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ABSTRACT

To determine needed competencies in welding for agricultural maintenance, questionnaires from 185 farmers familar with welding and 96 job-shop welders representing 40 percent of the Iowa vocational agriculture departments were rated and evaluated. The ten most needed competencies in arc welding were found to be: (1) understanding of the effect of amperage, arc length, speed of travel, and angle of electrode on weld quality, (2) ability to weld in various positions, (3) understanding of properties of metals, (4) ability to select proper electrode and amperage setting, (5) understanding of poperties and uses of electrodes, (6) understanding of safe operating procedures, (7) ability to prepare and fit pieces to be joined, (8) ability to weld cast and malleable iron, and (9) ability to recognize and make corrections for weld defects. In oxyacetylene welding, the most needed competencies were the abilities to adjust proper gas settings, obtain correct flame, select welding and cutting equipment and materials, identify steel and cast iron temperatures by color, as well as to understand safe operating procedures and the effect of tip size, gas pressures, speed of travel, angle of tip, and type of flame on weld quality. This M.S. thesis was submitted to Iowa State University. (GB)

COMPETENCIES IN WELDING NEEDED FOR AGRICULTURAL MACHINERY MAINTENANCE

by

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Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
MASTER OF SCIENCE

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INTRODUCTION

The evaluation of the content of subject matter units is a continuing process for the vocational educator. Due to changing occupational requirements and changing subject matter technology, units which were designed a few years ago may need to be expanded, curtailed or even dropped as the needs of the students change.

Since the Vocational Education Act of 1963, vocational agriculture teachers have been re-evaluating their subject matter units especially as they relate to the off-farm agricultural related occupations. Much interest has been shown in the agricultural mechanics phases of vocational agriculture both because of the potential in off-farm employment and because of the continued increase in the mechanization of production agriculture.

The 1964 U. S. Census of Agriculture (12) shows the number of tractors on farms in Iowa rose from 232,304 in 1950 to 329,172 in 1964 even though the number of farms having tractors dropped from 159,391 to 143,210 during the same period. The number of pickup balers increased from 13,211 to 60,111 and the number of combines and corn pickers also showed increases during this same period, however, the numbers of the latter two decreased from 1959 to 1964. Another clue to the amount of mechanization taking place is the amount of gasoline and other petroleum fuels and oil used on Iowa farms. This increased from $75,560,738 in 1950 to $106,959,826 in 1964.

One of the more traditional areas of agricultural mechanics is welding. For the past 20 to 30 years, welding has been one of the most common units taught by vocational agriculture teachers in their agricultural

mechanics programs. It has also been a popular unit for adult, young farmer and veterans classes. Henderson (3) found that in 1949, 77.6 percent of the Iowa vocational agriculture instructors surveyed offered welding as a unit in their agricultural mechanics classes. Henderson states (p. 51), "Welding in farm mechanics instruction has increased in importance paralleling that of industrial fabrication." Hoerner (4) found that welding was the most common unit taught in agricultural mechanics classes by Pennsylvania vocational agriculture instructors. The question arises, what are the present and future needs for competence in welding by vocational agriculture students? Is welding still an important unit to be taught? What are the needs for those entering off-farm occupations in agricultural mechanics? These are some of the types of questions which prompted this study.

Specifically, the purposes of this study were:

1. To determine what competencies in welding are needed for agricultural machinery maintenance.
2. To determine to what degree these competencies are needed by farmers and agricultural machinery service personnel.
3. To determine to what degree these competencies are possessed by farmers and agricultural machinery service personnel.
4. To determine what factors have influenced the degree these competencies are needed and possessed by each group.
5. To determine the agricultural education implications in teaching welding at the secondary and post-secondary levels.

For the purposes of this study, welding included manual shielded arc welding and oxygen-acetylene welding and cutting. The term competency

included understandings and abilities. Farmers were defined as those actively engaged in production agriculture while agricultural machinery service personnel included those repairmen employed by retail farm machinery distributors and self-employed job-shop weldors.

This study is one of a series which has been conducted to determine the competencies needed by those entering production agriculture and the off-farm agricultural related occupations. This series has been directed by the Department of Agricultural Education and the Agriculture and Home Economics Experiment Station at Iowa State University in cooperation with the Agriculture Education Section, Division of Vocational Education, State Department of Public Instruction, Des Moines, Iowa.

It was hoped that this study would serve as a basis for revision of present programs and development of new units of instruction in welding at the secondary and post-secondary levels of agricultural education.

REVIEW OF LITERATURE

Several studies have been conducted related to agricultural mechanics. These have been in both the production and off-farm agricultural areas. Several of the studies, which were more general in scope, did mention some of the welding skills. While some have dealt with welding skills needed by farmers, none of the studies reviewed dealt specifically with welding as related to on-farm and off-farm occupations.

In a study conducted in 1948, Kindschy (6) surveyed 246 former Iowa vocational agriculture students, who were then farming, to determine the importance of several areas of agricultural mechanics instruction, one of which was welding. The farmers were contacted through 33 vocational agriculture departments distributed throughout the state. The data were summarized by the five types of farming areas of Iowa and also for the state as a whole. The farmers were asked to rate each competency as: important, of little importance, or should not be included in the vocational agriculture curriculum. There was not a number rating attached to each category. Percentages were computed as to the number which rated the competency as important.

Of the five welding competencies included in the survey, the ability to select pieces to be welded was rated as important by 85 percent of the respondents. The second highest competency was the ability to recognize a good weld when the work was done by a tradesman. This ability received important ratings by 78.6 percent of the farmers replying. The ability to arc weld was rated important by 75 percent of those who responded, whereas the ability to weld, with both gas and arc, was rated important by 56.5

percent. The ability to gas weld was rated lowest with 52 percent. Kindschy (6), using the chi-square technique, did find significant differences among the different types of farming areas of the state.

In his summary of the data on welding, Kindschy (p. 14) stated,

> It might be concluded from these tabulations of the importance of welding as course content for departments of vocational agriculture in Iowa, that the ability to determine what pieces can satisfactorily be welded, the ability to recognize a good weld when the work is done by a tradesman, and the ability to arc weld to the extent that the student can weld cast and malleable iron for average farm repair and construction, should be included in vocational instruction in agriculture. Acetylene welding could be touched upon rather briefly, if at all, perhaps depending upon the need as determined by local conditions where the instruction is to be given. Also it could be concluded that the importance of the need for the welding abilities listed on the schedule varies with the type of farming areas.

In 1949, Henderson (3) surveyed 152 vocational agriculture departments offering agricultural mechanics programs in Iowa. Of these, 100 reported they had arc welding equipment with 57 of these classifying their usage as "much" and 43 classifying their usage as "some." He also found that of the 152 schools reporting, 82 had oxy-acetylene welding equipment with 37 classifying their usage as "much" and 45 "some." In his report, Henderson[1] (Pp. 78-79) stated,

> Arc welders have become increasingly popular since the expansion of electric power lines in rural areas by the Rural Electrification Administration and by other public service organizations. More schools are teaching welding than ever before, and there has been a growing interest in such training particularly in adult, young farmer, and veteran's classes.
>
> Because of it's speed, savings of material, and strength, the manufacturing and building industries use welding for fabrication of many joints, this is true in farm machinery. Oftentimes, now, a farmer cannot fix a machine by simply

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[1] Henderson's reference in the following quote was to Kindschy (6).

replacing broken or worn parts, the joint must be welded which is a faster process anyway.

The need for training in welding is not merely to teach farmers to weld. Many farmers do not have welders at the present time and some perhaps never will have such equipment. But it is of benefit to the farmer to be able to recognize a good weld or a poor one and to understand which material may or may not be fabricated in this manner. According to a recent survey (1) the foregoing two points were considered by Iowa farmers as the most important thing to be learned in the welding unit.

Norfleet and Riggs (9) reported a study conducted in Indiana, in which 75 vocational agriculture instructors were surveyed to determine the skills they felt should be taught and when they would teach them. Eighty-seven percent of the 75 teachers returned usable questionnaires. A list of skills was developed by the researchers and reviewed by agricultural education and agricultural engineering staff members at Purdue University. A list of 66 skills were included in the questionnaire. Thirty-two were in arc welding, and 36 were in oxy-acetylene welding. Eight additional arc welding and 2 additional oxy-acetylene welding skills were recommended by the teachers surveyed for a total of 75 skills. Each instructor was asked to indicate when he taught each skill.

It was determined by the researchers that the largest percentage of arc welding skills were taught to juniors with 31.8 percent in this category. The second highest percentage was to the senior class with 25.9 percent followed by the sophomore class with 22.5 percent of the skills being taught. Twenty-one percent of the skills were taught to young farmers, 20.7 percent taught to adults and 13.8 percent to freshmen.

In the oxy-acetylene area, lower percentages were taught in all categories. The researchers reported 20.6 percent of the oxy-acetylene skills

were taught to juniors, 17.1 percent to seniors, 15.2 percent to sophomores, 12.3 percent to young farmers and 11.2 percent to adult farmers. The least number of skills was 7.7 percent taught to freshmen.

The general breakdown of welding skills were: 1. Arc welding--a. general, b. fundamentals, c. flat and horizontal position, d. vertical position, and e. miscellaneous welding operations; 2. Oxy-acetylene welding--a. general, b. fundamentals, c. fusion welding, d. braze (bronze) welding, and e. other oxy-acetylene welding operations.

In another study related to welding, Merrill (7) asked a group of successful farmers to evaluate the farm mechanics course of study in Idaho. One hundred seventeen former Idaho State Farmer Degree winners, who were considered successful farmers by the vocational agriculture teachers and county agents in their local areas were surveyed. The farmers were selected randomly with one drawn from each school district in the state and 40 additional selected from the state at random. A 75 percent response was received for a total of 117.

Of the 23 units included in the survey, arc welding instruction was received in the vocational agriculture shop by 78 percent of the farmers and oxy-acetylene instruction was had by 76 percent. These were the highest percentages reported among the 23 units of instruction.

When asked which of the units should be taught, 97 percent reported they felt arc welding should be taught in the agricultural mechanics program and 98 percent felt oxy-acetylene should be taught. Other units reported with high scores were: Tractor maintenance, 99 percent; construction and repair, 99 percent; farm machinery, 98 percent; and farm leveling, 97 percent.

The farmers surveyed were also asked to rate each unit as to its value on the farm. Both arc and oxy-acetylene welding were rated by 84 percent of the respondents as "very useful," 14 percent indicated "some use," whereas 2 percent indicated "no value." Other units rated high were: Construction and repair, 96 percent; tractor maintenance, 91 percent; and farm machinery, 84 percent in the "very useful" category.

In a ranking of the instructional units, the researcher reported that the farmers ranked both arc and oxy-acetylene skills in the upper 50 percent. Specifically, of the 67 skill areas, arc welding techniques ranked second; arc welding-electrodes ranked fourth; principles of arc welding ranked seventh; oxy-acetylene welding techniques ranked eighth; use of carbon arc torch ranked nineteenth; small oxy-acetylene welding projects ranked twenty-second; and small arc welding projects ranked thirty-second.

In his summary, Merrill (7) concluded that the five most important instructional areas in vocational agriculture mechanics were: (1) construction of projects, (2) tractor care and maintenance, (3) arc welding, (4) oxy-acetylene welding, and (5) farm machinery. The recommended Idaho vocational agriculture curriculum permits 50 percent of the total instructional time to be devoted to agricultural mechanics and of this 30 hours to arc welding and 20 hours to oxy-actylene welding.

In 1964, two studies were completed at Iowa State University which dealt with agricultural mechanics. The first, by Kahler (5), was designed to determine the competencies needed by males employed in retail farm machinery distributorships. One hundred sixty-six farm machinery distributors were surveyed to determine these needed competencies. Fifty-six agricultural competencies were included in the questionnaire which was

completed by managerial, clerical, sales, parts, and service employees. Of the 56 competencies included, one dealt with welding, namely, the ability to use both arc and oxy-acetylene welders in making special process welds. This competency was rated as one of the 10 most needed for parts and service employees.

In the same year, Robinson (10) surveyed 400 Iowa farmers to determine the competencies needed in farm machinery maintenance. The respondents were divided into "farmer" and "outstanding farmer" groups. Of the 47 competencies in this study, the ability to weld new points and edges on plow shares ranked 4th in the degree of competence needed, and the ability to hardsurface plow shares ranked 5th in competence needed by the farmer group. The outstanding farmer group ranked these two abilities, 8th and 4th respectively, in the degree of competence needed.

In another study related to agricultural mechanics, Dettmann (1) received questionnaires from 156 Iowa vocational agriculture instructors to determine the competencies needed to teach vocational agriculture. The questionnaire included 56 competencies of which 14 were related to welding. Of these, 6 were arc welding and 8 were oxy-acetylene competencies. These competencies were: Understandings--(1) operating principles and selection of arc welders, (2) electrode selection, (3) distortion of metals and its control, (4) principles of acetylene welding, (5) basic metallurgy as related to welding and metal work, (6) safety factors in welding; Abilities--(1) electric arc weld in all positions, (2) cut with arc welder, (3) use of the carbon torch, (4) prepare metal projects for welding, (5) set up oxy-acetylene welder, light and adjust flames, (6) fusion weld various metals: steel, cast, aluminum, (7) braze weld, and (8) cut with oxy-acetylene.

