6 large
9. slow 1 2 3 4 5 6 fast
10. bad 1 2 3 4 5 6 good
11. passive 1 2 3 4 5 6 active
12. ugly 1 2 3 4 5 6 beautiful

### Car races

13. fast 1 2 3 4 5 6 slow
14. good 1 2 3 4 5 6 bad
15. beautiful 1 2 3 4 5 6 ugly
16. weak 1 2 3 4 5 6 strong
17. active 1 2 3 4 5 6 passive
18. large 1 2 3 4 5 6 small
War

19. bad 1 2 3 4 5 6 good
20. beautiful 1 2 3 4 5 6 ugly
21. large 1 2 3 4 5 6 small
22. slow 1 2 3 4 5 6 fast
23. strong 1 2 3 4 5 6 weak
24. active 1 2 3 4 5 6 passive

Me

25. large 1 2 3 4 5 6 small
26. bad 1 2 3 4 5 6 good
27. slow 1 2 3 4 5 6 fast
28. beautiful 1 2 3 4 5 6 ugly
29. weak 1 2 3 4 5 6 strong
30. passive 1 2 3 4 5 6 active

Fire

31. strong 1 2 3 4 5 6 weak
32. beautiful 1 2 3 4 5 6 ugly
33. large 1 2 3 4 5 6 small
34. passive 1 2 3 4 5 6 active
35. fast 1 2 3 4 5 6 slow
36. bad 1 2 3 4 5 6 good
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revolt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>passive</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>38.</td>
<td>small</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>39.</td>
<td>ugly</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>40.</td>
<td>weak</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>41.</td>
<td>fast</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>42.</td>
<td>good</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dope</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.</td>
<td>active</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>44.</td>
<td>bad</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>45.</td>
<td>large</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>46.</td>
<td>beautiful</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>47.</td>
<td>strong</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>48.</td>
<td>fast</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49.</td>
<td>ugly</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>50.</td>
<td>bad</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>51.</td>
<td>fast</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>52.</td>
<td>strong</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>53.</td>
<td>active</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>54.</td>
<td>small</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Violence
55. slow 1 2 3 4 5 6 fast
56. active 1 2 3 4 5 6 passive
57. weak 1 2 3 4 5 6 strong
58. ugly 1 2 3 4 5 6 beautiful
59. bad 1 2 3 4 5 6 good
60. large 1 2 3 4 5 6 small

Please answer the following questions. The value of this exercise depends upon your truthfulness and care in answering these questions.

Accident Survey

Your involvement in accidents during the last 3 years.
Number of accidental injuries to yourself requiring a doctor's treatment.
61. 0 1 2 3 4 5 6 7 8 9 or more
Number of the above accidents in which you were at fault.
62. 0 1 2 3 4 5 6 7 8 9 or more
Number of accidental injuries to yourself requiring only first aid.
63. 0 1 2 3 4 5 6 7 8 9 or more
Number of the above accidents in which you were at fault.
64. 0 1 2 3 4 5 6 7 8 9 or more
Number of accidents causing only damaged property.
65. 0 1 2 3 4 5 6 7 8 9 or more
Number of the above accidents in which you were at fault.
66. 0 1 2 3 4 5 6 7 8 9 or more
Number of accidents causing injuries to other people.
67. 0 1 2 3 4 5 6 7 8 9 or more
Number of the above accidents in which you were at fault.
68. 0 1 2 3 4 5 6 7 8 9 or more
APPENDIX III: SEMANTIC SCALE OF ATTITUDES
The purpose of this exercise is to determine the relationships between reactions to certain stimuli.

You are to give your reaction to the underlined word at the beginning of each item by marking one space between two opposing adjectives. For example you will have several spaces for your reaction between the adjectives good and bad.

Example:

Machines

good ___: ___: ___: ___: ___: ___: ___: ___ bad.

or

bad ___: ___: ___: ___: ___: ___: ___: ___ ___ good

Please put your X in one of the spaces provided. You may at times feel that you should put your mark between two spaces. In this situation choose the space that most nearly describes your reaction and mark that space.

Sixteen pairs of opposing adjectives are included in each item. Please react to the underlined word at the beginning of each item sixteen times.

Work at a fairly fast rate. Your first reactions are usually the best. On the other hand, please do not be careless because we want your true reaction.
1. War

<table>
<thead>
<tr>
<th>Good</th>
<th>Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tame</td>
<td>Wild</td>
</tr>
<tr>
<td>Dull</td>
<td>Sharp</td>
</tr>
<tr>
<td>Drunk</td>
<td>Sober</td>
</tr>
<tr>
<td>Fast</td>
<td>Slow</td>
</tr>
<tr>
<td>Dirty</td>
<td>Clean</td>
</tr>
<tr>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Ugly</td>
<td>Beautiful</td>
</tr>
<tr>
<td>Rugged</td>
<td>Delicate</td>
</tr>
<tr>
<td>Hot</td>
<td>Cold</td>
</tr>
<tr>
<td>Light</td>
<td>Heavy</td>
</tr>
<tr>
<td>Fair</td>
<td>Unfair</td>
</tr>
<tr>
<td>Insane</td>
<td>Sane</td>
</tr>
<tr>
<td>Passive</td>
<td>Active</td>
</tr>
<tr>
<td>Weak</td>
<td>Strong</td>
</tr>
<tr>
<td>Cruel</td>
<td>Kind</td>
</tr>
</tbody>
</table>
2. Iron

