ABSTRACT OF THESIS

SCORE CARD FOR SAFETY FACTORS IN SCHOOL MACHINE SHOP

Submitted by

Russell A. Gebby

In partial fulfillment of the requirements

for the Degree of Master of Education

Colorado

Agricultural and Mechanical College

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ABSTRACT

Introduction

The industrial arts shop teacher is probably in a more advantageous position to teach good, sound, practical safety practices than is any other person in the field of education. He must teach the safe use of every machine and tool in the shop. His motto is always, "The right way is the safe way." The shop teacher helps to make his students safety conscious by insisting that they use correct methods and the guards provided on the machines in order to avoid accidents. By using guarded machinery the student learns first that equipment can be guarded satisfactorily, and second that properly guarded machines can be operated efficiently. Furthermore, the well-trained student will be more likely, as an employee to use guards on machinery and will be more receptive to safety training from his foreman.

A school which neglects to develop attitudes and habits of safety in its students is failing in a major obligation to the student, to industry, and to society. The ideal shop program not only includes instruction of the individual in the attitude, knowledge, and skill to avoid accidents, but also must provide a safe environment.

There is need for continued study of safety conditions and their application to the environment of school

machine shops. Thus it became the purpose of this study to determine desirable safety factors in school machine shops.

Problem

What would be the design of a score card for evaluating the physical factors to be considered in attaining a high degree of safety in high school machine shops?

Problem analysis.--The following questions were considered in the analysis of the problem:

1. At what machines are accidents most prevalent in school machine shops?
2. What conditions of room and equipment relative to safety and safety devices are most frequently found in school machine shops?
3. What are the relationships between shop conditions as determined by the score card and accidents in the shop?
4. How do Class B school machine shops in lower Michigan compare according to the score card?

Delimitations.--This study was limited to development and analysis of the score card as applied to conditions of room and power equipment in public school machine shops in Class B high schools in lower Michigan exclusive of Detroit. This study did not include safety instruction.

Methods and materials

The first task undertaken in solving this problem was to develop a score card. This score card was made from

items secured from reference to the literature. The form of the score card was patterned after Strayer and Englehardt's score card for city school buildings. Each item on the card was assigned an arbitrary scale, making a total value of 500 points for a perfect score.

An accident report was developed and sent to the cooperating instructors, in order that a uniform record could be kept. This was constructed in such a manner that it would help instructors keep a record of individual accidents, and help in the analysis of conditions under which the accident occurred.

In September, 1947, letters were sent to instructors of machine shops in Class B public high schools in lower Michigan. They were asked to cooperate in the study of causes of accidents in machine shops by keeping an accurate record of accidents that occurred in their shops over a six-month period: October 1, 1947, to April 1, 1948. Each letter included a self-addressed, stamped postal card for convenient reply.

Favorable replies were received from 28 machine shop instructors indicating they would be willing to cooperate with the study.

Letters were sent to the 28 cooperating schools thanking them for their interest and assistance. The number of accident reports that each estimated as necessary for the study were enclosed in this letter.

The latter part of March, 1948, letters were sent to the cooperating instructors stating the approximate time

at which the writer would visit their schools.

The superintendent of schools of Niles, Michigan, cooperated by permitting the first visit to inspect shops in various schools Thursday, March 17, instead of attending county institute. He also permitted inspection and visitation the following day, Friday, March 18. This made a three-day week-end which made it possible to visit 17 schools in the east and north-central part of the state. The remainder of the shops were contacted during evenings or on week-ends, depending on the distance necessary to drive to get to the school. During these visits accident records available were collected and machine shops were inspected and scored using the score card developed for this purpose.

To have a more accurate study, results from four of the score cards filled on cooperating schools were eliminated. One was eliminated because the instructor had misinterpreted the term "machine shop" to mean use of machines in connection with woodshop. In two cases machine shop work was considered in relation to general shop and therefore would not give reliable results. The other elimination was a farm shop where only a minor amount of machine shop work was carried on. Elimination of four samples left a total of 24 cooperating Class B high schools which were the source of data upon which this study was based.

Analysis of data

Training in the crafts is now recognized as the responsibility of the public schools. Such training can be

effective only when it includes training in safe work practices. Therefore, no person's training is complete which has not provided for the integration of safe work practices with experiences.

Sensing the need for material that will assist teachers in the execution of a program to include safety, this score card was formed and this study conducted. The analysis of this study is given in the following pages.

Of a total of 136 accidents the operation of the metal lathe resulted in 69 accidents, or 50.7 per cent of the total number of accidents reported. None of the accidents could be classified as serious. Most of the accidents resulted in minor cuts or scratches. All but two schools reported accidents on the lathe, revealing a wide spread through the samples shown.

Operation of the drill press was responsible for 24 of the 136 accidents, or 17.6 per cent of a total number.

Ten accidents occurred while operating the grinder, equaling 7.3 per cent of the total number of accidents reported. This machine was responsible for a broken finger, the most serious accident reported.

The operation of the do-all saw, the shaper, and hand filing each resulted in four accidents. Thus, the operation of each machine resulted in 2.9 per cent of the accidents reported.

The use of the backsaw and the operation of hand tapping each resulted in three minor cuts or burns on the

operators' hands, or 2.2 per cent eachof all accidents.

The use of the forge and the screwdriver resulted in two minor accidents each, or 1.5 per cent each of all accidents.

The operation of the milling machine, welding equipment, and use of the wrenches each resulted in one minor accident or .8 per cent of the total for each type of equipment.

The range of scores on the 24 shops visited and checked, according to this score card, was 185 points. High score was 455 points; low score was 270 points.

Power equipment was scored on seven items with a total of 130 points for a perfect score. Ten shops of the 24 had a perfect score under this heading.

The recommended illumination for general work in machine shop is 30 to 40 foot-candles, and for close work 50 to 100 foot-candles. According to this recommendation, the illumination of the various shops was the most deficient item of any checked. Every shop was deficient, either in general lighting or lighting for close work, and many were deficient in both.

Electrical equipment was scored on the basis of six items with a total of 80 points for a perfect score. Of the 24 shops visited and scored, 11 were perfect in this item.

Room facilities for the various shops visited were checked on eight items totaling 65 points for a perfect

score. Two shops of the 24 rated a perfect score. Sound-proofing was found on ceilings in four shops; one additional shop had approximately one half of the ceiling sound-proofed.

The 24 shops were checked on six items relative to facilities for housekeeping, based on a perfect score of 80 points. Three shops rated perfect on this basis.

Facilities for body protection of students in the 24 machine shops covered by this study were scored on five items totaling 65 points. Of the 24 shops checked, 19 scored 65 points, or a perfect scoreing.

Six miscellaneous items were checked and scored in the 24 shops visited for this study. Color dynamics painting was used in three of the shops.

Discussion

Application of the newer ideas of illumination, sound-proofing, and color dynamic paint were rarely found.

Adequate light is only one phase of proper light planning. The avoidance of glare, heavy shadows, and provision for proper diffusion are to be considered. The colors used on walls, machines, and floors also constitute a safety factor. The application of color dynamics is helpful and effective in giving desirable color contrasts which lessen nervous fatigue, increase efficiency, and call attention to danger points.

Unnecessary noise from machines can be greatly reduced by keeping them in repair. Insulating the upper part of the shop will help absorb the natural noise.

It appears probable that if school authorities were conscious of the efficiency that could be derived by providing adequate light including color dynamics many would be willing to cooperate. The cost of applying the right kind of paint properly would be no more than that of the ineffective application so commonly evident.

Employment of an illumination engineer appears advisable when planning a shop. His fee would be money well spent.

The relationship between shop conditions as determined by the score card and accidents in the shop were consistent in many cases, as was shown in Figure 11.

Of 24 shops visited and checked in this study, 16 having scores of 370 points or above had eight or less accidents. Three shops having low scores had a comparatively high number of accidents. The records of these 19 shops over a six-month period substantiates the validity of the score card developed for this study. Of the remaining five shops, three had high scores and also a high frequency of accidents. This may have been due to inefficient instruction and management. A careless workman with the best of equipment and conditions can be a hazard to himself and his fellow students. A study of the accident situation gives the feeling that a great many people have never learned to do things correctly or safely. Students do not know how to do things; or they fail to do them as well as they know how. In either case, the result may be an accident.

Two shops had low scores according to the score card and also a low accident frequency. This was probably due to efficient instruction and management on the part of the instructor. A student properly instructed can work safely although probably not as efficiently as if he were in better surroundings.

In this study all scratches and cuts regardless of how slight were recorded as accidents. A slight cut or scratch under slightly different circumstances might have been a serious accident. An accident that has occurred, regardless of how slight or serious, is a symptom of some underlying cause. The result of an accident is not nearly as important as the unsafe practice which may continue to bring more of the same result.

As previously revealed, inspections primarily lead to the discovery of unsafe practices.

Results of the study appear to justify the use of a score card as designed for the solution of this problem. Many unsafe practices and procedures leading to numerous minor accidents and potentially to those of a much more serious nature were revealed. It seems evident that the score card may be helpful in pointing out the deficiencies in school machine shops, which if corrected may prevent unnecessary hazards to pupils.

T H E S I S

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COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

August 10 1948

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY RUSSELL A. GEBBY

ENTITLED SCORE CARD FOR SAFETY FACTORS IN SCHOOL MACHINE SHOP

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

MAJORING IN INDUSTRIAL ARTS EDUCATION

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Permission to publish this thesis or any part of it must be obtained from the Dean of the Graduate School.

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To the instructors of the school machine shops included in this study for their willing cooperation and helpfulness.

The writer also wishes to recognize the great debt he owes his wife for her constant encouragement, patience, understanding, and diligent efforts to make a difficult and sometimes monotonous task more pleasant and worth-while.

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Chapter I

INTRODUCTION

Doing a job the right way means doing it accurately with a minimum loss of time, a minimum waste of motion and materials, and a minimum drain upon the energies of the person doing the job.

The shop teacher is, perhaps, in a better position to teach good, sound, practical safety than anyone else in the field of education. He must teach the safe use of every machine and every tool in the shop. His motto is always, "The right way is the safe way." The shop teacher helps to make his students safety conscious by insisting that they use correct methods and that they use guards provided on the machines in order to avoid accidents. By using guarded machinery, the student learns, first, that equipment can be guarded satisfactorily, and, second, that properly guarded machines can be efficiently operated. Furthermore, the well-trained student will be more likely, as an employee, to use guards on machinery and will be more receptive to safety training from his foreman.

It is just as important for a student to learn safe practices as it is for him to learn how to make a certain part or do a particular job. Safety training, as

a part of machine shop training and a part of education, leads students to the safe way of living. Failure to take safety measures is expensive to the students, to the community, and to the nation.

During World War II there were more persons killed by accidents on the home front than were killed on the battle front. This is a heavy price to pay, especially when accidents do not have to occur. Some large plants have proved that they can cut down their accidents more than 90 per cent through the use of proper safeguards, care, and safety methods.

A school which neglects to develop attitudes and habits of safety in its students is failing in a major obligation to the student, to industry, and to society. The ideal school shop program not only includes instruction of the individual in the attitude, knowledge, and skill to avoid accidents, but also must provide a safe environment.

There is, then, a need for a study of safety conditions or environment in school machine shops. This study has been undertaken as a means of determining desirable safety factors in school machine shops.

stop

Problem

What would be the design of a score card for evaluating the physical factors to be considered in attaining a high degree of safety in high school machine shops?

Problem analysis.--The following questions must be considered in the analysis of the problem:

1. At what machines are accidents most prevalent in school machine shops?

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4. How do Class B school machine shops in lower Michigan compare according to the score card?

Delimitations.--This study is limited to development and analysis of the score card as applied to conditions of room and power equipment in public school machine shops in Class B high schools in lower Michigan, exclusive of Detroit. This study does not include safety instruction.

Chapter II

REVIEW OF LITERATURE

Various articles have been written with regard to safety rules, instruction, and placing of guards on various machines in school shops. Some of these studies included suggestions as to proper arrangement of equipment and ideal working conditions. Since this study considers the construction and validity of a score card, these related works have been reviewed.

New York (State) University (8), 1916, issued a bulletin giving rules for guarding various machines operated in industrial arts departments.

Rules for Guarding Drill. (belt driven)

1. Driving belts should be guarded to height of six feet from floor.

2. Tight and loose pulley belt shifter should extend through guard and be equipped with automatic locking device.

3. Cone pulley belt shifter should be applied.

4. All power-driven gears should be completely enclosed.

5. Spindle shaft should be guarded as shown on plate.

6. Safety drill sockets should be used.

7. Table should be equipped with drill press vise, or clamps, or other provisions to be made properly to secure stock when drilling.

Rules for Guarding Planer. (belt driven)

1. Driving belts should be guarded to a height of six feet from the floor.

2. Table should have 18" clearance from all stationary objects when in extreme position. Otherwise space to be permanently and effectively barred against passage.