The competencies were all determined as needed by the vocational agriculture instructors.

In an Illinois study by Young (13), 250 farmers were surveyed to determine the equipment they had related to agricultural mechanics. Of the 250 farmers replying, 38.4 percent had electric welders, whereas 17.2 percent had acetylene welders. Of those farms over 480 acres, 71.8 percent had electric welders and 35.9 percent had acetylene welders.

Eaddy (2) made a study in Louisiana to find: (1) whether or nor welding instruction should be included in the farm mechanics course, (2) what skills should be taught, and (3) what equipment should be obtained to conduct a satisfactory program of welding instruction in departments of vocational agriculture in Louisiana.

He sent questionnaires to 300 farmers through 100 vocational agriculture departments stratified by the major agricultural production areas of Louisiana. Fifty-one percent responded. Factors considered in determining need for welding competencies were: (1) interest in welding, (2) welding services utilized by farmers, (3) investment in farm machinery, and (4) ownership of welding equipment. Six conclusions were drawn by the researcher in this study. They were: (1) welding instruction should be provided to inform the students of the potential economy of this type of farm machinery maintenance; (2) the electric arc and oxy-acetylene welding processes are perhaps most useful because they are best adapted to on-the farm operations; (3) the subject areas of welding determined to be of greater importance to farmers were maintenance and safe operation of welding equipment, basic skills in oxy-acetylene welding, identification of various metals and welding technique, and repair and construction of farm

machinery and equipment; (4) a minimum of two stationary type A.C. welding machines rated at 180 amperes and powered by 230 volt service outlets should be primarily used for welding instruction with classes of 12 to 15 students in vocational agriculture; (5) a minimum of one set of oxy-acetylene welding equipment, perhaps of medium duty service, should be obtained for instruction of the gas welding processes in classes of 12 to 15 students; and (6) a survey should be made by departments of vocational agriculture concerning the need for welding instruction.

Hoerner (4) studied the competencies needed and possessed by teachers of agriculture in Pennsylvania. One hundred forty-eight skills were divided into seven groups: (1) general mechanics, (2) carpentry construction, (3) welding and metals, (4) concrete, (5) power and machinery, (6) electricity and motors, and (7) irrigation and soils. Results indicated the Pennsylvania teachers taught arc welding as the most common unit in the four-year program. Out of a pos ible score of four which would indicate the unit in a four-year progra and had been taught, the 133 responding teachers' mean frequency was 3.8 for the highest mean of all units. The Pennsylvania teachers also revealed that they spent 43 percent of their teaching time in agricultural mechanics.

When asked to rate the seven skills groups as to degree of competence needed, the teachers rated welding and metals skills with a mean competence needed score of 2.92 and a mean competence possessed score of 2.50. These mean competence needed and possessed scores were the highest of the seven skill groups. A score of 4 indicated very much competence needed or possessed. A score of 0 indicated no competence needed or possessed. The welding competencies identified and listed in order of degree of competence

needed were: (1) select oxy-acetylene welding and cutting equipment; (2) attach and adjust gauges and regulators for gas welding; (3) select proper flux, rods, and tips for gas welding; (4) select arc welding electrodes; (5) identify metals by the spark test; (6) operate a carbon arc torch; (7) make common welds in the four positions (flat, horizontal, vertical, and overhead); (8) operate and maintain an electric arc welder; (9) operate and maintain a TIG or MIG welding machine; (10) select electric arc welding machines; (11) braze, weld and cut metal with oxy-acetylene; (12) understand the principles of operation of the arc welding machine; and (13) understand the principles of the fusion and adhesion welding processes.

The Center for Research and Leadership Development in Vocational and Technical Education (8, p. i) at the Ohio State University, in its course of study for preparation for entry into agricultural machinery-service occupations, recommends a 48 hour course in welding. Of the 48 hours, 12 hours are in classroom instruction and 36 hours involve laboratory experience. The competencies to be developed are:

I. To understand the fundamentals and safe practices of welding.
II. To select and care for welding equipment.
III. To identify metals commonly welded.
IV. To select the proper electrode.
V. To become proficient in striking an arc; carrying a puddle, and re-starting the arc.
VI. To run a bead in a weaving motion.
VII. To make a butt weld.
VIII. To fillet weld in the flat and horizontal position.
IX. To weld in the vertical position.
X. To weld in the overhead position.
XI. To operate and maintain a carbon arc torch.
XII. To operate and maintain an oxy-acetylene torch, and to fusion-weld.
XIII. To hardsurface metals (ferrous).
XIV. To cut metal with an arc welder and oxy-acetylene welder.
XV. To weld nonferrous metals and braze ferrous metals.
XVI. To weld with inert gas.

METHOD OF PROCEDURE

Identification of Competencies

One of the most important aspects of this study was the identification of the competencies to be included in the questionnaire. To accomplish this, the researcher located and obtained the assistance of a panel of specialists. Eleven such persons were located. Included in the panel were two university agricultural engineering staff members, two welding industry representatives, two vocational agriculture teachers, two job-shop weldors and three farmers. The names of those participating on the panel were: Assoc. Prof. Thomas Hoerner, Agricultural Engineering Department, Iowa State University; Asst. Prof. Willard Anderson, Agricultural Engineering Department, Iowa State University; Mr. Charles Kessler, Kessler Distributing Co., Fairfield, Iowa; Mr. Lee Algood, Lincoln Electric Co., Des Moines, Iowa; Mr. Charles Perdue, Vocational Agriculture Instructor, Oskaloosa, Iowa; Mr. Elwood P. Iverson, Vocational Agriculture Instructor, Hawarden, Iowa; Mr. David Renfrow, Renfrow Welding Shop, Pleasantville, Iowa; Mr. Merlin Okland, Okland Welding Shop, Story City, Iowa; Mr. Dean Goldsmith, Corning, Iowa; Mr. David Schrader, Charles City, Iowa; and Mr. Ralph Sonnicksen, Webster City, Iowa.

Lists of competencies (understandings and abilities) were suggested by the 11 panel members. At that time, understandings were defined as "mental skills" while abilities were defined as "primarily physical skills." The lists from the panel members was consolidated by the researcher, standardized in form, abbreviated in wording and returned to the panel for corrections or additional suggestions. A final list of 50 com-

petencies was obtained. Of these, 27 were arc welding and 23 were oxy-acetylene welding competencies. A five-level rating scale was assigned to the 50 competencies under two categories, competence needed and competence possessed. The levels of the rating scale were: 4 - very much competence needed (or possessed), 3 - much competence needed (or possessed), 2 - some competence needed (or possessed), 1 - little competence needed (or possessed), and 0 - no competence needed (or possessed).

Information Sheet

Additional information was obtained from the respondents. The farmer group provided the following information: age, total acreage of farm or farms operated, farming status, type of farm, highest grade completed in school, training received in welding, welding equipment on the farm, value of welding to the farm per year, amount of time spent welding per year, whether or not they weld for others, and the percentage of their welding time spent welding for others.

The job-shop weldor group provided information concerning the following: age, percentage of their time spent as a weldor, percentage of their time spent welding on agricultural machinery, whether or not they make and sell welded metal equipment, percentage of time spent welding on metal equipment to be sold, highest grade completed in school, training received in welding, and welding equipment in their shop. The form of these questions may be seen in the actual questionnaires in the Appendix.

Selection of Sample

A random sample by Iowa supervisory district was selected from the Iowa Vocational Agriculture Departments. Forty percent of the departments

from each district were selected. Each of the 96 departments selected were contacted and asked for lists of names of all of the job-shop weldors in their community, and the names of four farmers who were familiar with welding. Eighty-eight percent of the departments responded with the names of 300 farmers and 218 job-shop weldors.

Collection of Data

Separate questionnaires identified by color were sent to the two groups. Ninety-six (44 percent) usable questionnaires were obtained from the job-shop weldor group while 185 (61.6 percent) usable questionnaires were obtained from the farmer group. Of the 185 questionnaires returned by the farmer group, 44 did not complete the section on oxy-acetylene welding but were considered usable for the rest of the data.

The information from the questionnaires was coded onto 80 column data cards and machine tabulated by the Computation Center at Iowa State University. Statistical analyses were in accordance with Snedecor and Cochran (11).

FINDINGS

Objectives

The objectives of this study were: (1) to determine what competencies in welding are needed for agricultural machinery maintenance, (2) to determine to what degree these competencies are needed by farmers and agricultural machinery service personnel, (3) to determine to what degree these competencies are possessed by farmers and agricultural machinery service personnel, (4) to determine what factors have influenced the degree these competencies are needed and possessed by members of each group, and (5) to determine the agricultural education implications in teaching welding at the secondary and post-secondary levels. In order to achieve these objectives, several null hypotheses were stated. Where a statistical analysis was used to test these hypotheses, the .05 level of significance was used as the basis for acceptance or rejection.

Rating of Competencies, Needed and Possessed

The first two hypotheses stated were in relation to identifying the welding competencies needed and possessed in agricultural machinery maintenance. They were: (Ho:1) there are no competencies in welding (a) needed or (b) possessed by farmers, and (Ho:2) there are no competencies in welding (a) needed or (b) possessed by job-shop weldors.

A tabulation of the mean scores of the competencies for the farmer group show mean competence needed scores of 2.24 or above and mean competence possessed scores of 1.37 or above. The overall grand mean competence needed score for the farmer group was 2.87 and the overall grand mean competence possessed score was 2.03. Since the scale used to rate

the competencies was: 4 - very much competence needed (or possessed), 3 - much competence needed (or possessed), 2 - some competence needed (or possessed), 1 - little competence needed (or possessed), 0 - no competence needed (or possessed); the first hypothesis was rejected.

A similar tabulation of the mean scores for the job-shop weldors showed mean competence needed scores of 2.51 or above and mean competence possessed scores of 2.23 or above. The overall grand mean competence needed score for the job-shop weldor group was 2.96 and the overall grand mean competence possessed score was 2.84. These scores indicated a rejection of the second hypothesis. A tabulation of these mean scores is shown in Table 1, in the order in which they were asked on the questionnaire.

The next four hypotheses stated were: (Ho:3) there is no similarity in the rank order of the degree the specific arc welding competencies are needed by farmers and job-shop weldors, (Ho:4) there is no similarity in the rank order of the degree the specific oxy-acetylene welding competencies are needed by farmers and job-shop weldors, (Ho:5) there is no similarity in the rank order of the degree the specific arc welding competencies are possessed by farmers and job-shop weldors, and (Ho:6) there is no similarity in the rank order of the degree the specific oxy-acetylene welding competencies are possessed by farmers and job-shop weldors.

The Spearman rank order coefficient of correlation was used to test these hypotheses. The formula used was from Snedecor and Cochran (11, p. 194).

$$r_s = 1 - \frac{6\Sigma d^2}{N(N^2 - 1)}$$

The rank order coefficient of correlation for the arc welding competencies

Table 1. Competencies in welding needed and possessed by farmers and job-shop weldors

Competency	Farmers		Job-shop weldors	
	Degree needed[a]	Degree possessed[b]	Degree needed	Degree possessed
Arc welding competencies	N = 185		N = 96	
Understandings:				
1. Safe operating procedures for arc welding.	3.00	2.63	3.20	2.97
2. Basic electricity as it applies to arc welding.	2.37	2.13	2.40	2.39
3. Operating characteristics of AC and DC welding machines.	2.43	2.03	2.76	2.70
4. Processes involved in the arc and molten pool during welding.	2.76	2.25	2.85	2.72
5. Affect of amperage, arc length, speed of travel and angle of electrode on weld quality.	3.29	2.64	3.28	3.20
6. Properties of metals as they affect weld-ability.	3.18	2.23	3.32	2.79
7. Affect of weld distortion on metals.	2.90	2.14	3.09	2.69
8. Functions of flux coating on electrodes.	2.43	2.05	2.68	2.53
9. Properties and uses of various electrodes.	3.03	2.16	3.23	2.81
10. Elementary blueprints and weld symbols.	2.24	1.43	2.44	2.23

[a] 4 - very much competence needed, 3 - much competence needed, 2 - some competence needed, 1 - little competence needed, 0 - no competence needed.

[b] 4 - very much competence possessed, 3 - much competence possessed, 2 - some competence possessed, 1 - little competence possessed, 0 - no competence possessed.