unfair:__:__:__:__:_:_:_:_:_fair
delicate:__:__:__:__:__:_:_:_:_:_rugged
dsane:__:__:__:__:__:_:_:_:_:_insane
slow:__:__:__:__:__:__:_:_:_:fast
heavy:__:__:__:__:__:_:_:_:_:_light
bad:__:__:__:__:__:_:_:_:_:_good
cold:__:__:__:__:__:_:_:_:_:_hot
clean:__:__:__:__:__:_:_:_:_:_dirty
active:__:__:__:__:__:_:_:_:_:_passive
sober:__:__:__:__:__:_:_:_:_:_drunk
weak:__:__:__:__:__:_:_:_:_:_strong
sharp:__:__:__:__:__:_:_:_:_:_dull
cruel:__:__:__:__:__:_:_:_:_:_kind
wild:__:__:__:__:__:_:_:_:_:_tame
small:__:__:__:__:__:_:_:_:_:_large
beautiful:__:__:__:__:__:_:_:_:_:_ugly
3. Love

wild________tame
dirty________clean
sharp________dull
kind________cruel
heavy________light
sober________drunk
rugged________delicate
good________bad
slow________fast
unfair________fair
cold________hot
strong________weak
ugly________beautiful
passive________active
large________small
sane________insane
4. **Death**

<table>
<thead>
<tr>
<th>hot</th>
<th>cold</th>
</tr>
</thead>
<tbody>
<tr>
<td>dirty</td>
<td>clean</td>
</tr>
<tr>
<td>insane</td>
<td>sane</td>
</tr>
<tr>
<td>good</td>
<td>bad</td>
</tr>
<tr>
<td>tame</td>
<td>wild</td>
</tr>
<tr>
<td>small</td>
<td>large</td>
</tr>
<tr>
<td>fast</td>
<td>slow</td>
</tr>
<tr>
<td>beautiful</td>
<td>ugly</td>
</tr>
<tr>
<td>active</td>
<td>passive</td>
</tr>
<tr>
<td>cruel</td>
<td>kind</td>
</tr>
<tr>
<td>weak</td>
<td>strong</td>
</tr>
<tr>
<td>fair</td>
<td>unfair</td>
</tr>
<tr>
<td>delicate</td>
<td>rugged</td>
</tr>
<tr>
<td>sober</td>
<td>drunk</td>
</tr>
<tr>
<td>dull</td>
<td>sharp</td>
</tr>
<tr>
<td>light</td>
<td>heavy</td>
</tr>
</tbody>
</table>
5. Violence

passive:__:__:__:__:__:__:_:_active

good:__:__:__:__:__:__:_:_bad

insane:__:__:__:__:__:_:_:_sane

sharp:__:__:__:__:__:_:_:_dull

kind:__:__:__:__:__:__:_:_cruel

wild:__:__:__:__:__:_:_:_tame

strong:__:__:__:__:__:_:_:_weak

unfair:__:__:__:__:__:_:_:_fair

rugged:__:__:__:__:__:_:_:_delicate

cold:__:__:__:__:__:_:_:_hot

clean:__:__:__:__:__:_:_:_dirty

heavy:__:__:__:__:__:_:_:_light

drunk:__:__:__:__:__:_:_:_sober

ugly:__:__:__:__:__:_:_:_beautiful

slow:__:__:__:__:__:_:_:_fast

large:__:__:__:__:__:_:_:_small
6. Me

cruel:__:__:__:__.__:__:__:_kind
sane:__:__:__:__:__:__:__:__:insane
small:__:__:__:__:__:__:__:__:large
tame:__:__:__:__:__:__:__:__:wild
dull:__:__:__:__:__:__:__:__:sharp
dirty:__:__:__:__:__:__:__:__:clean
sober:__:__:__:__:__:__:__:__:drunk
fast:__:__:__:__:__:__:__:__:slow
bad:__:__:__:__:__:__:__:__:good
weak:__:__:__:__:__:__:__:__:strong
active:__:__:__:__:__:__:__:__:passive
beautiful:__:__:__:__:__:__:__:__:ugly
delicate:__:__:__:__:__:__:__:__:rugged
hot:__:__:__:__:__:__:__:__:cold
light:__:__:__:__:__:__:__:__:heavy
fair:__:__:__:__:__:__:__:__:unfair
APPENDIX IV: ACCIDENT SURVEY
Accident Survey

Your Name________________________

Please answer the following questions concerning your involvement in all kinds of accidents during the last 3 years. Please put a number or a zero in each blank.

1. Number of accidental injuries to yourself requiring a doctor's treatment.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

2. Number of the above accidents in which you were at fault.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

3. Number of accidental injuries to yourself requiring only first aid.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

4. Number of the above accidents in which you were at fault.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

5. Number of accidents causing only damage to property.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

6. Number of the above accidents in which you were at fault.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

7. Number of accidents causing injuries to other people.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____

8. Number of the above accidents in which you were at fault.
   Traffic____, Farm Shop____, Machinery____, Livestock____,
   School____, Other____