Rules for Guarding Shaper. (belt driven)

1. Driving belts should be guarded to a height of six feet from the floor.

2. Ram to have 18" clearance from all stationary objects when in extreme position. Otherwise space to be permanently and effectively barred against passage. (8:89)

Strayer and Engelhardt published a "Score Card for City School Buildings" (11), 1920. This form has been used in constructing the score card for evaluating the machine shops checked in this study (see Appendix A.) A portion of the items listed on this score card follows:

III. Service Systems.

A. Heating and Ventilation.

1. Kind.
2. Installation.
3. Air supply.
4. Fans and motors.
5. Distribution.
6. Temperature control.
7. Special provisions.

B. Fire Protection System.

1. Apparatus.
2. Fireproofness.
3. Escapes.

4. Electrical wiring.
5. Firedoors and partitions.
6. Exit lights and signs.

C. Cleaning System.

1. Kind.
2. Installation.
3. Efficiency.

D. Artificial Lighting System.

1. Gas and Electricity.
2. Outlets and adjustment.
3. Illumination.
4. Methods and fixtures.

E. Electric Service System.

1. Clock.
2. Bell.
3. Telephone.

F. Water Supply System.

1. Drinking.
2. Washing.
3. Bathing.
4. Hot and cold. (11:338-9)

Humble (5), 1937, made a study of "Practices and Provisions for Protecting Pupils in School Shops" and made the following recommendations:

Specifications for a Good Guard.

1. It must reduce the chance for injury to the lowest practicable minimum consistent with operating.

2. It must be substantially constructed of material in workmanlike fashion.

3. It must provide for oiling and for making repairs and changes with a minimum of delay.

4. If possible, it should be automatic in action.

5. If possible, the removal or opening of the guard should shut off the power.

6. The guard should fit into the machine design and must be kept in repair and in place.

Arrangement of Machines.

1. Safety lines around machines.

2. Illumination 50 to 100 foot candles.

3. Individual lights on machines.

The factor of arrangement of the shop is of vital importance in promoting safety. The chance for injury to pupils engaged in school shop activities may be reduced through:

1. The correct placement of machines.

2. Providing adequate illumination.

3. Insuring sufficient ventilation.

4. Selecting desirable floor coverings.

5. Indicating danger areas.

6. Arranging special rooms or compartments for the performance of especially dangerous operations. (5:12)

Hall (3), 1940, listed electrical hazards prevailing in industrial arts shops as follows:

1. Are machines individual motor driven?

2. Are switches covered?

3. Can switches be locked?

4. Are locks used?

5. Are fuse boxes covered?

6. Are badly worn extension cords in use?

7. Are machines over 150 volts grounded?

8. Is there a master switch in use? (3:39)

Wilder (13), 1940, published an article giving safety rules for safe use of machine shop equipment. Many of these rules were similar to the ones published by New York (State) University referred to previously. However, a few new ones are given.

Grinder.

1. Provide metal safety collars on either side of grinding wheels with some kind of cushion.

Engine Lathes.

1. All gears should be properly covered. (13:276)

The Industrial Arts and Vocational Education Magazine published an article, "Safety in School Shops," written by Van Duzee (12), 1941, discussing shop conditions and effectiveness of safety instruction in training shop students.

> Shop safety is dependent to a great extent on two factors. One is shop conditions and the other is effectiveness of instruction. (12:267-70)

The National Safety Council (7), 1941, published a bulletin, Inspection of Shops and Laboratories. This bulletin pointed out the necessity of regular inspections of shop and laboratories to maintain safe environments for both students and employees. The safety council maintained that inspections primarily lead to the discovery of unsafe physical conditions and unsafe practices. A partial check

list for shops and laboratories was suggested.

A partial check list for shop inspections may include:

1. Hand tools--use, condition, storage.
2. Portable electric tools.
3. Equipment for head and eye protection.
4. Protective clothing.
5. Handling materials by hand and mechanically.
6. Storage of materials.
7. Electrical hazards.
8. Ladders.
9. Welding and cutting equipment.
10. Pressure vessels.
11. Sanitary facilities.
12. Drinking water.
13. Guarding of mechanical power and transmission apparatus.
14. Guarding at points of operation on machine tools, etc.
15. Housekeeping.
16. Lighting.
17. Ventilation.
18. Special equipment.
19. Occupational disease hazards.
20. Scaffold and construction equipment.

(7:42)

Schmidt (9), 1943, wrote:

> The matter of safety education is at last receiving deserved attention at the hands of school authorities in an increasing ratio. (9:135)

He further stated that 36 per cent of accidents to school children occurred in school and 19 per cent within the buildings themselves. Of the latter, gymnasiums, corridors, and stairs were the scenes of the greatest number of accidents. Classrooms and shops just about split even with about 14 to 15 per cent each. This study revealed that very few accidents are due to defective machinery or lack of instruction, but there is still plenty of room for improvement, and the school shop is no exception. (9:17-19)

Hall (4), 1944, stated that accidents to pupils in the public schools caused a total absence of 2,160,000 pupil-days during one year. In one state, one accident to every three students took place in one year. The National Safety Council, which was quoted in this article, said:

> The influence of the vocational shop and the gymnasium on the accident rate is indicated by the sudden jump in the rate from the sixth to the seventh grade, which rose from 1.5 to 3.5. Further advance to 4.7 in the tenth grade and 5.4 in the eleventh indicates an increase in exposure to accidents. (4:125)

Sotzin (10), 1944, published a suggested score sheet for checking the general physical conditions of a school plant. This article dealt mostly with general items of the shop such as location, construction, heating, venti-

lation, noise (sound-proofing), safety measures, storage, display and bulletin boards, blackboard facilities, and so forth. (10:301)

Dunne (1), 1944, wrote an article, "What Every New Worker Should Know," in which he stated,"Every new worker should know that the skill of doing his job includes doing it safely." (1:318) The worker should be taught there is one way to operate a machine skillfully and that is safely. A few safety devices were suggested as being helpful in preventing accidents, that is, safety goggles, respirators, hard-toed shoes, hair protection for girls, and leg shields for forge shop.

Every new worker should know:

1. That the skill of doing his job includes doing it safely.
2. That he can't "beat the guard."
3. About the danger of infection. (1:318)

Vocational schools should introduce students to personal safety equipment, and vocational students should be given responsibilities on the safety committee.

Murri (6), 1945, stated that it is the responsibility of every school administrator, teacher, and especially the shop teacher, to have learners work in safety. Accidents are caused not only by human behavior, termed carelessness, but also by an unsafe environment. In this article, he listed several items that should be considered in planning a new building, in observance of safety pre-

cautions.

1. All exit doors should swing out.

2. Large shops should have at least two exit doors.

3. Window sill height should be no less than 40 inches.

4. Provide proper heating and ventilation.

5. Have only approved electric wiring controls.

6. Order only substantial and safe machinery and equipment.

7. Have proper spacing between benches, machinery and equipment, usually not less than four feet.

8. See that aisle space is ample, usually not less than four feet.

9. Provide proper illumination.

10. See that workbenches are placed correctly with reference to light.

11. Locate fire extinguishers in appropriate places.

12. Install a first-aid cabinet.

Electrical

1. New wiring should be in rigid conduit; connections to motors may be made with short lengths of flexible conduit.

2. Motors, switches and starting equipment should be properly encased.

3. Switch board--dead front type (no exposed live parts) or rubber mat in front and protective railing.

4. Following foot-candles are recommended:

Shops (general work)	30 fc.

Shops (close work)	100 fc.
Drawing rooms	50 fc.
Sewing rooms	100 fc.
Laboratories (general work)	30 fc.
Laboratories (close work)	50 fc.
Corridors and stairways	5 fc.
Class and study rooms	30 fc.
Lecture rooms (general)	20 fc. (6:131)

Ericson (2), 1946, listed 13 conditions of room and equipment which may cause accidents:

1. Low ceilings.

2. Poor light (natural and artificial).

3. Bad location of machines, causing interference between operators.

4. Failure to mark safety zones around hazardous equipment.

5. Unguarded belts.

6. Unguarded pulleys, gear and grinders.

7. Dull tools or machines.

8. Unguarded switches.

9. Waste and scrap stock on the floor.

10. Wrong type of clothing worn.

11. Inadequately protected stairways and ladders leading to balconies and platforms.

12. Poorly constructed stock rack holding steel and other supplies.

13. Lack of ventilation in rooms where forging, metal casting or similar work is done. (2:163)

Summary and implications

In the foregoing references, each of the authors has emphasized the importance of ideal shop conditions as

being essential to safety for the students in schools and workers in industry.

Special emphasis has been placed on condition of the electrical equipment such as safety devices on the power units, adequate illumination, and approved controls.

Physical conditions of the room and facilities for good housekeeping are stressed as important to safety.

Proper body protection for hazardous work has been acknowledged as being important.

With these factors in mind, it was necessary to develop a score card by which to evaluate the safety factors of the individual machine shops visited and scored.

Chapter III

METHODS AND MATERIALS

In conducting a study to determine the design of a score card for evaluating the physical factors to be considered in attaining a high degree of safety in Class B high school machine shops, 28 Class B high schools were visited and evaluated.

The first task undertaken in solving this problem was to develop a score card 1/. This score card was made up in part from items secured from the following sources: Ericson (2:106) listed 13 conditions of room and equipment which may cause accidents; Murri (6:131) listed 12 items to be considered by the planner of the school which would furnish a safe environment for the student in the shop. He also listed four suggestions to be considered under the heading electrical, including the amount of foot-candle illumination recommended for various types of work; Sotzin (10:301) gave a suggested score sheet for checking the general physical conditions of a school plant, such as location of a shop, construction, heating, ventilation, noise (sound-proofing), storage, and so forth. Other items were added from personal experience to make a total of 40

1/ See Appendix A.

items on the score card.

The form of the score card was patterned after Strayer and Englehard's (11:338-9) score card for city school buildings. Each item on the score card was assigned an arbitrary scale, making a total value for a perfect score of 500 points.

After the score card was developed, it became apparent that it would be necessary to furnish the cooperating schools with a uniform accident report 2/ to use in keeping a record of accidents. This report was constructed in such a way that it would help the instructor keep a record of individual accidents and help him analyze conditions under which the accidents occurred.

In September, 1947, letters 3/ were sent to instructors of machine shops in Class B public high schools in lower Michigan. They were asked to cooperate in the study of causes of accidents in machine shops by keeping an accurate record of accidents that occurred in their shops over a six-month period, October 1, 1947, to April 1, 1948. Each letter included a self-addressed, stamped postal card 4/ for convenient reply. To encourage a higher percentage of replies, the correspondence side of the card was printed in form suitable for brief reply. The instructor was asked to

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2/ See Appendix B.

3/ See Appendix C.

4/ See Appendix D.

indicate the estimated number of accident reports needed and to sign his name and the name and address of his school. In addition, offer was made to send the instructor a copy of the completed score card in exchange for his cooperation.

A list of Class B public high schools was obtained from the Michigan High School Athletic Association Bulletin, December, 1946, Volume XXIII, Number 5. Reference was made to the Michigan Industrial Education Society Year Book for 1946-47 to obtain names of as many machine shop instructors as possible.

Out of the 66 Class B public high schools in lower Michigan, exclusive of Detroit, favorable replies were received from 28 machine shop instructors, indicating that they would be willing to cooperate with the study. Replies were received from 18 additional instructors stating that they did not have a machine shop in their school. Of the 20 remaining, nine were found not to have machine shops, leaving 11 Class B public schools originally contacted for which no information was available.

Letters 5/ were sent to the 28 cooperating schools thanking them for their cooperation. The number of accident reports that each estimated as necessary for the study were enclosed in this letter.

In the latter part of March, 1948, letters 6/

5/ See Appendix E.

6/ See Appendix F.

were sent to the cooperating instructors stating the approximate time at which the writer would visit their schools. In case the instructor could not be present on this date, he was asked to name an alternate who would make it possible to get into the machine shop. In the majority of cases, contact was made the first time. In one case, success was delayed until the third attempt.

The first series of inspections of school machine shops was made over the week-end of March 17, 18, and 19, 1948, which made it possible to visit 17 schools in the east and north-central part of the state. The remainder of the schools to be visited were contacted during evenings or on week-ends. During these visits, accident records were collected and checked and machine shops were inspected. In the process, the score card developed for this purpose was applied.

The Board of Public Works, Niles, Michigan, cooperated by loaning a light meter to use for checking foot-candle illumination in the machine shops on all of these visits.

To have a more reliable study, results from four of the score cards filled on cooperating schools were eliminated. One was eliminated because the instructor had misinterpreted the term "machine shop" to mean use of machines in connection with woodshop. In two cases, machine shop work was considered in relation to general shop and

therefore could not give reliable results. The other elimination was a farm shop wherein only a minor amount of machine shop work was carried on. The elimination of these four schools left a total of 24 cooperating Class B high schools which were the sources of data upon which this study has been based.

Chapter IV

ANALYSIS OF DATA

Training in the crafts is now recognized as a responsibility of the public schools. Such training can be effective only when it includes training in safe work practices. Therefore, no training program is complete which has not provided for the integration of safe practices with experiences.

Increasing numbers of shops and growing complexity of shop procedures have made imperative the study of safety practices. To facilitate such studies, some type of rating instrument was necessary. Thus recognition of the need for material that would assist teachers in the execution of a program to include training in safety practices led to the development and application of a score card. The analysis of the results of this study is given on the following pages.