Table 1 (Continued)

Competency	Farmers		Job-shop weldors	
	Degree needed[a]	Degree possessed[b]	Degree needed	Degree possessed
Abilities:				
1. Select and maintain arc welding machines.	2.53	2.03	2.66	2.68
2. Identify various metals by inspection and spark testing.	2.88	1.79	3.11	2.66
3. Select proper electrode and amperage setting.	3.18	2.66	3.35	3.15
4. Prepare and fit pieces to be joined.	2.99	2.75	3.08	3.15
5. Position, clamp and weld metals to control distortion.	2.99	2.32	3.10	2.98
6. Recognize and make corrections for weld defects.	2.94	2.17	3.15	2.97
7. Make bead and butt welds in the flat position.	2.77	2.74	2.79	3.21
8. Make weave or spread beads in the flat position.	2.81	2.57	2.82	3.07
9. Make lap and fillet welds in the flat position.	2.73	2.50	2.81	3.04
10. Make welds in horizontal, vertical and overhead positions.	3.21	1.98	3.29	2.96
11. Make welds using low hydrogen electrodes.	2.61	1.54	3.00	2.71
12. Make welds using hardsurfacing electrodes.	2.73	1.77	2.75	2.57
13. Weld cast and malleable iron using steel and nickel electrodes.	2.98	2.11	3.00	2.75
14. Join metals of different thicknesses.	2.74	2.39	2.89	3.06
15. Weld joints with poor fit.	2.77	2.33	3.01	2.97
16. Cut, gouge and pierce metals with appropriate electrodes.	2.72	2.30	2.35	2.51
17. Make tee and butt welds in pipe.	2.76	2.16	2.83	2.72

Table 1 (Continued)

Competency	Farmers		Job-shop weldors	
	Degree needed[a]	Degree possessed[b]	Degree needed	Degree possessed
Oxy-acetylene welding competencies				
Understandings:				
1. Safe operating procedures for O-A welding.	3.09	2.11	3.32	3.07
2. Properties of gases used in O-A welding.	2.64	1.62	2.70	2.58
3. Operating characteristics of O-A welding equipment.	2.95	1.96	2.98	2.90
4. Properties and uses of carburizing, neutral and oxidizing flames.	2.87	1.51	2.97	2.71
5. Affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality.	3.13	1.80	3.19	2.96
6. Properties and uses of fluxes in O-A welding.	2.90	1.62	2.99	2.85
7. Properties and uses of various filler rods.	2.83	1.47	2.74	2.51
8. Fusion process in joining metals.	2.80	1.52	2.86	2.64
9. Brazing process in joining metals.	2.94	1.94	3.02	2.96
10. Oxygen cutting process.	2.93	2.29	2.96	3.08
Abilities:				
1. Select and maintain O-A welding equipment.	2.99	1.89	3.01	2.83
2. Select and maintain welding and cutting tips.	3.01	1.93	2.99	3.02
3. Select correct filler rod and flux.	2.99	1.68	3.04	2.89
4. Adjust proper gas pressures.	3.14	2.03	3.09	3.04
5. Select, light and adjust the correct flame.	3.06	2.18	3.12	3.21
6. Control heat by torch manipulation.	2.96	1.94	3.06	3.07
7. Identify steel and cast iron temperatures by color.	2.96	1.37	2.98	2.45
8. Make bead and butt welds with steel filler rod.	2.80	1.52	2.94	2.81

Competency	Farmers		Job-shop weldors	
	Degree needed[a]	Degree possessed[b]	Degree needed	Degree possessed
9. Make bead and butt welds with brass or bronze rod.	2.85	1.74	2.94	2.90
10. Make fillet welds with brass or bronze rod.	2.86	1.67	2.89	2.79
11. Braze weld cast or malleable iron.	2.90	1.65	3.04	2.89
12. Join thin metals by O-A welding.	2.94	1.89	2.98	2.93
13. Cut, gouge and pierce metal with cutting torch.	3.00	2.26	2.99	3.09
Overall grand mean	2.87	2.03	2.96	2.85

needed was .9098 indicating rejection of Ho:3 beyond the .01 level. According to Snedecor and Cochran (11, p. 557), the tabled values needed for rejection were .381 at the .05 level and .487 at the .01 level with 25 degrees of freedom (N-2).

The rank order coefficient of correlation for the oxy-acetylene welding competencies needed was .8622, indicating rejection of Ho:4 beyond the .01 level. According to Snedecor and Cochran (p. 557), the tabled values needed for rejection were .413 at the .05 level and .526 at the .01 level with 21 degrees of freedom (N-2).

The rank order coefficient of correlation for the arc welding competencies possessed was .8172 indicating rejection of Ho:5 beyond the .01 level. The rank order coefficient of correlation for the oxy-acetylene welding competencies possessed was .9293 indicating rejection of Ho:6 beyond the .01 level. Tables 2, 3, 4, and 5 show the rank order of the competencies for these four comparisons.

The next analysis of the data involved determining the significance of the differences between groups. The hypotheses stated were: (Ho:7) there is no difference between the arc welding competence needed scores of farmers and job-shop weldors, (Ho:8) there is no difference between the arc welding competence possessed scores of farmers and job-shop weldors, (Ho:9) there is no difference between the oxy-acetylene welding competence needed scores of farmers and job-shop weldors, and (Ho:10) there is no difference between the oxy-acetylene welding competence possessed scores of farmers and job-shop weldors.

The t-test was used to test the hypotheses concerning the mean scores presented in Table 6. The formula used was from Snedecor and Cochran

Competency (U = understanding) (A = ability)	Farmers N = 185 Degree needed	Rank	Job-shop welders N = 96 Degree needed	Rank
U - Affect of amperage, arc length, speed of travel and angle of electrode on weld quality.	3.29	1	3.28	4
A - Make welds in horizontal, vertical and overhead positions.	3.21	2	3.29	3
U - Properties of metals as they affect weld-ability.	3.18	3.5	3.32	2
A - Select proper electrode and amperage setting.	3.18	3.5	3.35	1
U - Properties and uses of various electrodes.	3.03	5	3.23	5
U - Safe operating procedures for arc welding.	3.00	6	3.20	6
A - Prepare and fit pieces to be joined.	2.99	7.5	3.08	11
A - Position, clamp and weld metals to control distortion.	2.99	7.5	3.10	9
A - Weld cast and malleable iron using steel and nickel electrodes.	2.98	9	3.00	13.5
A - Recognize and make corrections for weld defects.	2.94	10	3.15	7
U - Affect of weld distortion on metals.	2.90	11	3.09	10
A - Identify various metals by inspection and spark testing.	2.88	12	3.11	8
A - Make weave or spread beads in the flat position.	2.81	13	2.82	18
A - Make bead and butt welds in the flat position.	2.77	14.5	2.79	20
A - Weld joints with poor fit.	2.77	14.5	3.01	12
U - Processes involved in the arc and molten pool during welding.	2.76	16.5	2.85	16
A - Make tee and butt welds in pipe.	2.76	16.5	2.83	17
A - Join metals of different thicknesses.	2.74	18	2.89	15
A - Make lap and fillet welds in the flat position.	2.73	19.5	2.81	19
A - Make welds using hardsurfacing electrodes.	2.73	19.5	2.75	22
A - Cut, gouge and pierce metals with appropriate electrodes.	2.72	21	2.35	27
A - Make welds using low hydrogen electrodes.	2.61	22	3.00	13.5
A - Select and maintain arc welding machines.	2.53	23	2.66	24

Table 2 (Continued)

Competency (U = understanding) (A = ability)	Farmers N = 185		Job-shop weldors N = 96	
	Degree needed	Rank	Degree needed	Rank
U - Operating characteristics of AC and DC welding machines.	2.43	24.5	2.76	21
U - Functions of flux coating on electrodes.	2.43	24.5	2.68	23
U - Basic electricity as it applies to arc welding.	2.37	26	2.40	26
U - Elementary blueprints and weld symbols.	2.24	27	2.44	25

Table 3. Rank of oxy-acetylene competencies needed by farmers and job-shop weldors

Competency (U = understanding) (A = ability)	Farmers N = 141		Job-shop weldors N = 96	
	Degree needed	Rank	Degree needed	Rank
A - Adjust proper gas pressures.	3.14	1	3.09	4
U - Affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality.	3.13	2	3.19	2
U - Safe operating procedures for O-A welding.	3.09	3	3.32	1
A - Select, light and adjust the correct flame.	3.06	4	3.12	3
A - Select and maintain welding and cutting tips.	3.01	5	2.99	11
A - Cut, gouge and pierce metal with cutting torch.	3.00	6	2.99	11
A - Select and maintain O-A welding equipment.	2.99	7.5	3.01	9
A - Select correct filler rod and flux.	2.99	7.5	3.04	6.5
A - Control heat by torch manipulation.	2.96	9.5	3.06	5
A - Identify steel and cast iron temperatures by color.	2.96	9.5	2.98	14
U - Operating characteristics of O-A welding equipment.	2.95	11	2.98	14
U - Brazing process in joining metals.	2.94	12.5	3.02	8
A - Join thin metals by O-A welding.	2.94	12.5	2.98	14
U - Oxygen cutting process.	2.93	14	2.96	17
U - Properties and uses of fluxes in O-A welding.	2.90	15.5	2.99	11
A - Braze weld cast or malleable iron.	2.90	15.5	3.04	6.5
U - Properties and uses of carburizing, neutral and oxidizing flames.	2.87	17	2.97	16
A - Make fillet welds with brass or bronze rod.	2.86	18	2.89	20
A - Make bead and butt welds with brass or bronze rod.	2.85	19	2.94	18.5
U - Properties and uses of various filler rods.	2.83	20	2.74	22
U - Fusion process in joining metals.	2.80	21.5	2.86	21
A - Make bead and butt welds with steel filler rod.	2.80	21.5	2.94	18.5
U - Properties of gases used in O-A welding.	2.64	23	2.70	23

Table 4. Rank of arc welding competencies possessed by farmers and job-shop weldors

Competency (U = understanding) (A = ability)	Farmers N = 185		Job-shop weldors N = 96	
	Degree possessed	Rank	Degree possessed	Rank
A - Prepare and fit pieces to be joined.	2.75	1	3.15	3.5
A - Make bead and butt welds in the flat position.	2.74	2	3.21	1
A - Select proper electrode and amperage setting.	2.66	3	3.15	3.5
U - Affect of amperage, arc length, speed of travel and angle of electrode on weld quality.	2.64	4	3.20	2
U - Safe operating procedures for arc welding.	2.63	5	2.97	10
A - Make weave or spread beads in the flat position.	2.57	6	3.07	5
A - Make lap and fillet welds in the flat position.	2.50	7	3.04	7
A - Join metals of different thicknesses.	2.39	8	3.06	6
A - Weld joints with poor fit.	2.33	9	2.97	10
A - Position, clamp and weld metals to control distortion.	2.32	10	2.98	8
A - Cut, gouge and pierce metals with appropriate electrodes.	2.30	11	2.51	25
U - Processes involved in the arc and molten pool during welding.	2.25	12	2.72	16.5
U - Properties of metals as they affect weld-ability.	2.23	13	2.79	14
A - Recognize and make corrections for weld defects.	2.17	14	2.97	10
U - Properties and uses of various electrodes.	2.16	15.5	2.81	13
A - Make tee and butt welds in pipe.	2.16	15.5	2.72	16.5
U - Affect of weld distortion on metals.	2.14	17	2.69	20
U - Basic electricity as it applies to arc welding.	2.13	18	2.39	26
A - Weld cast and malleable iron using steel and nickel electrodes.	2.11	19	2.75	15
U - Functions of flux coating on electrodes.	2.05	20	2.53	24
U - Operating characteristics of AC and DC welding machines.	2.03	21.5	2.70	19
A - Select and maintain arc welding machines.	2.03	21.5	2.68	21
A - Make welds in horizontal, vertical and overhead positions.	1.98	23	2.96	12

Table 4 (Continued)

Competency (U = understanding) (A = ability)	Farmers N = 185		Job-shop weldors N = 96	
	Degree possessed	Rank	Degree possessed	Rank
A - Identify various metals by inspection and spark testing.	1.79	24	2.66	22
A - Make welds using hardsurfacing electrodes.	1.77	25	2.57	23
A - Make welds using low hydrogen electrodes.	1.54	26	2.71	18
U - Elementary blueprints and weld symbols.	1.43	27	2.23	27

Table 5. Rank of oxy-acetylene competencies possessed by farmers and job-shop weldors

Competency (U = understanding) (A = ability)	Farmers N = 141		Job-shop weldors N = 96	
	Degree possessed	Rank	Degree possessed	Rank
U - Oxygen cutting process.	2.29	1	3.08	3
A - Cut, gouge and pierce metal with cutting torch.	2.26	2	3.09	2
A - Select, light and adjust the correct flame.	2.18	3	3.21	1
U - Safe operating procedures for O-A welding.	2.11	4	3.07	4.5
A - Adjust proper gas pressures.	2.03	5	3.04	6
U - Operating characteristics of O-A welding equipment.	1.96	6	2.90	11.5
U - Brazing process in joining metals.	1.94	7.5	2.96	8.5
A - Control heat by torch manipulation.	1.94	7.5	3.07	4.5
A - Select and maintain welding and cutting tips.	1.93	9	3.02	7
A - Select and maintain O-A welding equipment.	1.89	10.5	2.83	16
A - Join thin metals by O-A welding.	1.89	10.5	2.93	10
U - Affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality.	1.80	12	2.96	8.5
A - Make bead and butt welds with brass or bronze rod.	1.74	13	2.90	11.5
A - Select correct filler rod and flux.	1.68	14	2.89	13.5
A - Make fillet welds with brass or bronze rod.	1.67	15	2.79	18
A - Braze weld cast or malleable iron.	1.65	16	2.89	13.5
U - Properties of gases used in O-A welding.	1.62	17.5	2.58	21
U - Properties and uses of fluxes in O-A welding.	1.62	17.5	2.85	15
U - Fusion process in joining metals.	1.52	19.5	2.64	20
A - Make bead and butt welds with steel filler rod.	1.52	19.5	2.81	17
U - Properties and uses of carburizing, neutral and oxidizing flames.	1.51	21	2.71	19
U - Properties and uses of various filler rods.	1.47	22	2.51	22
A - Identify steel and cast iron temperatures by color.	1.37	23	2.45	23

Table 6. Grand means and t-values for differences between farmers and job-shop weldors in arc and oxy-acetylene welding competencies needed and possessed

Competencies	Farmers	Job-shop weldors	Diff.	t-value
	Grand means	Grand means		
Arc welding needed	2.81	2.93	.12	1.653
Arc welding possessed	2.21	2.93	.61	7.408**
Oxy-acetylene welding needed	2.94	2.99	.05	1.466
Oxy-acetylene welding possessed	1.81	2.88	1.07	15.858**

**Significant at the .01 level.

(11, p. 103).