Machines on which accidents occurred

From a total of 136 accidents, as shown in Figure 1, the operation of the metal lathe resulted in 69 accidents, or 50.7 per cent of the total reported. However, none of the accidents could be classified as serious. Most

of the accidents resulted in minor cuts or scratches from steel shavings or from bumping the cutter bit. Installing or removing chucks on the lathe resulted in a number of bruised fingers. All but two schools reported accidents on the lathe, revealing the general distribution of accidents on this machine throughout the samples shown. One shop reporting the greatest number of accidents on the lathe reported the greatest total number of accidents.

Operation of the drill press, as shown in Figure 1, was responsible for 24 of 136 accidents, or 17.6 per cent of the total number. These accidents were of minor nature such as cuts on fingers or knuckles resulting from revolving burrs hitting the operator's hands. Two accidents occurred from objects breaking loose from the drill press vise and revolving against the operator's hands, causing deep cuts on thumb and first finger of left hand.

Ten accidents occurred while operating the grinder, equaling 7.3 per cent of the total, as shown on Figure 1. The operation of this machine resulted in a broken finger, the most serious accident reported. The remaining nine injuries were minor in nature, such as cuts on fingers or hands. A few students got particles in their eyes while operating the grinding machines. These were removed by the instructor without injury.

Handling of materials resulted in eight minor injuries, or 5.9 per cent of all accidents, as shown in

FREQUENCY OF ACCIDENTS OCCURRING IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

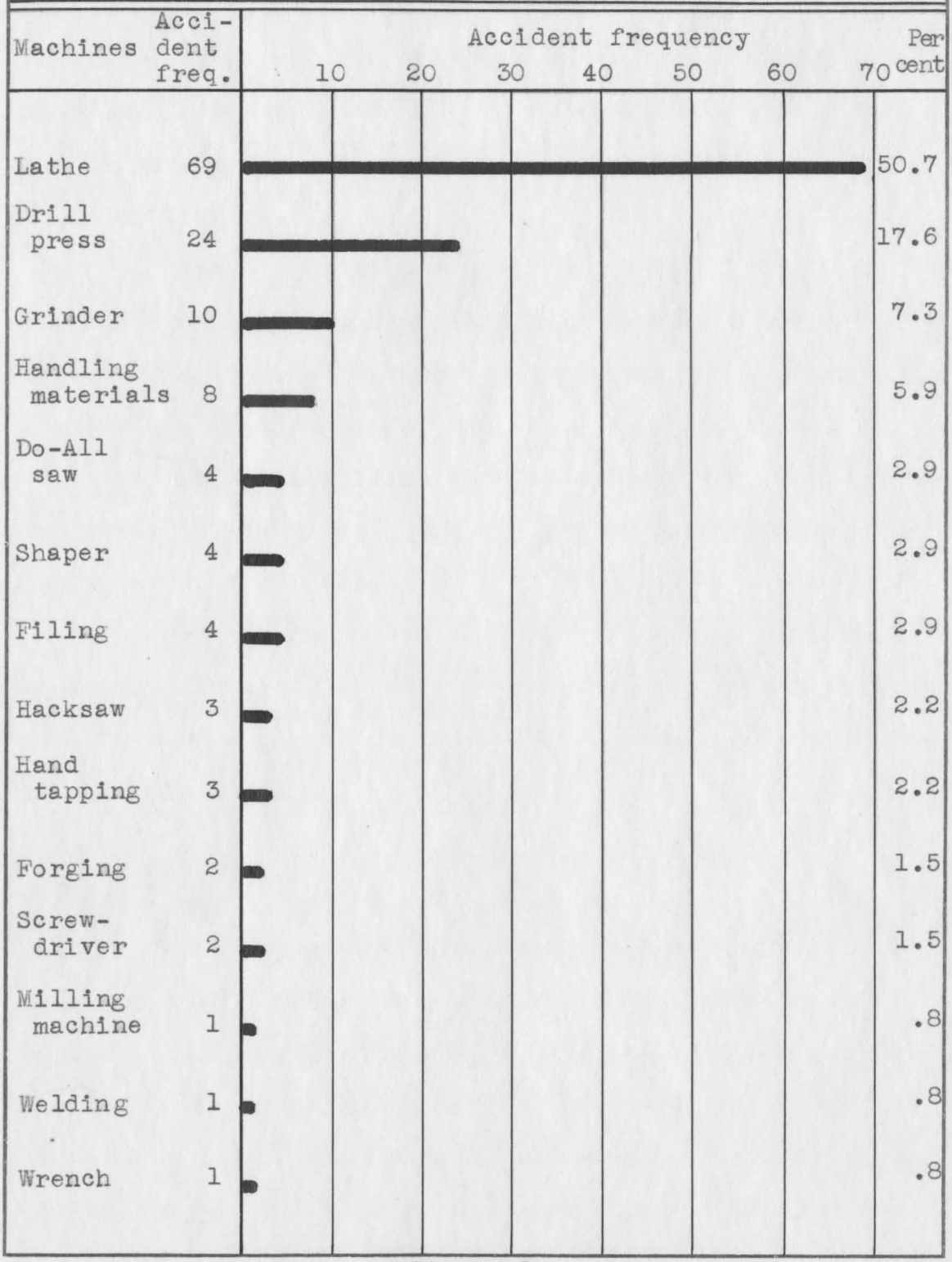

Figure 1

Figure 1.

The operation of the do-all saw and the shaper and hand filing each resulted in four accidents, as shown in Figure 1. Thus, the operation of each machine or tool resulted in 2.9 per cent of the accidents reported. All accidents were minor in nature, such as slight cuts on hands or fingers.

Use of the hacksaw and the operation of hand tapping each resulted in three minor cuts or burns on the operator's hands, or 2.2 per cent each of all accidents, as shown in Figure 1.

Use of the forge and the screwdriver resulted in two minor accidents each, or 1.5 per cent each of all accidents, as shown in Figure 1.

The operation of the milling machine, welding equipment, and the use of the wrenches each resulted in one minor accident, or .8 per cent of the total for each type of equipment.

Conditions of room and equipment

The score card used to score conditions of room and equipment relative to safety in Class B public school machine shops was based on a perfect score of 500 points.

The range of the scores on the 24 shops visited and checked, according to this score card, was 185 points. High score was 455 points, and low score was 270 points, as

CONDITIONS OF ROOM AND EQUIPMENT RELATIVE TO SAFETY AND SAFETY DEVICES MOST FREQUENT IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

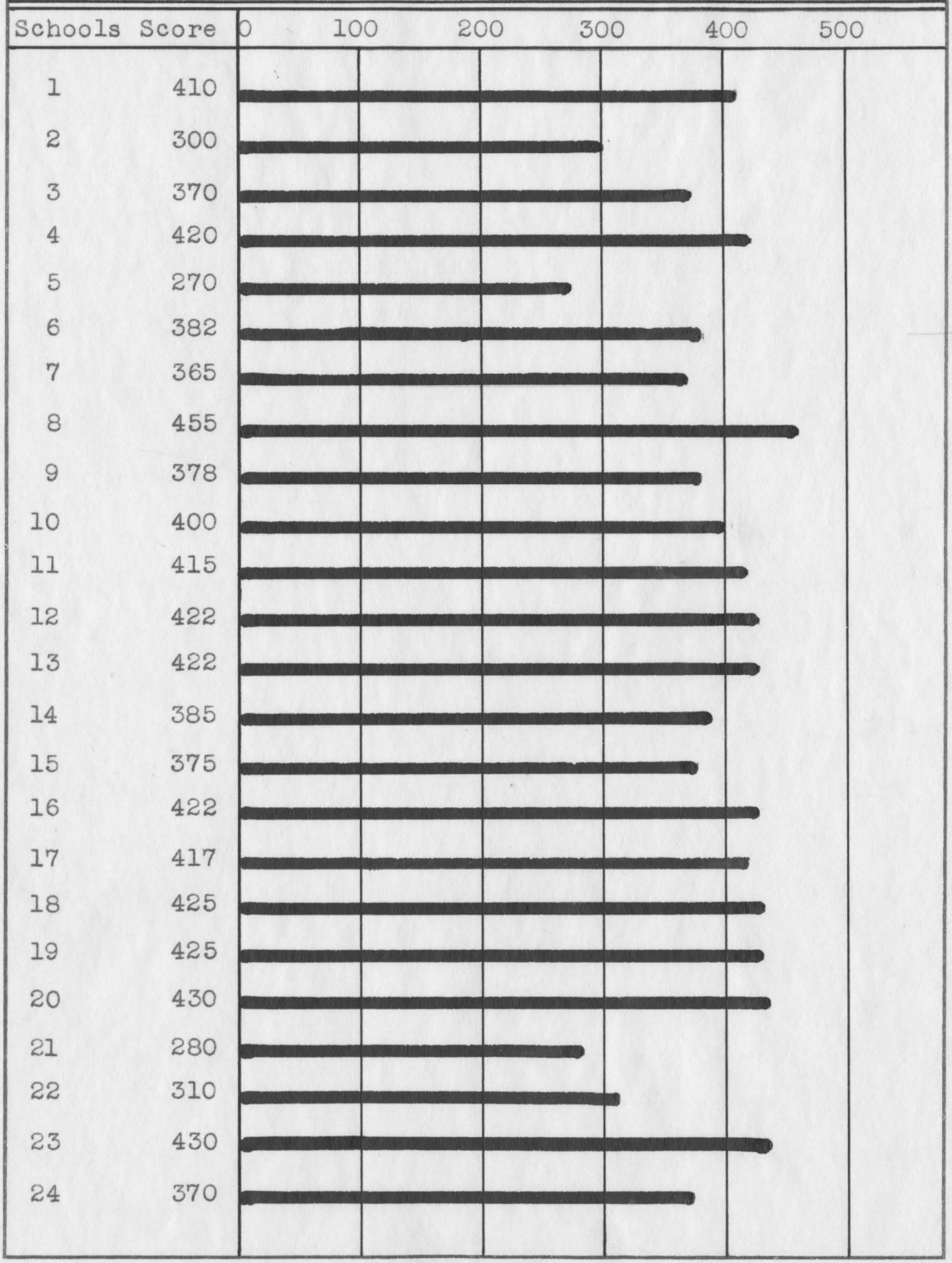

Figure 2

shown in Figure 2.

Power equipment was checked on seven items with a total score of 130 points. Of the 24 shops visited, 10 received perfect scores under this heading, as shown in Figure 3.

Consideration of power sources revealed that all shops were equipped with individual motors on machines, except one which had approximately 50 per cent individual motor equipment. Every shop visited and scored had approved switches on all machines. Approved guards were found in every instance except one. In this case, the instructor had removed one guard.

In the case of safety shields on grinders, four shops were found without shields, one shop with shields on one third of the machines, but in all cases safety collars were used.

Eleven of 24 shops were crowded to the extent that they had aisles less than four feet in width. Five shops had some item of equipment with less than 18 inches clearance between its extreme position and a stationary object.

Conditions of illumination

The recommended illumination for general work in machine shops is 30 to 40 foot-candles and for close work 50 to 100 foot-candles.

CONDITIONS OF POWER EQUIPMENT RELATIVE TO SAFETY AND SAFETY DEVICES MOST FREQUENT IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

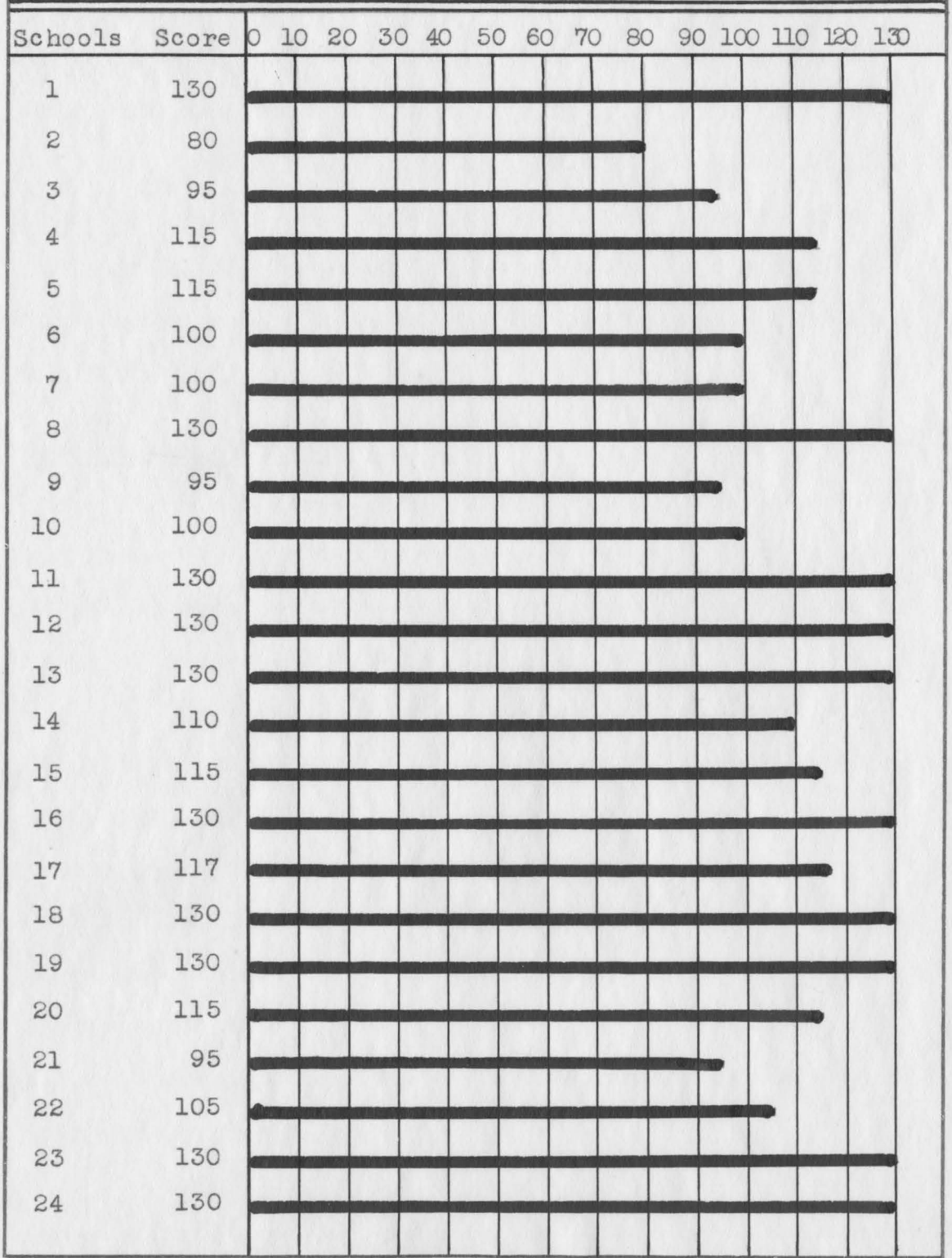

Figure 3

According to this recommendation, the illumination of the various shops was the most deficient item of any checked, as shown in Figure 4. Every shop was deficient in either general lighting or lighting for close work, and many were deficient in both.

Twelve shops had less than 30 foot-candle illumination for general lighting, and 19 had less than 50 foot-candle illumination for close work and inspection. Nine shops were deficient in both general and close illumination.

Electrical equipment

Electrical equipment was scored on the basis of six items with a total of 80 points for a perfect score. Of the 24 shops visited and scored, 11 were perfect on this item, as shown in Figure 5.

Twenty-two shops of the 24 were equipped with dead-front switchboards. One shop lacked proper encasing for switches; but in all cases, shops were equipped with proper electrical controls.

Failure to provide proper grounds for motors on machines was found in five shops, while in three other instances partial neglect was discovered in this area. All of the shops that had use for extension cords were using the approved type of equipment.

One shop lacked both a clock and a bell, two other shops lacked a clock, and still another lacked a bell.

GENERAL ILLUMINATION IN FOOT-CANDLES OF 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

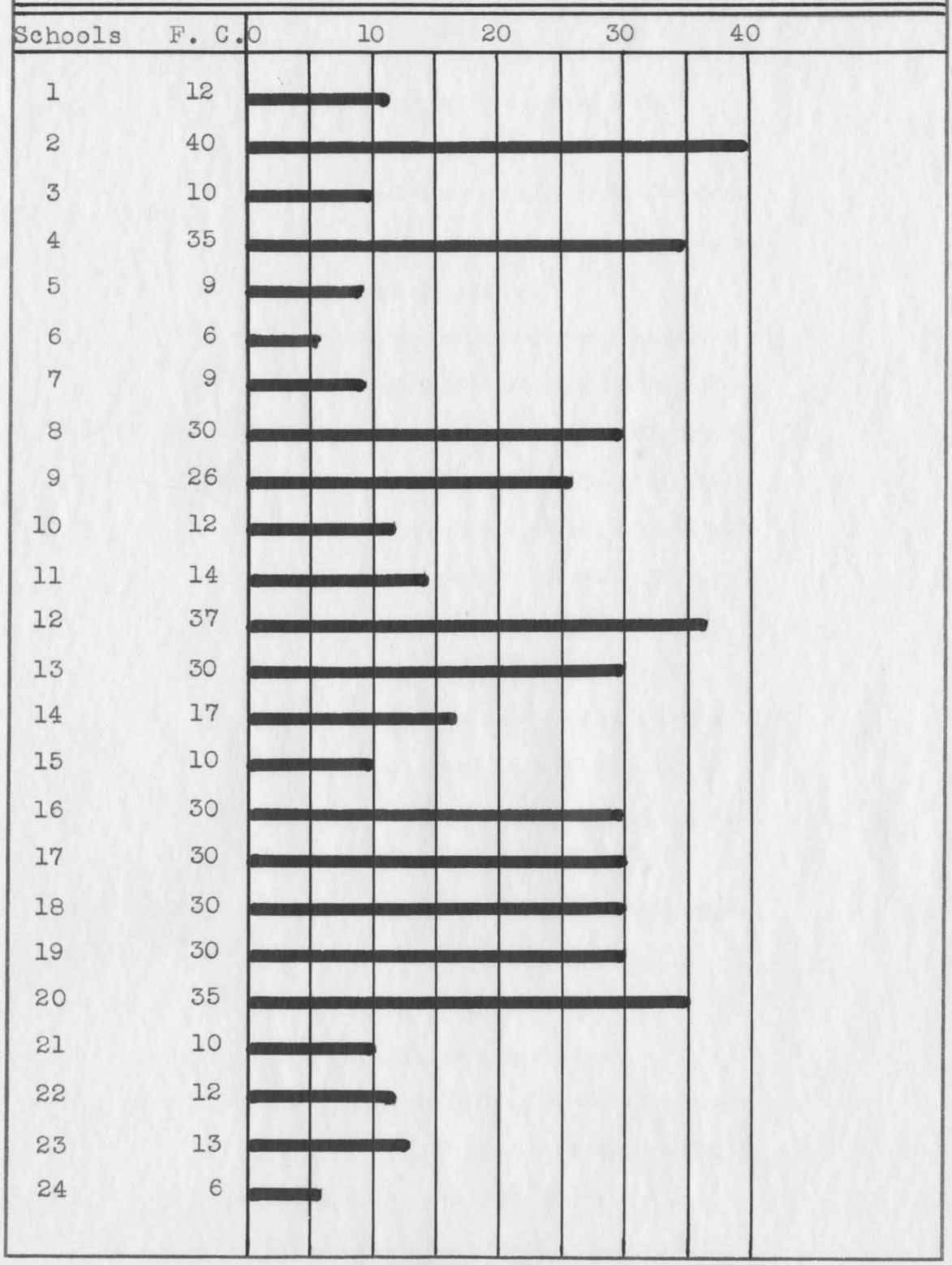

Figure 4

CONDITIONS OF ELECTRICAL EQUIPMENT IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

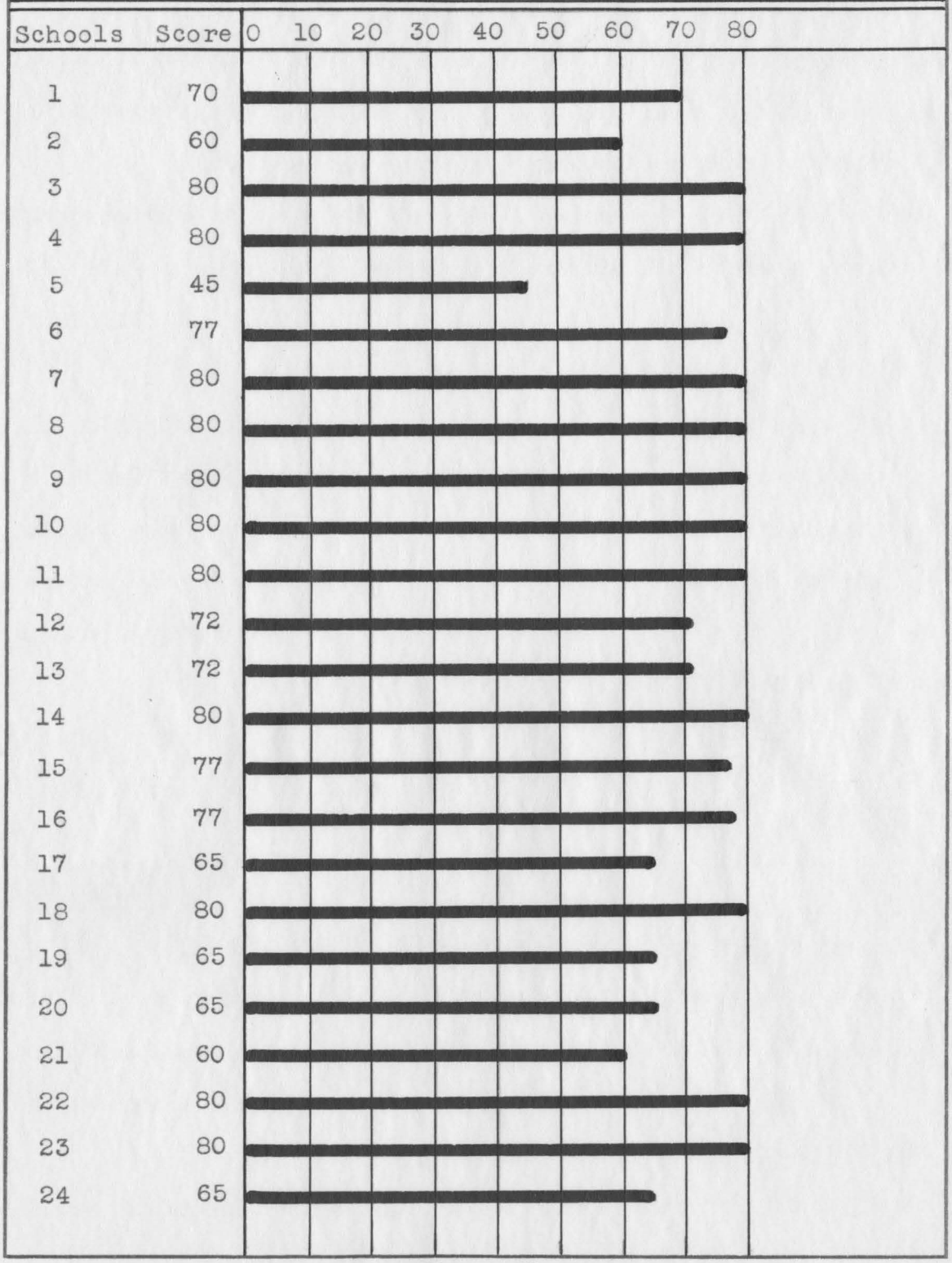

Figure 5

Room facilities

Room facilities for various shops visited were checked on eight items, totaling 65 points for a perfect score. Two shops of the 24 included in this study received a perfect score under this heading, as shown in Figure 6.

Seventeen shops were equipped so that a proper temperature of between 60 and 70 degrees was maintained at all times. One shop lacked facilities for adequate ventilation.

The ceiling height in 20 shops exceeded the minimum height of 10 feet, and all shops of 2,000 square feet of floor space or over had two exit doors. Window sill height was 40 inches or over in 22 shops included in this study. Seventeen shops checked had a drinking fountain, and all shops had washing facilities.

Sound-proofing was found on the ceilings of four shops; however, one additional shop had approximately one half of the ceiling sound-proofed.

Facilities for housekeeping

The 24 shops visited and scored were checked on six items relative to facilities for housekeeping, based on 80 points for a perfect score. On this basis, three shops received perfect scores, as shown in Figure 7.