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_{\bar{X}_1 - \bar{X}_2}}$$

The grand mean competence needed score for all arc welding competencies for the farmer group was 2.81, and 2.93 for the job-shop group. The t-value for the difference between these two means was 1.653 indicating failure to reject Ho:7. According to Snedecor and Cochran (p. 549), the tabled values necessary for rejection were 2.006 at the .05 level and 2.674 at the .01 level with 52 degrees of freedom 2(N-1).

The grand mean competence possessed score for all arc welding competencies for the farmer group was 2.21 and 2.82 for the job-shop group. The t-value for the difference between these two means was 7.408 indicating

rejection of Ho:8 beyond the .01 level.

The grand mean competence needed score for all oxy-acetylene welding competencies was 2.94 for the farmers and 2.99 for the job-shop weldors. The t-value of the difference between these two means was 1.466 indicating failure to reject Ho:9. According to Snedecor and Cochran (11, p. 549), the tabled values necessary for rejection were 2.015 at the .05 level and 2.693 at the .01 level with 44 degrees of freedom 2(N-1).

The grand mean competence possessed score for all oxy-acetylene welding competencies was 1.81 for the farmer group and 2.88 for the job-shop weldor group. The t-value of the difference between these two means was 15.858 indicating rejection of Ho:10 beyond the .01 level.

The next treatment of data dealt with the differences between the mean scores within groups. The hypotheses stated were: (Ho:11) there is no difference between the arc welding competence needed and possessed scores for farmers, (Ho:12) there is no difference between the arc welding competence needed and possessed scores for job-shop weldors, (Ho:13) there is no difference between the oxy-acetylene welding competence needed and possessed scores for farmers, and (Ho:14) there is no difference between the oxy-acetylene welding competence needed and possessed scores for job-shop weldors. The t-test was used to test these hypotheses.

The grand mean competence needed score for all arc welding competencies for the farmer group was 2.81, whereas the grand mean competence possessed score was 2.21. The t-value of the difference between these two means was 7.189, indicating rejection of Ho:11 beyond the .01 level.

The grand mean competence needed score for all arc welding competencies for the job-shop weldor group was 2.93, whereas the grand mean

competence possessed score was 2.82. The t-value of the difference between these two means was 1.571 indicating failure to reject Ho:12.

The grand mean competence needed score for all oxy-acetylene welding competencies for the farmer group was 2.94, whereas the grand mean competence possessed score was 1.81. The t-value of the difference between these two means was 19.028 indicating rejection of Ho:13 beyond the .01 level.

The grand mean competence needed score for all oxy-acetylene welding competencies for the job-shop weldor group was 2.99, whereas the grand mean competence possessed score was 2.88. The t-value of the difference between these two means was 2.394 indicating rejection of Ho:14 at the .05 level. The tabulation of these means and t-values may be seen in Table 7.

Table 7. Grand means and t-values for differences between competencies needed and possessed in arc and oxy-acetylene welding by farmers and by job-shop weldors

Competencies	Needed	Possessed	Diff.	t-value
	Grand means	Grand means		
Farmers--arc welding	2.81	2.21	.60	7.189**
Job-shop weldors--arc welding	2.93	2.82	.11	1.571
Farmers--oxy-acetylene welding	2.94	1.81	1.13	19.028**
Job-shop weldors--oxy-acetylene welding	2.99	2.88	.11	2.394*

*Significant at the .05 level.

**Significant at the .01 level.

Tests of the overall grand mean scores between and within groups were also made. The hypotheses tested were: (Ho:15) there is no difference between the competence needed scores of farmers and job-shop weldors, (Ho:16) there is no difference between the competence possessed scores of farmers and job-shop weldors, (Ho:17) there is no difference between the competence needed and competence possessed scores within the farmer group, and (Ho:18) there is no difference between the competence needed and competence possessed scores within the job-shop weldor group. The tabulation of the overall grand mean scores and the t-values of the differences as tested in the previous four hypotheses is shown in Tables 8 and 9.

Table 8. Overall grand means and t-values for differences between farmers and job-shop weldors in welding competencies needed and possessed

Competencies	Overall grand means		Diff.	t-value
	Farmers	Job-shop weldors		
All competencies needed	2.87	2.96	.09	2.068*
All competencies possessed	2.03	2.85	.82	13.419**

*Significant at the .05 level.

**Significant at the .01 level.

The overall grand mean competence needed score for the farmer group was 2.87, whereas the job-shop overall grand mean competence needed score was 2.96. The t-value of the difference between these two means was 2.068, indicating rejection of Ho:15 at the .05 level.

Table 9. Overall grand means and t-values for differences between competence needed and possessed in welding by farmers and job-shop weldors

Group	Overall grand means		Diff.	t-value
	Needed	Possessed		
Farmers	2.87	2.03	.84	13.983**
Job-shop weldors	2.96	2.85	.11	2.524*

*Significant at the .05 level.

**Significant at the .01 level.

The overall grand mean competence possessed score for the farmer group was 2.03, whereas the overall grand mean competence possessed score for the job-shop group was 2.85. The t-value of the difference between these two means was 13.419 indicating rejection of Ho:16 at the .01 level.

The overall grand mean competence needed score of 2.87 was compared with the overall grand mean competence possessed score of 2.03 for the farmer group. The t-value for the difference between these two means was 13.983, indicating rejection of Ho:17 beyond the .01 level.

The overall grand mean competence needed score of 2.96 was compared with the overall grand mean competence possessed score of 2.85 for the job-shop weldor group. The t-value of the difference between these two means was 2.524, indicating rejection of Ho:18 at the .05 level.

In order to determine which competencies had the greatest differences between the degree needed and degree possessed, the competencies were ranked by this factor in Tables 10 and 11. These comparisons were made for

Table 10. Rank of arc welding competencies by greatest difference between degree needed and degree possessed by farmers

Competencies	Degree needed	Degree possessed	Difference
(U = understanding, A = ability)			
A - Make welds in horizontal, vertical and overhead positions.	3.21	1.98	1.23
A - Identify various metals by inspection and spark testing.	2.88	1.79	1.09
A - Make welds using low hydrogen electrodes.	2.61	1.54	1.07
A - Make welds using hardsurfacing electrodes.	2.73	1.77	.96
U - Properties of metals as they affect weld-ability.	3.18	2.23	.95
U - Properties and uses of various electrodes.	3.03	2.16	.87
A - Weld cast and malleable iron using steel and nickel electrodes.	2.98	2.11	.87
U - Elementary blueprints and weld symbols.	2.24	1.43	.81
A - Recognize and make corrections for weld defects.	2.94	2.17	.77
U - Affect of weld distortion on metals.	2.90	2.14	.76
A - Position, clamp and weld metals to control distortion.	2.99	2.32	.67
U - Affect of amperage, arc length, speed of travel and angle of electrode on weld quality.	3.29	2.64	.65
A - Make tee and butt welds in pipe.	2.76	2.16	.60
A - Select proper electrode and amperage setting.	3.18	2.66	.52
U - Processes involved in the arc and molten pool during welding.	2.76	2.25	.51
A - Select and maintain arc welding machines.	2.53	2.03	.50
A - Weld joints with poor fit.	2.77	2.33	.44
A - Cut, gouge and pierce metals with appropriate electrodes.	2.72	2.30	.42
U - Operating characteristics of AC and DC welding machines.	2.43	2.03	.40
U - Functions of flux coating on electrodes.	2.43	2.05	.38
U - Safe operating procedures for arc welding.	3.00	2.63	.37
A - Join metals of different thicknesses.	2.74	2.39	.35
U - Basic electricity as it applies to arc welding.	2.37	2.13	.24

Table 10 (Continued)

Competencies	Degree needed	Degree possessed	Difference
(U = understanding, A = ability)			
A - Prepare and fit pieces to be joined.	2.99	2.75	.24
A - Make weave or spread beads in the flat position.	2.81	2.57	.24
A - Make lap and fillet welds in the flat position.	2.73	2.50	.23
A - Make bead and butt welds in the flat position.	2.77	2.74	.03

Table 11. Rank of oxy-acetylene welding competencies by greatest difference between degree needed and degree possessed by farmers

Competencies	Degree needed	Degree possessed	Difference
(U = understandings, A = ability)			
A - Identify steel and cast iron temperatures by color.	2.96	1.37	1.59
U - Properties and uses of carburizing, neutral and oxidizing flames.	2.87	1.51	1.36
U - Properties and uses of various filler rods.	2.83	1.47	1.36
U - Affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality.	3.13	1.80	1.33
A - Select correct filler rod and flux.	2.99	1.68	1.31
U - Properties and uses of fluxes in O-A welding.	2.90	1.62	1.28
U - Fusion process in joining metals.	2.80	1.52	1.28
A - Make bead and butt welds with steel filler rod.	2.80	1.52	1.28
A - Braze weld cast or malleable iron.	2.90	1.65	1.25
A - Make fillet welds with brass or bronze rod.	2.86	1.67	1.19
A - Adjust proper gas pressures.	3.14	2.03	1.11
A - Make bead and butt welds with brass or bronze rod.	2.85	1.74	1.11
A - Select and maintain O-A welding equipment.	2.99	1.89	1.10
A - Select and maintain welding and cutting tips.	3.01	1.93	1.08
A - Join thin metals by O-A welding.	2.94	1.89	1.05
U - Properties of gases used in O-A welding.	2.64	1.62	1.02
A - Control heat by torch manipulation.	2.96	1.94	1.02
U - Brazing process in joining metals.	2.94	1.94	1.00
U - Operating characteristics of O-A welding equipment.	2.95	1.96	.99
U - Safe operating procedures for O-A welding.	3.09	2.11	.98
A - Select, light and adjust the correct flame.	3.06	2.18	.88
A - Cut, gouge and pierce metal with cutting torch.	3.00	2.26	.74
U - Oxygen cutting process.	2.93	2.29	.64

the farmer group which had the greater differences between the grand means.

The arc welding competencies which had the greatest differences between the degree needed and possessed were: (1) make welds in horizontal, vertical and overhead positions; (2) identify various metals by inspection and spark testing; (3) make welds using low hydrogen electrodes; (4) make welds using hardsurfacing electrodes; and (5) properties of metals as they affect weld-ability.

The oxy-acetylene welding competencies which had the greatest differences between the degree needed and possessed were: (1) identify steel and cast iron temperatures by color; (2) properties and uses of carburizing, neutral and oxidizing flames; (3) properties and uses of various filler rods; (4) affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality; and (5) select correct filler rod and flux.

Description of Samples

In preparation to determining what factors influenced the degree the competencies were needed and possessed by the two groups, means and frequency counts were made of the data from the information sheets of the questionnaires.

Table 12 lists the means of selected factors for the farmer group. The data show a mean age of 39.5 years, acres operated of 443.8, and education completed of 11.8 years. In addition to the percentage which participated in each of the training programs, the mean number of training programs participated in was 1.97. The mean value of welding to the farm per year was $358.84 and hours spent welding per year was 69.0 hours. The pro-

Table 12. Means of selected factors for the farmer group

Factor	Mean N = 185
Age	39.5 years
Acres operated	443.8 acres
Education completed	11.8 years
Percentage who received training in welding in:	
High school vocational agriculture	30.8
High school industrial arts	10.8
College credit course	26.5
Trade or vocational school course	28.1
Vo-ag young or adult farmer class	48.6
Agricultural extension course	2.7
Military training course	5.9
Apprentice training program	3.8
Self taught	81.6
Number of training programs received	1.97 programs
Value of welding to the farm per year	$358.84
Hours spent welding per year	69.0
Percentage who weld for others	59.5
Percentage of welding time spent welding for others	10.4
Twelve most needed arc competencies	3.03
Twelve most possessed arc competencies	2.44
Twelve most needed oxy-acetylene competencies	3.01
Twelve most possessed oxy-acetylene competencies	2.01

portion who did welding for others was 59.5 percent, whereas the proportion of their welding time spent welding for others was 10.4 percent. This mean was based on an N of 185, whereas the percentage of time spent by those who did welding for others was actually 17.4 percent.