It was found that only three visited had safety lines around machines; however, 22 had more than 40 square

ROOM FACILITIES OF 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

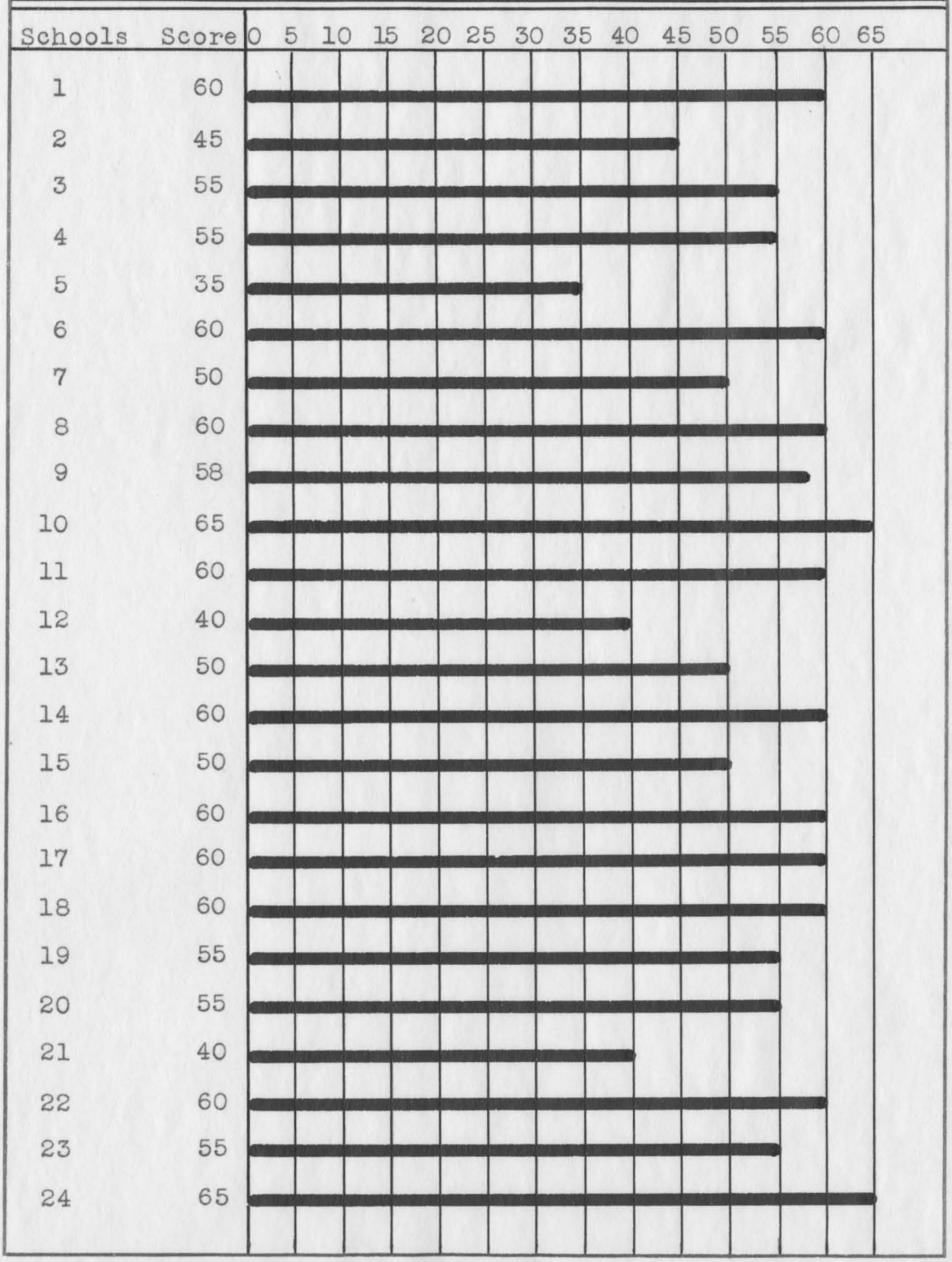

Figure 6

FACILITIES FOR HOUSEKEEPING IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

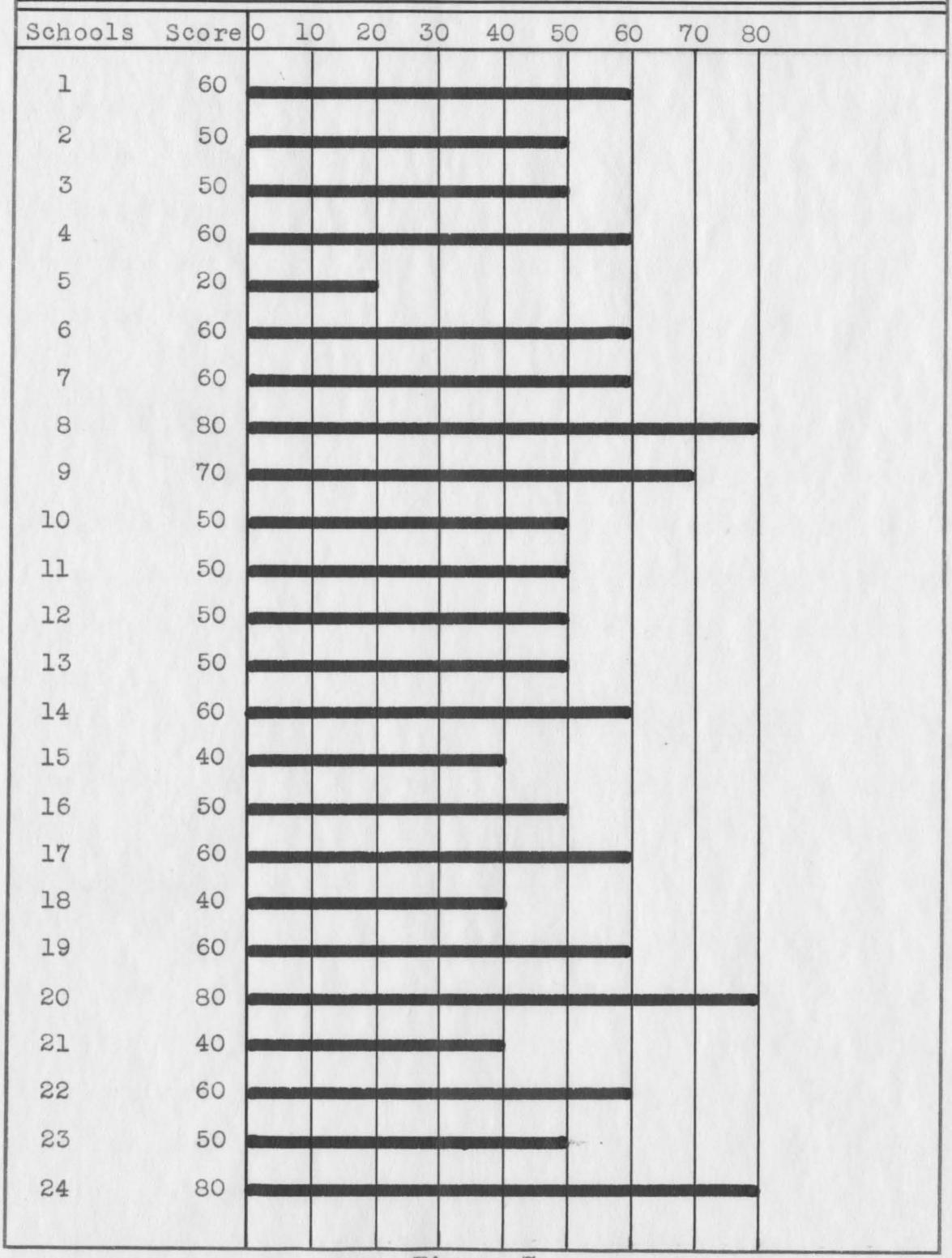

Figure 7

feet of working space for each pupil, as shown in Figure 8. The average working area per pupil in the 34 shops visited and scored was 82 square feet.

All 24 shops had "non-slippery" floors, Safety containers for oily or soiled rags were found in 13 shops visited. Eight shops had balconies; however, steps leading to these balconies were all located in non-dangerous areas away from machinery. Housekeeping in general was good in 19 shops visited.

Facilities for body protection

Facilities for body protection of students in the 24 machine shops covered by this study were scored on five items, totaling 65 points. Nineteen shops scored 65 points, or perfect, according to the score card used, as shown in Figure 9.

Clear goggles or shields for eye protection on hazardous jobs were lacking in four shops visited. However, all shops having welding equipment also had welding helmets or dark goggles for eye protection.

Asbestos gloves needed while handling molten metal were lacking in three of the 12 shops where this type of work was offered. Leather aprons to be worn while handling molten metal were also lacking in six of the 12 shops that included this type of activity. Dust masks were available in the two shops that had need for this type of protection.

SQUARE FEET OF FLOOR AREA PER PUPIL IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

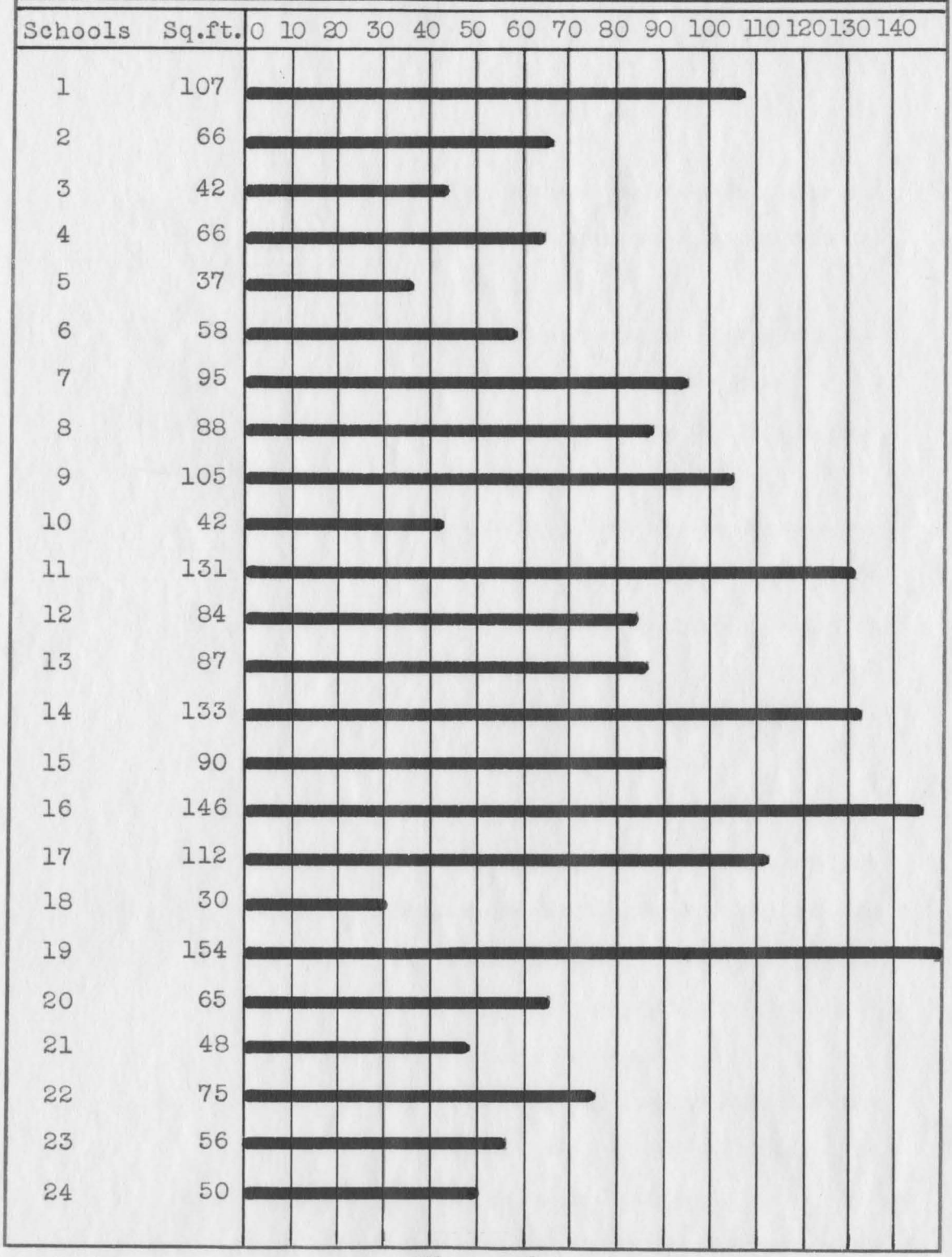

Figure 8

FACILITIES FOR BODY PROTECTION OF PUPILS IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

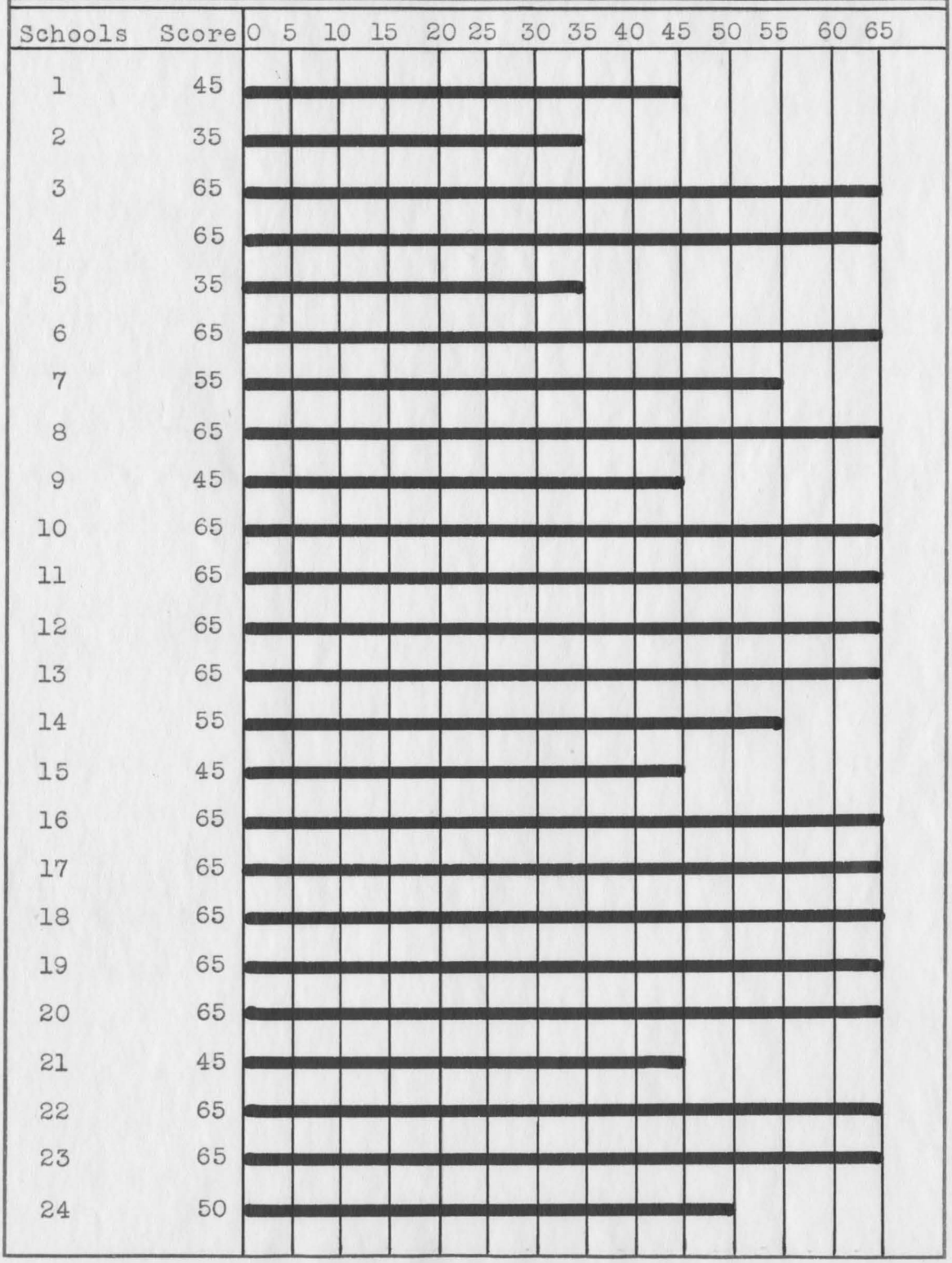

Figure 9

Miscellaneous

Under this heading, six items were checked and scored for a total of 60 points. No shop received a perfect score under this heading, as shown in Figure 10.