Also included in Table 12 are the means of the 12 most needed and possessed arc and oxy-acetylene welding competencies. It may be noted that by dividing the value of welding to the farm per year by the number of hours spent welding each year, the return per hour of welding may be computed. The result of this division indicated a return of $5.20 per hour.

Qualitative data relating to proprietorship and type of farm operated are shown in Table 13. The sample of farmers included 88 owner-renters,

Table 13. Frequency counts for qualitative factors of the farmer group

Factor	Frequency count N = 185
Farming status (proprietorship)	
Owner	43
Renter	37
Owner and renter	88
Partnership	15
Hired operator	2
Type of farm	
Crop	34
General	71
Livestock	80

43 owners, 37 renters, 15 partnerships, and 2 hired operators. Crop farms were designated as those which listed more than 60 percent of their income

from the sale of crops, whereas livestock farms were those which listed more than 60 percent of their income from livestock sales. Of the 185 farms, 80 were livestock farms, 71 were general farms, and 34 were crop farms.

In Table 14 is a tabulation of data concerning the ownership of welding equipment by the farmer group. These data indicate a much larger incidence of ownership of arc welders than oxy-acetylene welders. Arc welders

Table 14. Ownership of welding equipment by the farmer group

Type of machine	Frequency count N = 185
Arc welder	184
Size of arc welder	
180 Amp or less	115
181 to 225 Amp	31
Over 225 Amp	38
Oxy-acetylene welder	77
Cutting torch	81

were owned by 184 of the 185 respondents, whereas only 77 indicated they owned oxy-acetylene welders. Cutting torches were indicated as owned by 81 of the respondents.

Table 15 includes a tabulation of the selected factors for the job-shop weldor group. The mean age reported by these respondents was 46.4 years, whereas the education completed was reported as 11.1 years. The proportion of time spent as weldors by this group was 42.8 percent, and of

Table 15. Means of selected factors for the job-shop weldor group

Factor	Mean N = 96
Age	46.4 years
Percentage of time spent as a weldor	42.8
Percentage of welding time spent on agricultural machinery	52.8
Percentage who make and sell welded metal equipment	52.0
Percentage of time spent on welded metal equipment	11.9
Education completed	11.1 years
Percentage who received training in welding in:	
High school vocational agriculture	10.4
High school industrial arts	10.4
College credit course	3.1
Trade or vocational school course	18.8
Vo-ag young or adult farmer class	11.5
Agricultural extension course	3.1
Military training course	11.5
Apprentice training program	18.8
Self taught	79.2
Number of training programs participated in	1.67 programs
Twelve most needed arc competencies	3.19
Twelve most possessed arc competencies	3.05
Twelve most needed oxy-acetylene competencies	3.07
Twelve most possessed oxy-acetylene competencies	3.01

this, 52.8 percent was spent on agricultural machinery. The proportion of those who make and sell welded metal equipment was 52.0 percent and the proportion of time spent doing this type of work was 11.9 percent. In addition to the data on the proportion of those participating in the several training programs, Table 15 lists the mean number of training programs as 1.67. Also listed are the means of the 12 most needed and possessed arc and oxy-acetylene welding competencies.

Table 16 lists the data on the ownership of welding equipment by the job-shop group. Of the 96 reporting, 82 indicated they owned AC arc welders, whereas 54 owned DC arc welders. Fifty-four of the respondents also reported they owned gasoline powered portable arc welders. Oxy-acetylene welders and cutting torches were owned by 95 of the 96 reporting.

Correlation of Selected Quantitative Factors with Needed and Possessed Scores

To locate linear relationships between certain factors and competence needed and competence possessed scores, the means of the 12 highest ranked arc welding competencies and the 12 highest ranked oxy-acetylene welding competencies, both needed and possessed, were computed for each respondent. These were correlated with selected quantitative factors for each group. The formula used was from Snedecor and Cochran (11, p. 172).

$$r = \frac{\Sigma x_1 x_2}{\sqrt{(\Sigma x_1^2)(\Sigma x_2^2)}}$$

The correlation matrix for the farmer group is presented in Table 17. It is assumed that a null hypothesis was stated for each comparison. According to Snedecor and Cochran (p. 557), the tabled r-values necessary

Table 16. Ownership of welding equipment by the job-shop group

Type of machine		Frequency count N = 96
AC arc welder		82
Size of AC arc welder		
180 Amp or less	20	
181 to 225 Amp	13	
Over 225 Amp	49	
DC arc welder		54
Size of DC arc welder		
180 Amp or less	6	
181 to 225 Amp	9	
Over 225 Amp	39	
Gas powered portable arc welder		54
Type of gas powered portable arc welder		
AC	8	
DC	34	
Combination AC/DC	12	
Oxy-acetylene welder		95
Oxy-acetylene cutting torch		95
Tungsten inert gas (TIG) welder		11
Metallic inert gas (MIG) welder		9
Spot welder		22
Other types of welders		10

Table 17. Correlations between selected quantitative factors and needed and possessed competency scores for farmers

Variables	1[a]	2[a]	3[a]	4[a]	5[a]	6[a]	7[a]
1	1.000						
2	-0.044	1.000					
3	-0.357**	0.256**	1.000				
4	-0.451**	-0.007	0.119	1.000			
5	-0.294**	0.033	0.155	0.118	1.000		
6	-0.194**	0.235**	0.413**	0.097	0.229**	1.000	
7	-0.030	-0.004	-0.076	0.138	0.203**	-0.015	1.000
8	0.017	-0.053	-0.011	0.062	0.044	0.090	-0.069
9	-0.032	-0.054	0.053	0.027	0.264**	0.078	0.186*
10	0.096	0.043	0.051	0.025	0.133	0.014	0.004

[a]1 - age, 2 - acres, 3 - education completed, 4 - training received in welding in high school vocational agriculture, 5 - training received in welding in high school industrial arts, 6 - training received in welding in college credit course, 7 - training received in welding in trade or vocational school course, 8 - training received in welding in vo-ag young or adult farmer class, 9 - training received in welding in agricultural extension course, 10 - training received in welding in military training course.

*Significant at the .05 level.

**Significant at the .01 level.

Table 17 (Continued)

Variables	1[a]	2[a]	3[a]	4[a]	5[a]	6[a]	7[a]
11	-0.103	-0.024	0.095	-0.008	0.022	0.050	0.141
12	0.088	0.013	-0.095	-0.062	-0.060	-0.234**	0.047
13	-0.351**	0.064	0.218**	0.444**	0.544**	0.341**	0.359**
14	-0.117	0.137	0.061	0.108	-0.019	0.102	0.179*
15	-0.244**	-0.064	0.040	0.245**	0.051	-0.007	0.189*
16	-0.087	-0.105	-0.113	0.099	0.004	-0.097	0.058
17	-0.030	-0.209**	-0.034	0.254**	-0.004	-0.068	0.112
18	0.008	0.008	-0.002	0.022	0.013	-0.100	0.096
19	-0.077	-0.087	0.034	0.060	0.032	0.106	0.181*
20	0.019	-0.120	0.027	0.061	-0.007	-0.089	0.138
21	-0.095	-0.114	0.020	0.151	0.151	0.074	0.212*

[a]11 - training received in welding in apprentice training program, 12 - training received in welding in self taught, 13 - number of training programs received, 14 - value of welding to the farm per year. 15 - hours spent welding per year, 16 - extent welding was done for others, 17 - percentage of welding time spent welding for others, 18 - twelve most needed arc competencies, 19 - twelve most possessed arc competencies, 20 - twelve most needed oxy-acetylene competencies, 21 - twelve most possessed oxy-acetylene competencies.

Table 17 (Continued)

Variables	8[a]	9[a]	10[a]	11[a]	12[a]	13[a]	14[a]
1							
2							
3							
4							
5							
6							
7							
8	1.000						
9	0.038	1.000					
10	-0.016	0.099	1.000				
11	0.034	0.142*	-0.050	1.000			
12	-0.097	-0.179*	-0.176*	-0.052	1.000		
13	0.482**	0.324**	0.226**	0.250**	0.148*	1.000	
14	-0.178*	-0.010	0.041	0.029	0.111	0.087	1.000
15	-0.038	0.108	0.093	0.021	0.043	0.192**	0.477**
16	0.011	0.070	0.115	0.106	0.035	0.105	0.124
17	0.091	-0.011	0.180*	-0.011	-0.021	0.093	0.045
18	-0.183*	0.122	0.037	-0.120	0.090	-0.007	0.058
19	-0.057	0.113	0.062	0.160*	-0.017	0.134	0.260**
20	-0.124	0.087	0.104	0.004	0.079	0.062	0.063
21	-0.003	0.103	0.128	0.092	-0.033	0.271**	0.286*

Table 17 (Continued)

Variables	15[a]	16[a]	17[a]	18[a]	19[a]	20[a]	21[a]
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15	1.000						
16	0.297**	1.000					
17	0.301**	0.495**	1.000				
18	0.128	0.014	-0.001	1.000			
19	0.273**	0.223**	0.166*	0.344**	1.000		
20	0.188*	0.122	0.074	0.707**	0.258**	1.000	
21	0.256**	0.276**	0.245**	0.188*	0.663**	0.273**	1.000

for significance for the first 19 variables was .144 at the .05 level and .190 at the .01 level, with 183 degrees of freedom (N-2). For the last two variables, the tabled r-values necessary for significance was .166 at the .05 level and .217 at the .01 level, with 139 degrees of freedom (N-2).

Significant r-values were found between: training received in welding at a trade or vocational school and arc welding competencies possessed, .181; training received in welding at a trade or vocational school and oxy-acetylene welding competencies possessed, .212; vo-ag young or adult farmer class and arc welding competencies needed, -.183; apprentice training program and arc welding competencies possessed, .160; number of training programs and oxy-acetylene welding competencies possessed, .271; value of welding per year and arc welding competencies possessed, .260; value of welding per year and oxy-acetylene welding competencies possessed, .286; hours spent welding per year and arc welding competencies possessed, .273; hours spent welding per year and oxy-acetylene welding competencies needed, .188; hours spent welding per year and oxy-acetylene welding competencies possessed, .256; extent welding was done for others and arc welding competencies possessed, .223; extent welding was done for others and oxy-acetylene welding competencies possessed, .276; percentage of time spent welding for others and arc welding competencies possessed, .166; and percentage of time spent welding for others and oxy-acetylene welding competencies possessed, .245.

The correlation matrix for selected quantitative factors and the most needed and possessed competencies for the job-shop weldors is presented in Table 18. According to Snedecor and Cochran (11, p. 557), the tabled r-values necessary for significance were .200 at the .05 level and .260 at

Table 18. Correlations between selected quantitative factors and needed and possessed competency scores for job-shop weldors

Variables	1[a]	2[a]	3[a]	4[a]	5[a]	6[a]	7[a]
1	1.000						
2	0.131	1.000					
3	0.026	0.151	1.000				
4	0.015	0.093	0.107	1.000			
5	-0.130	-0.005	0.035	0.507**	1.000		
6	-0.290**	-0.172	0.055	0.211*	0.236*	1.000	
7	-0.364**	-0.052	0.067	-0.014	0.163	0.188	1.000
8	-0.237*	0.175	-0.066	0.054	0.140	0.101	0.330**
9	-0.110	-0.148	0.218*	0.052	0.323**	0.326**	0.135
10	-0.043	0.321**	-0.029	0.140	-0.074	0.092	0.011

[a]1 - age, 2 - percentage of time spent as a weldor, 3 - percentage of welding time spent on agricultural machinery, 4 - extent welded metal equipment was made and sold, 5 - percentage of time spent on welded metal equipment, 6 - education completed, 7 - training received in welding in high school vocational agriculture, 8 - training received in welding in high school industrial arts, 9 - training received in welding in college credit course, 10 - training received in welding in trade or vocational school course.

*Significant at the .05 level.

**Significant at the .01 level.

Table 18 (Continued)

Variables	1[a]	2[a]	3[a]	4[a]	5[a]	6[a]	7[a]
11	-0.390**	-0.214*	0.094	-0.048	-0.032	0.212*	0.520**
12	0.132	0.150	0.106	0.052	-0.030	0.019	-0.061
13	0.002	0.016	-0.031	0.149	-0.128	0.027	0.199
14	0.021	0.172	-0.086	0.140	0.135	0.120	0.098
15	0.083	-0.174	0.266**	0.073	0.069	-0.138	-0.077
16	-0.271**	0.094	0.136	0.196	0.116	0.245**	0.642**
17	0.037	0.248*	0.099	0.142	-0.078	-0.107	0.008
18	0.018	0.489**	0.146	0.295**	0.071	-0.053	-0.107
19	0.039	0.216*	0.225**	-0.111	-0.085	-0.059	0.103
20	0.160	0.402**	0.115	0.248*	0.024	-0.023	-0.059

[a]11 - training received in welding in vo-ag young or adult farmer class, 12 - training received in welding in agricultural extension course, 13 - training received in welding in military training course, 14 - training received in welding in apprentice training program, 15 - training received in welding in self taught, 16 - number of training programs participated in, 17 - twelve most needed arc competencies, 18 - twelve most possessed arc competencies, 19 - twelve most needed oxy-acetylene competencies, 20 - twelve most possessed oxy-acetylene competencies.

Table 18 (Continued)

Variables	8[a]	9[a]	10[a]	11[a]	12[a]	13[a]	14[a]
1							
2							
3							
4							
5							
6							
7							
8	1.000						
9	-0.061	1.000					
10	0.186	-0.086	1.000				
11	0.091	0.123	-0.089	1.000			
12	-0.061	-0.032	0.067	-0.065	1.000		
13	0.091	-0.065	0.079	0.076	-0.065	1.000	
14	0.273**	-0.086	-0.026	0.079	0.220*	0.079	1.000
15	-0.077	0.092	-0.345**	-0.057	-0.055	-0.138	-0.279**
16	0.575**	0.175	0.286**	0.499**	0.175	0.403**	0.442**
17	0.137	-0.156	0.135	0.025	0.046	0.006	0.041
18	0.160	-0.001	0.321**	-0.246*	0.147	0.082	0.185
19	0.094	-0.069	0.164	0.047	0.060	0.007	-0.055
20	0.107	-0.039	0.321**	-0.220*	0.167	0.133	0.147

Variables	15[a]	16[a]	17[a]	18[a]	19[a]	20[a]
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15	1.000					
16	0.058	1.000				
17	-0.086	0.067	1.000			
18	-0.096	0.133	0.376**	1.000		
19	0.028	0.126	0.805**	0.376**	1.000	
20	-0.149	0.128	0.347**	0.861**	0.417**	1.000

the .01 level, with 94 degrees of freedom (N-2).

Significant r-values were found between: percentage of time spent as a weldor and arc welding competencies needed, .248; percentage of time spent as a weldor and arc welding competencies possessed, .489; percentage of time spent as a weldor and oxy-acetylene competencies needed, .216; percentage of time spent as a weldor and oxy-acetylene welding competencies possessed, .402; percentage of time spent on agricultural machinery and oxy-acetylene welding competencies needed, .225; extent welded metal projects were made and sold and arc welding competencies possessed, .295; extent welded metal projects were made and sold and oxy-acetylene welding competencies possessed, .248; training received in welding at a trade or vocational school and arc welding competencies possessed, .293; training received in welding at a trade or vocational school and oxy-acetylene welding competencies possessed, .321; vo-ag young or adult farmer class and arc welding competencies possessed, -.246; and vo-ag young or adult farmer class and oxy-acetylene welding competencies possessed, -.220.

Correlations Between Quantitative Factors

In addition to the significant r-values between several training programs for the farmer group, significant r-values were noted between: age and education completed, -.357; age and high school vocational agriculture, -.451; age and high school industrial arts, -.294; age and college credit course, -.194; age and number of training programs, -.351; age and hours spent welding, -.244; acres farmed and education, .256; acres farmed and time spent welding for others, -.209; education and college credit course, .413; education and number of training programs, .218; trade or

vocational school course and value of welding, .179; trade or vocational school course and hours spent welding, .189; vo-ag young or adult farmer class and value of welding, -.178; military training course and percentage of time spent welding for others, .180; number of training programs and hours spent welding, .192; value of welding and hours spent welding, .477; hours spent welding and extent welding was done for others, .297; hours spent welding and percentage of time spent welding for others, .301; and extent welding was done for others and percentage of time spent welding for others, .495.

In addition to the significant r-values between several training programs for the job-shop weldor group, significant r-values were noted between: age and education completed, -.290; age and high school vocational agriculture, -.264; age and high school industrial arts, -.237; age and vo-ag young or adult farmer class, -.390; age and number of training programs, -.271; percentage of time spent as a weldor and trade or vocational school course, .321; percentage of time spent as a weldor and vo-ag young or adult farmer class, -.214; percentage of welding time spent on agricultural machinery and college credit course, .218; percentage of welding time spent on agricultural machinery and self taught, .266; extent welded metal equipment was made and sold and percentage of time spent making welded metal equipment, .507; extent welded metal equipment was made and sold and education, .211; percentage of time spent making welded metal equipment and education completed, .236; education completed and college credit course, .326; education completed and vo-ag young or adult farmer class, .212; and education completed and number of training programs, .244.

Even though the r-value for the correlations between age and value of

welding was not significant, a tabulation of the value of welding by age groups indicated that a curvilinear relationship may exist. The 19 year and under category had a mean of $372.00, the 20-29 year group a mean of $372.00, the 30-39 year group a mean of $442.24, the 40-49 year group a mean of $380.23, the 50-59 year group a mean of $212.50, and the 60-69 year group a mean of $75.00. These data are listed in Table 19.

Table 19. Value of welding by age of farmers

Age groups	Frequency count N = 185	Mean value
19 and under	5	$226.00
20-29	27	372.50
30-39	60	442.24
40-49	69	380.23
50-59	22	212.50
60-69	2	75.00
Grand mean		358.84

The linear relationship indicated by the r-value of -.244 between age and hours spent welding per year may be noted in Table 20. The younger farmers spent more hours per year welding than the older farmers. The 19 and under category spent 125.8 hours welding, the 20-29 year group - 93.4 hours, the 30-39 year group - 77.3 hours, the 40-49 year group - 62.8 hours, the 50-59 year group - 45.3 hours, whereas the 60-69 year age group

Table 20. Time spent welding by age of farmers

Age groups	Frequency count N = 185	Mean
19 and under	5	125.8
20-29	27	93.4
30-39	60	77.3
40-49	69	62.8
50-59	22	45.3
60-69	2	14.0
Grand mean		69.0

spent only 14.0 hours in welding.

In Table 21 is shown the percentage of time spent welding for others by farmers stratified by age. The percentages ranged from 6.6 percent to 22.5 percent with a mean of 17.4 percent.

The value of welding done by farmers stratified by size of farm is shown in Table 22. The data substantiate the nonsignificant r-value between these two factors. The range was from $229.55 to $568.75 with a mean of $358.84.

The time spent welding by farmers grouped by size of farm is in Table 23. The data show the farmers who operated 481-640 acres spent 84.7 hours in welding, the 161-320 acre group - 72.4 hours, the 321-480 acre group - 70.4 hours, the 641-800 acre group - 68.6 hours, the 1-160 acre group - 65.6 hours, the 961 and over group - 56.7 hours, whereas the 801-960 acre

Table 21. Percentage of welding time spent welding for others by age of farmers

Age group	Frequency count N = 110	Mean percentage
19 and under	5	6.6
20-29	17	22.4
30-39	33	16.2
40-49	41	18.5
50-59	14	15.1
60-69	0	0.0
Grand mean		17.4

Table 22. Value of welding by size of farm

Size of farms	Frequency count N = 185	Mean
1-160	11	$229.55
161-321	61	354.49
321-480	57	326.39
481-640	26	446.15
641-800	16	568.75
801-960	7	270.00
961 and over	7	428.57
Grand mean		358.84

Table 23. Time spent welding by size of farm

Size of farms	Frequency count N = 185	Mean hours
1-160	11	65.6
161-320	61	72.4
321-480	57	70.4
481-640	26	84.7
641-800	16	68.6
801-960	7	36.3
961 and over	7	56.7
Grand mean		69.0

group spent 36.3 hours in welding.

The significant r-value of -.209 between percentage of welding time spent welding for others and size of farm is substantiated by the tabulation of the data in Table 24. The percentage of time spent decreased from 38.6 percent to 6.5 percent as the size of farm increased from the smallest to the largest.

Tabulation of Qualitative Data

The two qualitative factors, proprietorship and type of farm were not included in the correlation matrix. In order to evaluate the relationships of these two factors with selected quantitative factors, counts and means were computed for all categories of the qualitative factors.

Table 24. Percentage of welding time spent welding for others by size of farm

Size of farms	Frequency count N = 110	Mean percentage
1-160	7	38.6
161-320	38	20.9
321-480	36	12.3
481-640	15	16.6
641-800	6	13.0
801-960	4	14.3
961 and over	4	6.5
Grand mean		17.4

Table 25 lists the value of welding stratified by farming proprietorship. The highest mean was $500.00 for the hired operators, however, only two were counted in this category. The owner-renter group had the next highest mean at $415.90, whereas the owner group had a mean of $338.72. The renter group had a mean of $320.27, whereas the partnership group had a mean of $317.85.

Time spent welding by farmers grouped by farming proprietorship is listed in Table 26. The partnership group had a mean of 83.8 hours, whereas the renter group had a mean of 82.0 hours. The hired operators had a mean of 75.0 hours, the owner-renter group had a mean of 69.0 hours, whereas the owner group had a mean of 61.2 hours.

Table 25. Value of welding by farming proprietorship

Proprietorship	Frequency count N = 185	Mean value
Owner	43	$338.72
Renter	37	320.27
Owner and renter	88	415.90
Partnership	15	317.85
Hired operator	2	500.00
Grand mean		358.84

Table 26. Time spent welding by farming proprietorship

Proprietorship	Frequency count N = 185	Mean hours
Owner	43	61.2
Renter	37	82.0
Owner and renter	88	69.0
Partnership	15	83.8
Hired operator	2	75.0
Grand mean		69.0

Table 27 lists the percentage of welding time spent welding for others stratified by farming proprietorship. The owners had a mean of 24.6 percent, followed by the owner-renter group with a mean of 17.1 percent. The renter group had a mean of 14.3 percent, whereas the partnership group had a mean of 13.0 percent. The hired operator group had a mean of 10.0 percent with only one reported in this category.

Table 27. Percentage of welding time spent welding for others by farming proprietorship

Proprietorship	Frequency count N = 110	Mean percentage
Owner	21	24.6
Renter	28	14.3
Owner and renter	50	17.1
Partnership	10	13.9
Hired operator	1	10.0
Grand mean		17.4

The value of welding stratified by type of farm is reported in Table 28. The mean value was $411.36 for the crop farm, $388.78 for the livestock farms, and $330.66 for the general farms.

Time spent welding by farmers grouped by type of farm is listed in Table 29. The time spent by crop farmers was 79.1 hours per year. The time spent by livestock farmers was 69.1 hours, whereas the general farmers

Table 28. Value of welding by type of farm

Type of farm	Frequency count N = 185	Mean value
Crop	34	$411.36
General	71	330.66
Livestock	80	388.78
Grand mean		358.84

Table 29. Time spent welding by type of farm

Type of farm	Frequency count N = 185	Mean hours
Crop	34	79.5
General	71	68.9
Livestock	80	69.1
Grand mean		69.0

spent 68.9 hours in welding.

Table 30 lists the percentage of welding time spent welding for others stratified by type of farm. The crop farmers reported the largest mean value of 20.9 percent. The livestock farmers had a mean of 17.5 percent, whereas the general farmers spent 15.7 percent of their welding time welding for others.

Table 30. Percentage of welding time spent welding for others by type of farm

Type of farm	Frequency count N = 110	Mean percentage
Crop	22	20.9
General	46	15.7
Livestock	42	17.5
Grand mean		17.4

DISCUSSION

The first four objectives of this study have been accomplished as shown by data presented in the previous chapter. The fifth objective, to determine the implications concerning the teaching of welding at the secondary and post secondary levels, was of necessity, a matter of judgement on the part of the researcher. In this case, however, there was a good deal of factual information upon which to base those judgements.

The first implication had to do with whether or not welding is an important unit to be taught to those intending to farm or enter an off-farm agricultural machinery service occupation. Both the review of literature and the findings of this study tend to indicate that welding is an important unit to be taught to the two groups. The overall grand mean competence needed scores of 2.87 for the farmer group and 2.96 for the job-shop group indicate the degree competence was needed by members of both groups approached the "much" level. Another factor considered was the value of welding operations to the farm per year. The mean value of $358.84 with a return of $5.20 per hour indicate the importance of these skills to farmers, and that they should be included in training programs for those entering or engaged in farming. It was noted that 59.5 percent of the farmers surveyed did welding for others. This was evidence that there was need for persons with welding competence in the community.

Another question arose as to the relative importance of arc welding compared to oxy-acetylene welding. The grand mean competence needed scores for oxy-acetylene welding were higher than the arc welding scores for both groups. This might lead one to conclude that oxy-acetylene welding is more

important than arc welding, but it is the opinion of the researcher, that the relative difficulty of oxy-acetylene welding is more than that of arc welding. Therefore, in order to weld satisfactorily with oxy-acetylene, a higher degree of skill is required. The ownership of welding equipment by members indicates a much wider adoption of the arc welding process for agriculture machinery maintenance. The job-shop weldors still need to be proficient in oxy-acetylene welding. This can be substantiated by the significant r-value of .225 between the percentage of welding time spent on agricultural machinery and oxy-acetylene welding competencies possessed by the job-shop group.