Twenty-three of the 24 shops were equipped with fire extinguishers; however, only four had fire blankets. Ten of the 15 shops using inflammable liquid for cleaning purposes used approved safety cans for this material. The danger points in six shops were labeled to caution the students of the hazard involved at this particular position.

Color dynamic paint was used in three of the shops visited. The storage of steel was properly handled in 14 of the 24 shops included in this study.

Relationships between shop conditions and accidents

The relationships between shop conditions as determined by the score card and accidents in the shop were consistent in many cases, as shown in Figure 11.

Of 24 shops visited and checked in this study, 16 having scores of 370 points or above had eight or less accidents. Three shops having low scores had a comparatively high number of accidents. The remaining five shops did not compare favorably as to scores and accident rate. Two shops having low scores according to the score card had a low number of accidents.

MISCELLANEOUS ITEMS CHECKED IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

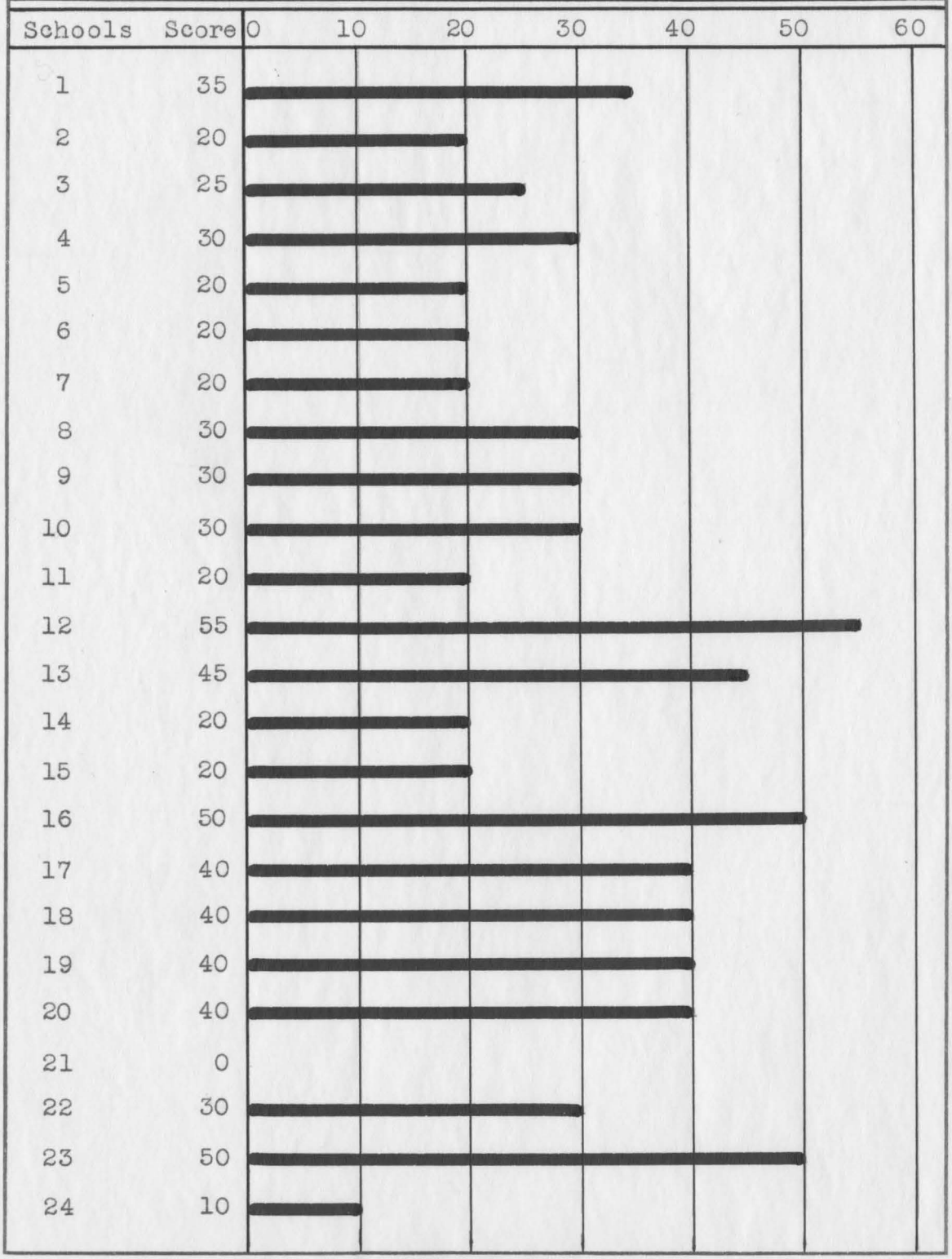

Figure 10

RELATIONSHIP BETWEEN SHOP CONDITIONS AND ACCIDENTS IN 24 SCHOOL MACHINE SHOPS IN LOWER MICHIGAN, 1947-48.

School	Score	Acc.
1	410	6
2	300	7
3	370	2
4	420	8
5	270	6
6	382	6
7	365	20
8	455	2
9	378	2
10	400	4
11	415	2
12	422	4
13	422	4
14	385	6
15	375	9
16	422	6
17	417	8
18	425	6
19	425	12
20	430	2
21	280	4
22	310	4
23	430	3
24	370	3

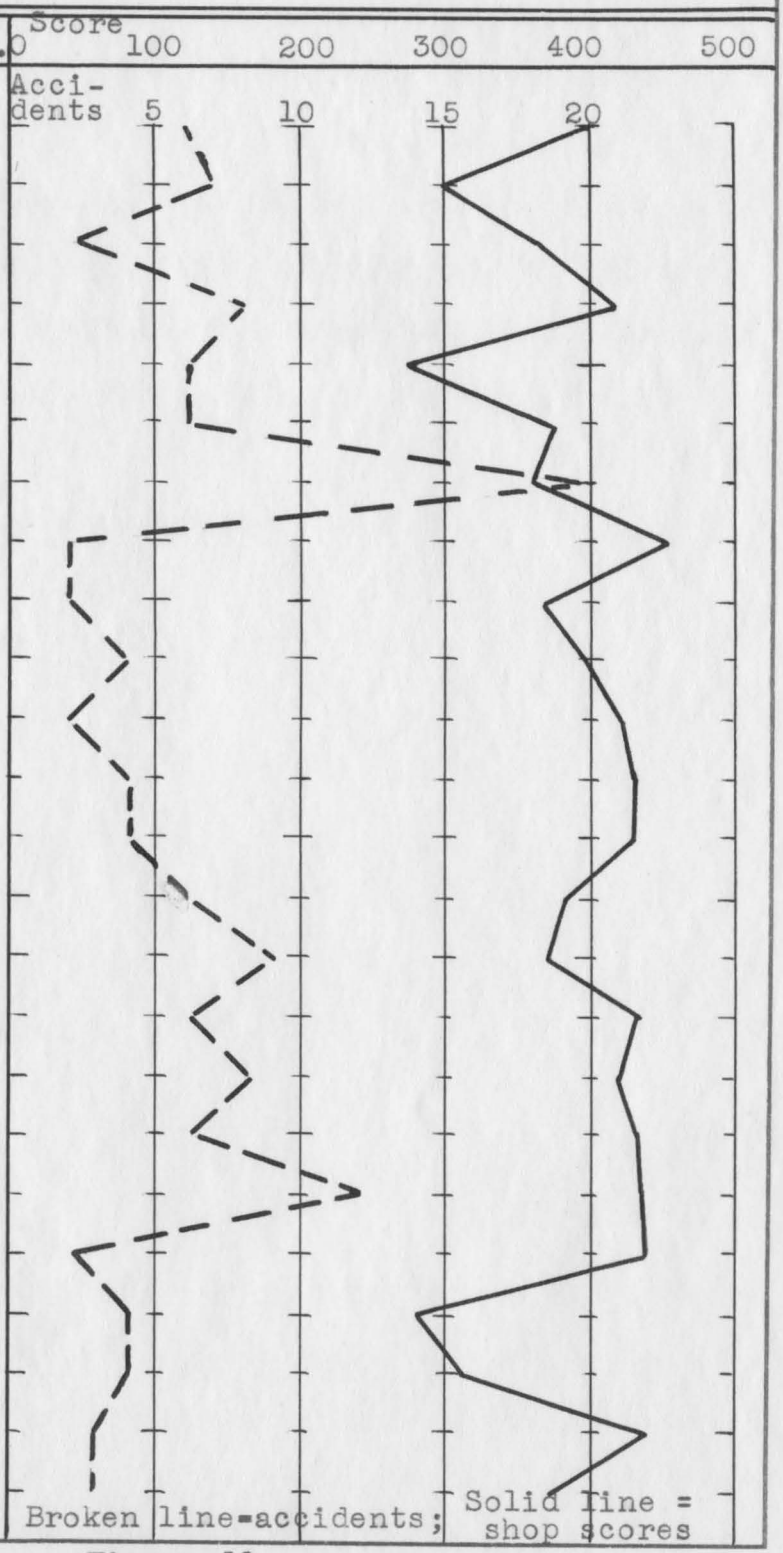

Figure 11

Summary

All accidents reported in this study were minor in nature. The operation of the metal lathe caused 69 of 136 accidents, or 50.7 per cent of the total, as shown in Figure 1. Operation of the drill press resulted in 24 accidents, or 17.6 per cent. A broken finger was the most serious accident reported. This happened at the grinder, which was the scene of nine other minor accidents, or 7.5 per cent of the total. The remaining accidents resulted from the following:

Handling of materials	8
Do-all saw	4
Shaper	4
Filing	4
Hacksaw	3
Hand tapping	3
Forging	2
Screwdriver	2
Milling machine	1
Welding	1
Wrench	1

All of these are shown in Figure 1.

Conditions of room and equipment in the 24 shops visited and scored varied from 270 points to 455 out of a possible 500, as shown in Figure 2. Power equipment, as shown in Figure 3, was in fairly good condition. Illumina-

tion of the shops, as shown in Figure 4, was deficient in all cases. Electrical equipment was in good condition in a majority of shops, as shown in Figure 5. Room facilities were fairly adequate in most shops visited, as shown in Figure 6. Facilities for housekeeping, generally, were fair or bordering on low and were quite consistent with room facilities, as revealed by a comparison of Figures 6, 7, and 8. Body protection facilities were high in many shops, as shown in Figure 9. Under the heading of miscellaneous, which included the newer idea of color dynamic paint, with five other items, all schools were deficient, as shown in Figure 10.

Class B school machine shops in lower Michigan compared favorably according to the score card, as revealed by a study of Figure 2.

A discussion of the various items will be given in the next chapter.

Chapter V

DISCUSSION

This chapter will set forth the implications of the review of literature, accident records of 24 machine shops visited and evaluated according to results obtained by using a score card developed for that purpose.

Implications

From the review of literature, it may be concluded that periodic inspections of machine shops are regarded as essential to the discovery of unsafe conditions of room and equipment. To discover such conditions, some type of objective measuring device was needed; therefore, development of the score card became necessary. Items included on the score card were emphasized by various authors as being important to safety in machine shops.

It was necessary to get an accurate record of accidents that happened in school machine shops over a given period of time. These records revealed that 50.7 per cent of all accidents to students working in machine shops occurred on the metal lathe. This high percentage may be accounted for because of the large number of lathes in each shop in comparison with other machines and the numerous operations for which the lathe is used.