Another implication was drawn in consideration of whether or not different courses of study are needed by those who are going to farm and those who are going to enter an agricultural machinery service occupation. The similarity of the competence needed scores and the high values of the Spearman rank order correlations, indicate that similar courses could be taught to the two groups. In the area of oxy-acetylene welding, however, the off-farm group should have more instruction and practice. The t-value of the competence needed scores between groups also indicated that similar levels of skill was desired. It should be noted that the t-value between the overall grand mean scores (Table 8) for competencies needed, showed a significant difference between the means at the .05 level. A further look at the means, however, indicated a difference of only .09 which, when compared to the scale used to rate the competencies, was not meaningful to the educator. A difference of .5 on this scale would have to be reached before these differences would be meaningful in planning instructional programs. This same reasoning may be applied to the .11 differences between the mean

scores in Tables 7 and 9.

The need for further training by the farmer group was evident. The highly significant t-values between the competence needed and competence possessed scores for farmers indicated additional training should be offered to this group. Close attention should be placed to those skills which had wide differences between competence needed and possessed ratings. The job-shop group indicated they possessed nearly all of the competence they needed and further training was not warranted.

In an attempt to identify those training programs which might have had a significant effect upon welding skills possessed, it was found that training received in trade and vocational schools was most often correlated with competence possessed by farmers and job-shop weldors in both arc and oxy-acetylene welding. This may indicate that this type of training had been particularly effective in developing welding skill. To further substantiate this statement, the training received at a trade or vocational school was significantly correlated with the value of welding operations and hours spent in welding by the farmer group.

Another group of significant r-values concerning arc and oxy-acetylene welding competencies possessed were noted. The value of yearly welding operations for the farmer group was correlated with arc and oxy-acetylene welding competencies possessed. The hours spent welding and the amount of welding done for others was also correlated with the competencies possessed. This would indicate that a high degree of skill possessed was beneficial. For the job-shop weldor group the same relationships existed. The amount of time spent as a weldor and percentage of time spent on agricultural machinery was significantly correlated with the degree of

competence possessed.

For the farmer group, training received in welding in high school vocational agriculture was correlated significantly with hours per year spent welding and percentage of time spent welding for others. This might indicate that this type of training did develop interest in welding.

An unusual relationship was noted between training received in welding in vo-ag young or adult farmer class and the degree of arc welding competence needed by farmers. This was negatively correlated at -.183, significant at the .05 level. One explanation could be that the training received might have emphasized the difficulty of several of the skills and the farmers felt that they should leave these skills to the job-shop weldors.

For the job-shop group, training received in welding in vo-ag young or adult farmer class was negatively correlated with competence possessed in both arc and oxy-acetylene welding. This might indicate that this training was not adequate for job-shop weldors and that they needed more intensive training involving a longer period of time.

The question arose as to the feasibility of designing specific welding programs to fit a given community. The data presented in this study tended to indicate that there would not be great differences in training needed for those engaged in a livestock farming program, a crop farming system, or a general farming situation. The data also indicated that acreage farmed was not correlated with the value of welding operations or time spent welding per year. The size of farm was negatively correlated with the percentage of time spent welding for others. This indicated that the larger farm operators did not have time to weld for others. It is the opinion of the researcher that welding on farm machinery is not dissimilar in various

farming areas, and that similar programs may be taught.

The data in Tables 19 and 20 had implications for those planning welding programs. These data indicated that the time spent in welding by farmers decreased as age increased. This would indicate that the young farmers did more of their own repairs and did more construction and redesigning of machines that they used. The data also indicated that the value of welding was the highest for the 30-39 year age group. This may indicate that persons in this age group became better weldors and were more efficient with their time after several years of welding experience.

The data in this study did not reveal any important relationships between farming proprietorship or type of farm and value of welding or time spent welding. This would indicate that similar programs may be offered to those entering or engaged in different farming situations.

In summary, vocational education programs which are preparing persons to enter farming and agriculture machinery service occupations should include instruction in welding. This instruction should include both classroom and laboratory experiences. A high level of competence should be developed in the skills taught. Particular attention should be paid to the most needed competencies as tabled in the previous chapter. In arc welding these included: (1) understanding of affect of amperage, arc length, speed of travel and angle of electrode on weld quality; (2) ability to make welds in horizontal, vertical and overhead positions; (3) understanding of properties of metals as they affect weldability; (4) ability to select proper electrode and amperage setting; (5) understanding of properties and uses of various electrodes; (6) understanding of safe operating procedures for arc welding; (7) ability to prepare and fit pieces to be joined; (8)

ability to position, clamp and weld metals to control distortion; (9) ability to weld cast and malleable iron using steel and nickel electrodes; and (10) ability to recognize and make corrections for weld defects.

In oxy-acetylene welding the most needed competencies included: (1) ability to adjust proper gas pressures; (2) understanding of affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality; (3) understanding of safe operating procedures for O-A welding; (4) ability to select, light and adjust the correct flame; (5) ability to select and maintain welding and cutting tips; (6) cut, gouge and pierce metals with cutting torch; (7) ability to select and maintain O-A welding equipment; (8) ability to select correct filler rod and flux; (9) ability to control heat by torch manipulation; and (10) ability to identify steel and cast iron temperatures by color.

Vocational education programs which are intended to upgrade those already engaged in farming should also include welding. This training should include those competencies which had the widest differences between the degrees of competence needed and possessed.

Since occupational choices are less firm at the high school level, more general programs may be offered. These programs should include both arc and oxy-acetylene welding. Selection of student learning activities should be carefully screened in order to develop a high degree of competence in those skills included in the course. It is the opinion of the researcher that when the time for training is limited, the number of competencies should be reduced rather than lowering the level of competence to be attained by the student in each skill.

In post-high school programs, where occupational choices are more

definite, more specific courses of study may be developed. These courses should be more intensive in nature, cover a wider range of competencies and should be longer in duration. Here again, a high level of competence should be developed in each of the skills included in the course.

SUMMARY

The purposes of this study were to: (1) to determine what competencies in welding are needed for agricultural maintenance, (2) to determine to what degree these competencies are needed by farmers and agricultural machinery service personnel, (3) to determine to what degree these competencies are possessed by farmers and agricultural machinery service personnel, (4) to determine what factors have influenced the degree these competencies are needed and possessed by each group, and (5) to determine the agricultural education implications in teaching welding at the secondary and post-secondary levels.

Forty percent of the Iowa vocational agriculture departments, stratified by supervisory districts, were randomly selected. Each department selected was asked to submit the names of all of the job-shop weldors in their communities and also the names of four farmers who were familiar with welding. The names of 300 farmers and 218 job-shop weldors were received.

A panel of eleven specialists including university agricultural engineering staff members, vocational agriculture teachers, welding industry representatives, job-shop weldors, and farmers was selected by the researcher. The panel was asked to suggest competencies in arc and oxy-acetylene welding which they thought were important in agricultural machinery maintenance. A composite list of 50 competencies, 27 in arc welding and 23 in oxy-acetylene welding, was assembled.

Questionnaires were developed for the two groups which included an introductory page, an information sheet and a section for the rating of the competencies. The information sheet for the farmer group included ques-

tions about age, total acreage of farm or farms operated, farming status, type of farm, education completed, training received in welding, welding equipment available on the farm, value of welding to the farm per year, amount of time spent welding per year, extent welding was done for others, and percentage of welding time spent welding for others. The information sheet for job-shop weldors included questions about age, percentage of time spent on agricultural machinery or equipment, extent welded metal equipment was made and sold, education completed, training received in welding, and welding equipment which was available in the shop.

A scale was developed for rating of the competencies. Each understanding or ability was to be rated as: 4 - very much competence needed (or possessed), 3 - much competence needed (or possessed), 2 - some competence needed (or possessed), 1 - little competence needed (or possessed), and 0 - no competence needed (or possessed). Each respondent was asked to rate each competency both as to the competence needed and degree of competence possessed.

The farmer group responded with 185 usable questionnaires of which 44 did not fill out the section on oxy-acetylene welding, but the other data were considered usable. The job-shop weldor group returned 96 usable questionnaires.

Mean scores were computed for all 50 competencies both competence needed and possessed by each group. The means for the farmer group ranged from 2.24 to 3.29 in competence needed with an overall grand mean of 2.87. The job-shop group had means ranging from 2.35 to 3.32 in the degree of competence needed with an overall grand mean of 2.96. For the degree of competence possessed, the farmer group ranged from 1.43 to 2.75 with an

overall grand mean of 2.03. The job-shop group ranged from 2.23 to 3.21 in the degree of competence possessed with an overall grand mean of 2.85.

Rank order coefficients of correlation were computed for arc welding competencies needed, arc welding competencies possessed, oxy-acetylene welding competencies needed, and oxy-acetylene welding competencies possessed by farmers and job-shop weldor groups. The comparisons of the rankings of the competencies showed a coefficient of correlation of .9098 for arc welding competencies needed, .8622 for oxy-acetylene welding competencies needed, .8172 for arc welding competencies possessed, and .9293 for oxy-acetylene welding competencies possessed.

Comparisons between means were made by use of the t test. The mean competence needed score for the 27 arc welding competencies of 2.81 for the farmer group was compared with the mean competence needed score of 2.93 for the job-shop weldor group. It yielded a t-value of 1.65 which was not significant. The means for the oxy-acetylene competencies needed were compared. A t-value of 1.47 between the mean of 2.94 for the farmer group and a mean of 2.99 for the job-shop weldors was obtained which was not significant.

Comparisons between groups showed mean competence possessed scores in arc welding of 2.21 for farmers and 2.82 for job-shop weldors with a t-value of 2.82 which was significant at the .01 level. The scores for oxy-acetylene competence possessed of 1.81 for farmers and 2.87 for job-shop weldors yielded a t-value of 15.86 which was significant at the .01 level.

The mean competence needed and possessed scores within groups were compared also using the t test. The mean competence needed score of 2.81 for arc welding was compared with the mean competence possessed score of

2.21 for the farmer group. A t-value of 7.19 was obtained which was significant at the .01 level. The oxy-acetylene competence needed score for farmers of 2.94 was compared to the competence possessed score of 1.81. The t-value of 19.03 obtained was also significant at the .01 level.

The mean competence needed score for arc welding competencies for job-shop weldors of 2.94 was compared with the mean competence possessed score of 2.82. A t-value of 1.57 was derived which was not significant. The mean competence needed score for oxy-acetylene welding for the job-shop group was 2.99 whereas the competence possessed score was 2.87. In comparing the two scores, the t-value of 2.39 was significant at the .05 level.

The comparison of the overall grand means including both arc and oxy-acetylene welding showed a significant t-value of 13.98 between competence needed and competence possessed scores for farmers. The means compared were 2.86 (competence needed) and 2.02 (competence possessed). The competence needed and competence possessed scores for the job-shop weldors were 2.96 and 2.85 producing a t-value of 2.52 which was significant at the .05 level. The overall mean competence needed score of 2.96 for job-shop weldors was compared with the equivalent score of 2.87 for farmers and the t-value of 2.07 obtained was significant at the .05 level. The final comparison of means was between the mean competence possessed scores of 2.85 for job-shop weldors and 2.03 for farmers. This yielded a t-value of 13.42 which was significant at the .01 level.

Product moment correlations were run between selected quantitative factors and arc and oxy-acetylene competencies needed and possessed for the two groups. Important relationships were noted between: (1) training

received at a trade or vocational school and arc and oxy-acetylene welding competencies possessed by the job-shop weldors, (2) training received at a trade or vocational school and value of welding operations for the farmer group, (3) training received at a trade or vocational school and hours spent welding per year by the farmer group, (4) training received in high school vocational agriculture and hours spent welding per year by farmers, and (5) training received in high school vocational agriculture and percentage of time spent welding for others by farmers.

The mean value of welding operations to the farm per year was $358.84. The data showed that farmers spent 69.5 hours per year in welding with an hourly return of $5.20. Over 59 percent of those reporting indicated that they did welding for others. Of those who did welding for others, 17.4 percent of their welding time was spent in this type of welding.

Size of farm, type of farm, and proprietorship factors did not seem to be related to other important factors of welding. The 30-39 year age group indicated that they rated the value of welding operations to their farms at $442.24. The youngest group (19 and under) spent the most hours welding per year with a mean of 125 hours.

In conclusion, it was determined that all 50 competencies were needed by farmers and job-shop weldors surveyed. The farmer group indicated they needed additional instruction in welding, whereas the job-shop group indicated they possessed nearly all the competence needed.