In this study, all scratches and cuts, regardless of how slight, were recorded as accidents. A slight cut or scratch under slightly different circumstances might have been a serious accident. An accident that has occurred, regardless of how slight or serious, is a symptom of some underlying cause. The result of an accident is not nearly as important as the unsafe practice which may continue to bring more of the same result.

The drill press was the second most common machine in use in school shops. Operations on this machine caused 24 of 136 accidents, or 17.6 per cent of the total number. The drill press is not considered a hazardous machine, and it is probably the large amount of work for which it is used that accounts for the frequency of accidents. All accidents were minor cuts from steel shavings or rough edges of revolving stock.

Operations of grinders resulted in one broken finger and nine minor injuries. The broken finger resulted when stock caught in a grinder and pulled the finger against the guard.

Accident frequency on all other machines was four or less mishaps per machine, as shown in Figure 1.

The 24 shops visited received high scores under the item of power equipment. Ten schools had perfect scores of 130 points each. With few exceptions, power equipment such as individual motors, approved switches, approved

guards, shields on grinders, and safety collars on grinders, was all in good condition.

In 13 shops aisles were less than the four-foot width recommended by Murri (6:131). In five shops visited and scored clearance between the extreme position of a shaper, planer, or similar machine, and a stationary object was less than the 18 inches recommended by New York (State) University (8 :89). Existence of narrow aisles and insufficient clearance around machines was due to lack of planning floor space for the machines in the shop. A number of schools received war surplus equipment and had moved much of this equipment into their shops, resulting in dangerous loss of essential working space. A number of shops with narrow aisles had less than the 82 square foot working area per pupil, which was average for the 24 shops included in this study.

Illumination of the shops was deficient in all instances. Ten shops had 30 foot-candles of illumination for general shop work. Three had a minimum illumination of 50 foot-candles for close work, but no shop had the recommended illumination for both. Two shops had six foot-candles of illumination as the maximum, while two had a maximum of nine foot-candles. Such practices seem unnecessary in view of the extensive research that has been done in recent years with reference to this subject. Students in poorly lighted workrooms are at a disadvantage. Some

schools supply the best of tools and equipment but fail to consider the importance of adequate lighting and the handicap imposed upon students and the strain produced upon eyes by poorly arranged and insufficient lighting. Apparently adequate lighting is an essential factor in obtaining high operating efficiency as well as for reduction of accidents.

Electrical equipment was in good condition in the 24 shops visited. Two shops had switchboards that did not pass inspection. One was located outside the shop room, making quick access to it impossible. Another switchbox contained a type of knife blade switch. The instructor insisted that he kept the cabinet containing this switch locked at all times and that no student was permitted to use it. Eight shops lacked proper grounding equipment for part or all of the motors in their shops.

Twenty shops visited were equipped with clock and bell systems. Such systems enable the instructor to devote more personal attention to administrative duties and permit schedule planning that gives students ample time to clear work and properly store tools.

Room facilities were adequate in most shops included in this study. One shop lacked adequate ventilation, and seven lacked proper temperature control. Four shops had ceiling height of less than 10 feet in all or part of the room. Every shop of 2,000 square feet or over had two exit doors. Window sill height was over 40 inches in 22 shops.

Both drinking and washing facilities were available in all shops. Four shops had sound-proofing on the ceiling, and one had sound-proofing on approximately one half of the ceiling. It has been demonstrated that sound-proofing on ceilings and upper side walls aids in deadening noise. Reduced noise appears to aid in the elimination of nervous fatigue. Such reduction is without a doubt a worth-while factor contributing to accident prevention.

Temperature and ventilation appear to be major contributing factors in the cause of accidents. Students working in room temperatures that vary beyond the 60 or 70 degrees recommended are not likely to work as carefully and safely as when working under correct room temperatures. Adequate ventilation is essential to safe working conditions, alert minds, and good health.

Poor housekeeping is another physical cause of accidents in school, industry, and at home. Aisles cluttered with materials, dirty stairways, oily floors, and objects out of place have been contributing factors in causing accidents. Clean, well-ordered shops present less in the way of physical hazards than those poorly maintained. Housekeeping was good in 19 of the 24 shops visited. Items included under this heading were taken from Humble (5:12), The National Safety Council (7:42), Ericson (2:163), and incorporated into the score card used for this study. General precautions that apply to good housekeeping are preven-

tion of interference with students in work areas, allowing only one student per machine, provision for the disposal of wiping cloths and oily wastes, careful removal of scrap materials from the floor, keeping aisles clear, and systematic arrangement of tools at work stations.

Eleven shops were not equipped with safety containers for oily rags and waste. Some instructors had open top barrels for this purpose; others insisted that oily rags should be removed and burned each day.

Two shops had a working area of less than 40 square feet per pupil, which was the minimum amount of space listed on the score card. The 24 shops averaged 82 square feet of working space per pupil. This is a high average.

Maintenance of safety lines in the 24 shops surveyed was poor. Only three shops had safety lines around machines. These shops reported only two accidents each during the six-month duration of the survey. Thus, it appears that safety lines are important as indicators of the area to be occupied by the person operating the machine, and as such contribute in a large degree toward safe operating conditions.

Ceiling height of more than 10 feet is necessary for the safe handling of long pieces of steel or large sheets of metal.

Steps to balconies were in non-hazardous areas.

Sixteen shops were on one floor level.

Facilities for body protection were adequate in most shops. Four failed to provide goggles or shields for eye protection necessary for hazardous jobs. However, schools having welding equipment all had dark goggles or welding helmets. Asbestos gloves were available for wear while handling molten metal in nine of the 12 shops having this type of work. Six of the 12 shops had leather aprons. The only two shops which needed dust masks had them available.

Goggles with hardened lenses should be used for all grinding and buffing. It has been recommended that they be worn at all times while working in a machine shop. Some industries that are safety conscious furnish goggles and require their employees to wear them.

Miscellaneous items were checked in the 24 shops. Fire extinguishers, safety cans for inflammable liquid, and steel storage racks were provided in most instances.

Fire blankets, labeling of danger points, and the use of color dynamic paints were found in only a few of the shops.

Shops visited were in good condition with respect to safety of power-driven machines, all electrical controls, room facilities, housekeeping facilities, and facilities for body protection.

Application of the newer ideas of illumination,

sound-proofing, and color dynamic paint were rarely found.

Adequate light is only one phase of proper light planning. The avoidance of glare, heavy shadows, and provision for proper diffusion are to be considered. The colors used on walls, machines, and floors also constitute a safety factor. The application of color dynamics is helpful and effective in giving desirable color contrasts which lessen nervous fatigue, increase efficiency, and call attention to danger points.

Unnecessary noise from machines can be greatly reduced by keeping them in repair. Insulating the upper part of the shop will help absorb the natural noise.

It appears probable that if school authorities were conscious of the efficiency that could be derived by providing adequate light including color dynamics, many would be willing to cooperate. The cost of applying the right kind of paint properly would be no more than that of the ineffective application so commonly evident. Employment of an illumination engineer appears advisable when planning a shop. His fee would be money well spent.

The relationship between shop conditions as determined by the score card and accidents in the shop was consistent in many cases, as was shown in Figure 11.

Of 24 shops visited and checked in this study, 19 had scores of 370 points or above. Of these 19 shops two had more than eight accidents.

This may have been due to inefficient instruction and management. A careless workman with the best of equipment and conditions can be a hazard to himself and his fellow students. A study of the accident situation gives the feeling that a great many people have never learned to do things correctly or safely. Students do not know how to do things, or they fail to do them as well as they know how. In either case, the result may be an accident.

Of the remaining five shops with scores of 365 or less, one had 20 accidents, four had seven or less accidents. The low accident rate in the four schools was probably due to efficient instruction and management on the part of the instructor. A student properly instructed can work safely although probably not as efficiently as if he were in better surroundings.

As previously revealed, inspections primarily lead to the discovery of unsafe practices.

Apparently the score card does reveal unsafe practices and procedures which among other factors may lead to numerous minor accidents and potentially to those of a much more serious nature.

Chapter VI

SUMMARY

A score card was designed for use while conducting this study. This card was designed to provide data necessary for evaluation of the physical factors to be considered in attaining a high degree of safety in high school machine shops. With extensive use of machines in everyday life, it is necessary that students, especially those in machine shop, work in a safe environment.

Cooperation of 24 high school machine shop instructors was secured. These instructors kept an accurate record of accidents which occurred in their shops over a period of six months. At the end of this period, the shops were visited and rated according to the items on the score card.

It was revealed that 50.7 per cent of all accidents occurred while operating the metal lathe. This may have been due to the extensive use of this machine and the many operations for which it is used. All accidents were minor in nature, consisting of cuts and scratches on hands and fingers or particles in eyes. These particles were removed without injury.

The score card revealed that shops visited were

in good condition with respect to safety:

1. Power driven machines
2. All electrical controls
3. Room facilities
4. Housekeeping facilities
5. Facilities for body protection

Provision in shops for such new factors as illumination, sound-proofing, and color dynamic paint was deficient.

With the score card as a guide, the instructor may more readily determine conditions prevailing in his shop which if corrected may prevent unnecessary hazards to students and a more efficient approach to the objectives of industrial arts machine shop.

A P P E N D I X

APPENDIX TABLE OF CONTENTS

Appendix A.--SCORE CARD

Score Card for Class B High School Machine Shops

A clean, methodical, and systematically organized shop promotes safety.

	1	2
I. Equipment (power)		130
1. Individual motors	20	
2. Approved switches	20	
3. Approved guards	20	
4. Shield on grinder	20	
5. Safety collars on grinder	20	
6. Aisles not less than 4 feet wide	15	
7. Clearance between stationary objects and extreme position of machine 18 inches	15	
II. Illumination		20
1. General work 30 f.c. - 40 f.c.	10	
2. Close work 50 f.c. -100 f.c.	10	
III. Electrical		80
1. Switchboards (dead front type)	20	
2. Motors, switches and starting equipment properly encased	15	
3. Approved design electrical controls	15	
4. Motors properly grounded	15	
5. Approved extension cords	10	
6. Clock and bell system	5	
IV. Room Facilities		65
1. Proper temperature 60-70 degrees	10	
2. Adequate ventilation	10	
3. Ceiling height not less than 10 feet	10	
4. Two exit doors for large shops, over 2,000 sq. ft.	10	
5. Window sill height not less than 40 inches	10	
6. Drinking water	5	
7. Washing facilities	5	
8. Sound proofing	5	
V. Housekeeping		80
1. Safety lines around machines	20	
2. Working space (40 sq.ft. per student)	20	
3. Non-slippery floors	10	
4. Safety container for oily waste	10	
5. Steps located in non-dangerous areas	10	
6. Housekeeping in general good	10	
VI. Body Protection		65
1. Safety Goggles or shields	20	
2. Welding helmets or goggles	20	
3. Asbestos gloves for handling molten metal	10	
4. Leather apron for handling molten metal	10	
5. Dust mask or respirators	5	
VII. Miscellaneous		60
1. Fire extinguisher	10	
2. Fire blanket	10	
3. Approved safety container for inflamable liquid	10	
4. Danger points labeled	10	
5. Color dynamic paint	10	
6. Properly constructed steel rack	10	
Totals	500	500

Instructions for using card- (1) Basis for scoring 500 points. (2) For scoring two columns are allowed. While actually at work in a shop only the first need be filled out, the second to be filled out at leisure. (3) Where credit is allowed for any single item not present and not needed in a shop draw a circle around such credit.

Appendix B.--ACCIDENT REPORT

Machine Shop Accident Report

Class B High Schools of Michigan

Name of school .....

Date of accident ..... Hour of day..... Age of individual .....

No. of sem. in shop ..... Size of class .....

I ACCIDENT

1. Description of the accident .....

.....

2 Description of the injury .....

II EQUIPMENT

1. Name of machine at which accident occurred .....
2. Model ..... Model number ..... Year Mfg. .....
3. Was the machine tool equipped with approved safety guards? yes no.
4. Was there sufficient equipment? yes no.
5. Was there logical arrangement of machines in the shop? yes no.
6. Was the machine defective? yes no.
7. Was the machine being misused? yes no.
8. Was the machine obsolete? yes no.

III ILLUMINATION

1. Was illumination adequate? yes no.
2. Was there glare? yes no.

IV ELECTRICAL HAZARDS

1. Were switch boards dead-front type ? (No exposed live parts) yes no.
2. Were motors, switch, and starting equipment properly encased? yes no
3. Were electrical controls of approved design? yes no.
4. Were motors properly grounded? yes no.

V HOUSEKEEPING

1. Was shop crowded? (Not enough equipment to give each student a working location) yes no.
2. Was proper temperature maintained? yes no.
3. Was there adequate ventilation? yes no.
4. Were floors slippery? yes no.
5. Were steps located in dangerous areas? yes no.
6. Was housekeeping in general, good, bad?

VI PERSONAL FACTORS

1. Was student fatigued? yes no.
2. Was proper clothing worn? yes no.
3. Was student wearing goggles if needed? yes no.
4. Was machine being run at improper speed? yes no.
5. Were guards being adjusted while machine was running? yes no.
6. Was student attempting to oil machine while it was running? yes no.
7. Was student engaged in horseplay? yes no.