It was determined that similar instructional programs may be offered to those entering both occupations with the exception of the oxy-acetylene welding skills which should be offered in more depth to those becoming job-shop weldors. These instructional programs should include the competencies

as determined by this study. In arc welding, the 10 most needed competencies were: (1) understanding of affect of amperage, arc length, speed of travel and angle of electrode on weld quality; (2) ability to make welds in horizontal, vertical and overhead positions; (3) understanding of properties of metals as they affect weldability; (4) ability to select proper electrode and amperage setting; (5) understanding of properties and uses of various electrodes; (6) understanding of safe operating procedures for arc welding; (7) ability to prepare and fit pieces to be joined; (8) ability to position, clamp and weld metals to control distortion; (9) ability to weld cast and malleable iron using steel and nickel electrodes; and (10) ability to recognize and make corrections for weld defects. In oxy-acetylene welding, the 10 most needed competencies were: (1) ability to adjust proper gas pressures; (2) understanding of affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality; (3) understanding of safe operating procedures for O-A welding; (4) ability to select, light and adjust the correct flame; (5) ability to select and maintain welding and cutting tips; (6) cut, gouge and pierce metals with cutting torch; (7) ability to select and maintain O-A welding equipment; (8) ability to select correct filler rod and flux; (9) ability to control heat by torch manipulation; and (10) ability to identify steel and cast iron temperatures by color.

Additional instruction offered to those already engaged in farming should include the competencies with the widest differences between the degree of competence needed and possessed. In arc welding, the six competencies with the widest difference between the degree competence was needed and possessed were: (1) ability to make welds in horizontal, vertical and

overhead positions; (2) ability to identify various metals by inspection and spark testing; (3) ability to make welds using low hydrogen electrodes; (4) ability to make welds using hardsurfacing electrodes; (5) understanding of properties of metals as they affect weld-ability; and (6) understanding of properties and uses of various electrodes. In oxy-acetylene welding, the six competencies with the widest differences between the degree competence was needed and possessed were: (1) ability to identify steel and cast iron temperatures by color; (2) understanding of properties and uses of carburizing, neutral and oxidizing flames; (3) understanding of properties and uses of various filler rods; (4) understanding of affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality; (5) ability to select correct filler rod and flux; and (6) understanding of properties and uses of fluxes in O-A welding.

Since the farmer group surveyed in this study was not a random sample from all farmers, overall conclusions cannot be drawn with respect to all farmers; but since welding competence was so valuable to those farmers who were familiar with welding, it may be concluded that it would also be valuable to most farmers if they had competence in welding.

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APPENDIX: QUESTIONNAIRES FOR FARMERS AND JOB-SHOP WELDORS

Page 1 of Questionnaire for Both Groups

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY
Ames, Iowa 50010

DEPARTMENT OF AGRICULTURAL ENGINEERING

Dear Sir:

A series of studies is now underway at Iowa State University to determine the understandings and abilities, or competencies, needed for success in agriculture. The competencies determined and their importance will be helpful in planning programs of vocational education for high school, post-high school and adult classes.

This study is one of a series in a joint project of the Department of Education and the Agricultural Experiment Station at Iowa State University and the State Department of Public Instruction.

The study I am developing is in the area of agricultural mechanics; specifically, the competencies in welding needed for agricultural machinery maintenance. The competencies will include both arc and oxy-acetylene welding. You have been recommended as one who has competence in welding and I am asking your assistance in this project.

I would like you to rate, on the attached questionnaire, the importance of each of the competencies in welding for maintaining agricultural machinery and equipment. Please rate also, the degree that you possess each competency. All information will be strictly confidential and used for group averages only.

A stamped, self-addressed envelope is enclosed for your reply. A prompt reply will be much appreciated. Be sure to complete all of the questionnaire before returning it. Thank you very much for your time and cooperation.

Sincerely,

Herbert E. Hansen

Herbert E. Hansen, Instructor
Agricultural Engineering

HEH/vjs

TURN PAGE

Page 2 of Questionnaire for Farmers

COMPETENCIES IN WELDING NEEDED FOR AGRICULTURAL MACHINERY MAINTENANCE

GENERAL INFORMATION

Age _____ years.

Total acreage of farm or farms operated _____ acres.

Farming status (check one) Owner_____ Renter_____

Owner & Renter_____ Partnership_____ Hired Operator_____

Type of farm. List percentage of gross farm income from

a. Crops_____% b. Livestock_____%

Circle the highest grade completed in school.

8 or less 9 10 11 12 College 1 2 3 4 over 4

Training received in welding:

	Yes	No
High school vocational agriculture.....		
High school industrial arts.....		
College credit course.....		
Trade or vocational school course.....		
Vo-ag young or adult farmer class.....		
Agricultural extension course.....		
Military training course.....		
Apprentice training program.....		
Self taught.....		

Welding equipment you have on your farm:

Arc welder Yes_____ No_____
Size (maximum amperage) _____Amps

Oxy-Acetylene welder Yes_____ No_____
Cutting torch Yes_____ No_____

Estimate the value of welding to your farm per year (savings of welding costs plus time saved) $_____

Estimate the amount of time you spend welding per year ___hrs.

Do you do welding for others? Yes_____ No_____

Estimate the percentage of your welding time that you spend welding for others _____%

GO ON TO NEXT PAGE

Page 2 of Questionnaire for Job-Shop Weldors

COMPETENCIES IN WELDING NEEDED FOR AGRICULTURAL MACHINERY MAINTENANCE

GENERAL INFORMATION

Age _____ years.

Estimate the percentage of your time spent as a weldor _____%

Estimate the percentage of your welding time spent on agricultural machinery or equipment _____%

Do you make and sell welded metal equipment when you are not doing repair or maintenance welding? Yes_____ No_____

Estimate the percentage of your welding time spent doing this type of welding _____%

Circle the highest grade completed in school.

8 or less 9 10 11 12 College 1 2 3 4 over 4

Training received in welding:

	Yes	No
High school vocational agriculture.....		
High school industrial arts.....		
College credit course.....		
Trade or vocational school course.....		
Vo-ag young or adult farmer class.....		
Agricultural extension course.....		
Military training course.....		
Apprentice training program.....		
Self taught.....		

Welding equipment you have in your shop:

AC arc welder Yes_____ No_____
Size (maximum amperage) _____Amps

DC arc welder Yes_____ No_____
Size (maximum amperage) _____Amps

Gas-powered portable arc welder Yes_____ No_____
AC_____ DC_____

Oxy-acetylene welder Yes_____ No_____
Cutting torch Yes_____ No_____

Tungsten inert gas (TIG welder Yes_____ No_____
Metallic inert gas (MIG) welder Yes_____ No_____
Electric spot welder Yes_____ No_____
Other (specify)_____

GO ON TO NEXT PAGE

Page 3 of Questionnaires for Both Groups
DIRECTIONS FOR COMPLETING QUESTIONNAIRE

1. The following scale is used to rate each understanding and ability as to the degree of competence needed or possessed:

   4 - Very much competence needed (or possessed)
   3 - Much competence needed (or possessed)
   2 - Some competence needed (or possessed)
   1 - Little competence needed (or possessed)
   0 - No competence needed (or possessed)

2. In column A rate each understanding and ability (competency) as to the degree each is needed by you.

3. In column B rate yourself as to the degree that you possess each understanding and ability (competency).

4. Circle the appropriate number in columns A and B to rate each understanding and ability.

ARC WELDING UNDERSTANDINGS	A Degree of Competence I Need	B Degree of Competence I Possess
Understanding of:		
0. (Example) Importance of arc welding in farming.	4 (3) 2 1 0	4 3 (2) 1 0
1. Safe operating procedures for arc welding.	4 3 2 1 0	4 3 2 1 0
2. Basic electricity as it applies to arc welding	4 3 2 1 0	4 3 2 1 0
3. Operating characteristics of AC and DC welding machines.	4 3 2 1 0	4 3 2 1 0
4. Processes involved in the arc and molten pool during welding.	4 3 2 1 0	4 3 2 1 0
5. Affect of amperage, arc length, speed of travel and angle of electrode on weld quality	4 3 2 1 0	4 3 2 1 0
6. Properties of metals as they affect weldability	4 3 2 1 0	4 3 2 1 0
7. Affect of weld distortion on metals.	4 3 2 1 0	4 3 2 1 0
8. Functions of flux coating on electrodes.	4 3 2 1 0	4 3 2 1 0
9. Properties and uses of various electrodes.	4 3 2 1 0	4 3 2 1 0
10. Elementary blueprints and weld symbols.	4 3 2 1 0	4 3 2 1 0

ARC WELDING ABILITIES		
Ability to:		
0. (Example) Identify quality welds.	4 (3) 2 1 0	4 3 2 (1) 0
1. Select and maintain arc welding machines.	4 3 2 1 0	4 3 2 1 0
2. Identify various metals by inspection and spark testing.	4 3 2 1 0	4 3 2 1 0
3. Select proper electrode and amperage setting	4 3 2 1 0	4 3 2 1 0
4. Prepare and fit pieces to be joined.	4 3 2 1 0	4 3 2 1 0
5. Position, clamp and weld metals to control distortion.	4 3 2 1 0	4 3 2 1 0
6. Recognize and make corrections for weld defects	4 3 2 1 0	4 3 2 1 0
7. Make bead and butt welds in the flat position.	4 3 2 1 0	4 3 2 1 0

TURN PAGE

Page 4 of Questionnaires for Both Groups

ARC WELDING ABILITIES (CONT.)	A Degree of Competence I Need	B Degree of Competence I Possess
8. Make weave or spread beads in the flat position.	4 3 2 1 0	4 3 2 1 0
9. Make lap and fillet welds in the flat position.	4 3 2 1 0	4 3 2 1 0
10. Make welds in horizontal, vertical and overhead positions.	4 3 2 1 0	4 3 2 1 0
11. Make welds using low hydrogen electrodes.	4 3 2 1 0	4 3 2 1 0
12. Make welds using hardsurfacing electrodes.	4 3 2 1 0	4 3 2 1 0
13. Weld cast and malleable iron using steel and nickel electrodes.	4 3 2 1 0	4 3 2 1 0
14. Join metals of different thicknesses.	4 3 2 1 0	4 3 2 1 0
15. Weld joints with poor fit.	4 3 2 1 0	4 3 2 1 0
16. Cut, gouge and pierce metals with appropriate electrodes.	4 3 2 1 0	4 3 2 1 0
17. Make tee and butt welds in pipe.	4 3 2 1 0	4 3 2 1 0

OXY-ACETYLENE (O-A) WELDING UNDERSTANDINGS

Understanding of		
0. (Example) Importance of O-A welding in farming.	4 (3) 2 1 0	4 3 (2) 1 0
1. Safe operating procedures for O-A welding.	4 3 2 1 0	4 3 2 1 0
2. Properties of gases used in O-A welding.	4 3 2 1 0	4 3 2 1 0
3. Operating characteristics of O-A welding equipment	4 3 2 1 0	4 3 2 1 0
4. Properties and uses of carburizing, neutral and oxidizing flames.	4 3 2 1 0	4 3 2 1 0
5. Affect of tip size, gas pressures, speed of travel, angle of tip and type of flame on weld quality.	4 3 2 1 0	4 3 2 1 0
6. Properties and uses of fluxes in O-A welding.	4 3 2 1 0	4 3 2 1 0
7. Properties and uses of various filler rods.	4 3 2 1 0	4 3 2 1 0
8. Fusion process in joining metals.	4 3 2 1 0	4 3 2 1 0
9. Brazing process in joining metals.	4 3 2 1 0	4 3 2 1 0
10. Oxygen cutting process.	4 3 2 1 0	4 3 2 1 0

OXY-ACETYLENE (O-A) WELDING ABILITIES

Ability to:		
0. (Example) Set up a portable O-A welder.	(4) 3 2 1 0	4 3 2 (1) 0
1. Select and maintain O-A welding equipment.	4 3 2 1 0	4 3 2 1 0
2. Select and maintain welding and cutting tips.	4 3 2 1 0	4 3 2 1 0
3. Select correct filler rod and flux.	4 3 2 1 0	4 3 2 1 0
4. Adjust proper gas pressures.	4 3 2 1 0	4 3 2 1 0
5. Select, light and adjust the correct flame.	4 3 2 1 0	4 3 2 1 0
6. Control heat by torch manipulation.	4 3 2 1 0	4 3 2 1 0
7. Identify steel and cast iron temperatures by color.	4 3 2 1 0	4 3 2 1 0
8. Make bead and butt welds with steel filler rod.	4 3 2 1 0	4 3 2 1 0
9. Make bead and butt welds with brass or bronze rod.	4 3 2 1 0	4 3 2 1 0
10. Make fillet welds with brass or bronze rod.	4 3 2 1 0	4 3 2 1 0
11. Braze weld cast or malleable iron.	4 3 2 1 0	4 3 2 1 0
12. Join thin metals by O-A welding.	4 3 2 1 0	4 3 2 1 0
13. Cut, gouge and pierce metal with cutting torch	4 3 2 1 0	4 3 2 1 0

Comments or Suggestions_____

Have you answered all questions?

THANK YOU