VII MISCELLANEOUS

1. Were danger points labeled? yes no.
2. Were steel racks properly constructed? yes no.
3. .....
4. .....

Appendix C.--LETTER TO SHOP INSTRUCTORS, SEPTEMBER, 1947

Industrial Arts Dept.
Russell Gebby, Director
NILES HIGH SCHOOL
NILES, MICH.

September 29, 1947

Dear Sir:

I am conducting a study of causes of accidents in public school machine shops, in Class B high schools in lower Michigan. The purpose is to develop a score card that can be used to appraise a school shop to detect certain hazards that may be a source of accidents. In this study I hope to enlist the cooperation of machine shop instructors and other school officials.

To build this score card it will be necessary to secure accurate and complete information concerning school machine shop accidents and the causes thereof. Knowing the conditions under which accidents occur, we shall be able to formulate safety precautions to guide shop practice. No effort will be made to compare shops. Each shop will be the unit on which the study will be based and each accident will be reported separately.

I am enclosing a copy of a machine shop accident report, which has been devised by myself with the cooperation of the Faculty of Colorado A & M College, Fort Collins, Colorado, for your information.

It is proposed that an accurate record of accidents in each cooperating machine shop be kept from October 1, 1947 to April 1, 1948.

I shall appreciate your cooperation in this project.

Sincerely yours,

Russell A. Gebby

Russell A. Gebby

Appendix D.--POSTAL CARD FOR SHOP INSTRUCTORS

POSTAL CARD FOR SHOP INSTRUCTORS

We should like to cooperate in the public school machine shop accident study. We will probably need_____ Machine Shop Accident Report Blanks.

_____
Signature

I would appreciate a copy of the completed score card for my own use.

_____
Signature

Name of School_____

Address_____

Immediate reply appreciated.

Appendix E.--LETTER TO COOPERATING SCHOOLS, OCTOBER, 1947

623 Vann Street
Niles, Michigan
October 28, 1947

Dear Mr.

I appreciate very much your interest in my study of causes of accidents in public school machine shops, in Class B high schools in lower Michigan.

For the purpose of this study please keep a record of every accident in your shop regardless of how minor the accident may be. Remember no effort will be made to compare shops.

I am planning to visit your shop sometime before April 1, 1948.

Enclosed find the accident reports that you indicated you might need. If more are needed, I will be glad to furnish them to you.

Thanks again for your willingness to cooperate with me on this study.

Yours very truly,

Russell A. Gebby

p

Enc.

Appendix F.--APPOINTMENT LETTERS, MARCH, 1947

INDUSTRIAL ARTS DEPARTMENT
Russell Gebby, Director
NILES HIGH SCHOOL
NILES, MICHIGAN

Dear Mr.

In connection with my study of causes of accidents in public school machine shops, I expect to be in your shop At this time I would like to pick up your accident reports to date and also apply the score card that I have developed.

If for any reason you will not be available on this date, please notify me as to whom I may contact to get into your machine shop.

Thank you for your cooperation with me in this study.

Yours very truly,

Russell A. Gebby

Appendix G.--MASTER DATA SHEET

MASTER DATA SHEET

	Score Card Results										Accidents								Power Equipment							
	School	I Equipment	II Illumination	III Electrical	IV Room Facilities	V Housekeeping	VI Body Protection	VII Miscellaneous	Total Score		Lathe	Drill Press	Milling Machine	Shaper	Grinder	Miscellaneous	Total		1 Individual Motors	2 Approved Switches	3 Approved Guards	4 Shield on Grinder	5 Safety Collars	6 Aisles 4 feet	7 Clearance 18 inches	Total
Perfect	130	20	80	65	80	65	60	500											20	20	20	20	20	15	15	130
1	130	10	70	60	60	45	35	410		5						1	6		20	20	20	20	20	15	15	130
2	80	10	60	45	50	35	20	300		4			1	1	1	7			20	20	20	0	20	0	0	80
3	95	0	80	55	50	65	25	370		1					1	2			20	20	20	0	20	0	15	95
4	115	10	80	60	60	65	30	420		2	2			1	3	8			20	20	20	20	20	0	15	115
5	115	0	45	35	20	35	20	270		4			1		1	6			20	20	10	20	20	10	15	115
6	100	0	77	60	60	65	20	382		4	1				1	6			20	20	20	20	20	0	0	100
7	100	0	80	50	60	55	20	365		10	3	1	1	2	3	20			20	20	20	20	20	0	0	100
8	130	10	80	60	80	65	30	455		1					1	2			20	20	20	20	20	15	15	130
9	95	0	80	58	70	45	30	378			1				1	2			20	20	20	0	20	0	15	95
10	100	10	80	65	50	65	30	400		2				1	1	4			20	20	20	20	20	0	0	100
11	130	10	80	60	50	65	20	415			1				1	2			20	20	20	20	20	15	15	130
12	130	10	72	40	50	65	55	422		3	1					4			20	20	20	20	20	15	15	130
13	130	10	72	50	50	65	45	422		2	1				1	4			20	20	20	20	20	15	15	130
14	110	0	80	60	60	55	20	385		2	1			1	2	6			20	20	20	20	20	10	0	110
15	115	10	77	50	40	45	20	375		4	1			2	2	9			20	20	20	20	20	0	15	115
16	130	10	77	60	50	65	50	422		4	2					6			20	20	20	20	20	15	15	130
17	117	10	65	60	60	65	40	417		4	2				2	8			20	20	20	7	20	15	15	117
18	130	10	80	60	40	65	40	425		3	1			1	1	6			20	20	20	20	20	15	15	130
19	130	10	65	55	60	65	40	425		6	4			1	1	12			20	20	20	20	20	15	15	130
20	115	10	65	55	80	65	40	430		1					1	2			20	20	20	20	20	0	15	115
21	95	0	60	40	40	45	0	280		2	1				1	4			20	20	20	0	20	0	15	95
22	105	10	80	60	60	65	30	310		2	1		1			4			10	20	20	20	20	0	15	105
23	130	0	80	55	50	65	50	430		2					1	3			20	20	20	20	20	15	15	130
24	130	0	65	65	50	50	10	370		1	1				1	3			20	20	20	20	20	15	15	130
										69	24	1	4	10	28	136										

MASTER DATA SHEET

		Illumination				Electrical								Room Facilities									
	School	General Work 30-40	Score	Close Work 50-100	Score	1 Switchboards (dead front)	2 Motors, Switches-encased	3 Approved Elect. Controls	4 Motors Grounded	5 Approved Extension Cords	6 Clock + Bell	Total		1 Temperature 60°-70°	2 Adequate Ventilation	3 Ceiling 10 feet	4 Two exit doors 200'	5 Window sill 40 inches	6 Drinking Water	7 Washing Facilities	8 Sound Proofing	Total	
Perfect		f.c.	10	f.c.	10	20	15	15	15	10	5	80		10	10	10	10	10	5	5	5	65	
	1	12	0	100	10	20	15	15	5	(10)	5	70		10	10	10	10	10	5	5	0	60	
	2	40	10		0	0	15	15	15	10	5	60		0	5	10	10	10	5	5	0	45	
	3	10	0		0	20	15	15	15	(10)	5	80		10	10	10	10	10	0	5	0	55	
	4	35	10		0	20	15	15	15	10	5	80		10	10	10	10	10	5	5	0	60	
	5	9	0		0	0	15	15	0	10	5	45		0	10	0	10	10	0	5	0	35	
	6	6	0		0	20	15	15	15	10	2	77		10	10	10	10	10	5	5	0	60	
	7	9	0		0	20	15	15	15	10	5	80		0	10	10	10	10	5	5	0	50	
	8	30	10		0	20	15	15	15	10	5	80		10	10	10	10	10	5	5	0	60	
	9	26	0		0	20	15	15	15	10	5	80		5	10	10	10	10	5	5	3	58	
	10	12	0	60	10	20	15	15	15	10	5	80		10	10	10	10	10	5	5	5	65	
	11	14	0	50	10	20	15	15	15	10	5	80		10	10	10	10	10	0	5	5	60	
	12	37	10		0	20	15	15	7	10	5	72		5	10	10	10	0	0	5	0	40	
	13	30	10		0	20	15	15	7	10	5	72		10	10	10	10	0	5	5	0	50	
	14	17	0		0	20	15	15	15	(10)	5	80		10	10	10	10	10	5	5	0	60	
	15	10	0	60	10	20	15	15	15	10	2	77		5	10	5	10	10	5	5	0	50	
	16	30	10		0	20	15	15	15	10	2	77		10	10	10	10	10	5	5	0	60	
	17	30	10		0	20	15	15	0	10	5	65		10	10	10	10	10	5	5	0	60	
	18	30	10		0	20	15	15	15	10	5	80		10	10	10	10	10	5	5	0	60	
	19	30	10		0	20	15	15	0	10	5	65		10	10	10	10	10	0	5	0	55	
	20	35	10		0	20	0	15	15	10	5	65		10	10	0	10	10	5	5	5	55	
	21	10	0		0	20	15	15	0	(10)	0	60		0	10	0	10	10	5	5	0	40	
	22	12	0	60	10	20	15	15	15	10	5	80		10	10	10	10	10	5	5	0	60	
	23	13	0		0	20	15	15	15	10	5	80		10	10	10	10	10	0	5	0	55	
	24	6	0		0	20	15	15	0	10	5	65		10	10	10	10	10	5	5	5	65	
		Circles indicate items not needed																					

MASTER DATA SHEET

		Housekeeping									Body Protection							Miscellaneous								
	School	1 Safety Lines	2 Working Space	3 Non-slippery Floors	4 Safety Container	5 Steps Non-dangerous	6 Housekeeping	Total	Sq. ft. per Pupil		1 Goggles - Shields	2 Welding Helmets	3 Asbestos Gloves	4 Leather Apron	5 Dust Mask	Total		1 Fire Extinguisher	2 Fire Blanket	3 Approved Safety Can	4 Danger-Points Labeled	5 Color-Dynamic	6 Steel Rack	Total	
Perfect		20	20	10	10	10	10	80			20	20	10	10	5	65		10	10	10	10	10	10	60	
	1	0	20	10	10	(10)	10	60	107		20	20	0	0	(5)	45		10	0	(10)	0	5	10	35	
	2	0	20	10	10	(10)	0	50	66		0	20	10	0	(5)	35		10	0	(10)	0	0	0	20	
	3	0	20	10	0	(10)	10	50	42		20	(20)	(10)	(10)	(5)	65		10	0	5	0	0	10	25	
	4	0	20	10	10	10	10	60	66		20	20	(10)	(10)	(5)	65		10	0	10	0	0	10	30	
	5	0	0	10	0	(10)	0	20	37		20	10	0	0	(5)	35		10	0	(10)	0	0	0	20	
	6	0	20	10	10	(10)	10	60	58		20	20	10	10	(5)	65		10	0	0	0	0	10	20	
	7	0	20	10	10	10	10	60	95		10	20	(10)	(10)	(5)	55		10	0	(10)	0	0	0	20	
	8	20	20	10	10	(10)	10	80	88		20	20	10	10	(5)	65		10	0	10	0	0	10	30	
	9	20	20	10	10	(10)	0	70	105		20	20	0	0	(5)	45		10	10	0	10	0	0	30	
	10	0	20	10	0	(10)	10	50	42		20	20	(10)	(10)	(5)	65		10	0	(10)	0	0	10	30	
	11	0	20	10	0	(10)	10	50	131		20	20	10	10	(5)	65		10	0	(10)	0	0	0	20	
	12	0	20	10	0	(10)	10	50	84		20	(20)	(10)	(10)	(5)	65		10	(10)	(10)	10	5	10	55	
	13	0	20	10	0	(10)	10	50	87		20	20	10	10	(5)	65		10	0	10	10	5	10	45	
	14	0	20	10	10	(10)	10	60	133		20	20	10	0	(5)	55		10	0	(10)	0	0	0	20	
	15	0	20	10	0	10	0	40	90		0	(20)	(10)	(10)	(5)	45		10	0	10	0	0	0	20	
	16	0	20	10	0	(10)	10	50	146		20	20	(10)	(10)	(5)	65		10	0	10	10	10	10	50	
	17	0	20	10	10	(10)	10	60	112		20	(20)	(10)	(10)	(5)	65		10	10	(10)	0	0	10	40	
	18	0	0	10	10	10	10	40	30		20	20	(10)	(10)	(5)	65		10	0	10	10	0	10	40	
	19	0	20	10	10	10	10	60	154		20	20	10	10	5	65		10	10	10	0	0	10	40	
	20	20	20	10	10	10	10	80	65		20	20	10	10	5	65		10	0	10	10	10	0	40	
	21	0	20	10	0	10	0	40	48		0	(20)	(10)	(10)	(5)	45		0	0	0	0	0	0	0	
	22	0	20	10	10	10	10	60	75		20	(20)	(10)	(10)	(5)	65		10	0	10	0	0	10	30	
	23	0	20	10	0	(10)	10	50	56		20	20	(10)	(10)	(5)	65		10	10	10	0	10	10	50	
	24	0	20	10	0	(10)	10	50	80		20	15	10	0	(5)	50		10	0	0	0	0	0	10	
	Circles indicate items not needed																								

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