DOCUMENT RESUME

ED 186 658 CE 025 051

AUTHOR Crosby, Richard K.
TITLE A System for Providing Relevant Metrics Education for Vocational Teachers in Kentucky. Final Report.
INSTITUTION Louisville Univ., Ky. Dept. of Occupational and Career Education.
SPONS AGENCY Kentucky State Dept. of Education, Frankfort. Bureau of Vocational Education.
PUB DATE 19 Oct 79
NOTE 253p.; Some pages in this document will not reproduce well due to light type.

EDRS PRICE MF01/PC11 Plus Postage.
DESCRIPTORS Air Conditioning; Auto Body Repairers; Auto Mechanics; Drafting; Educational Innovation; Equipment Utilization; Food Service; Horticulture; Industry; Inservice Teacher Education; Job Skills; Machine Repairers; Machine Tool Operators; *Material Development; *Measurement; Measurement Equipment; *Metric System; Postsecondary Education; *Professional Development; Repair; *School Business Relationship; Teacher Improvement; Teacher Workshops; Vocational Education; *Vocational Education Teachers; Welding.
IDENTIFIERS Kentucky

ABSTRACT

A project conducted in four vocational regions of Kentucky developed a system for providing vocational teachers with relevant metrics education and developed and identified materials to support and enhance the system. Ten occupational training areas selected as a focus of the project were air conditioning, auto-body, auto mechanics, diesel mechanics, drafting, food service, horticulture, machine shop, small engine, and welding. A needs assessment involved vocational teachers and industry in a cooperative effort to determine what industry was doing about metrics and gained information to develop scale instruments to measure (1) what metric tools and equipment were used and (2) what metric measurements were made in vocational programs and industry. Two additional scales were designed to aid in planning for shop conversion to metrics and to determine individual metric professional development needs. Teacher workshops were conducted to provide awareness experiences and aid in planning for changeover. A metric education course for vocational teachers based on 16 available individualized modules was designed and offered in one region. (Appendixes, amounting to four-fifths of the report, include literature review references, sample scales, workshop materials, and other project-developed or -related materials.) (YLB)

Final Report

A SYSTEM FOR PROVIDING RELEVANT METRICS EDUCATION FOR VOCATIONAL TEACHERS IN KENTUCKY

by

Dr. Richard K. Crosby
University of Louisville

October 19, 1979

Department of Occupational and
Career Education
School of Education
University of Louisville
Louisville, Kentucky 40208

The Research reported herein was performed pursuant to a contract with the Commonwealth of Kentucky, State Department of Education, Bureau of Vocational Education. Contractors undertaking projects under such sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official State Department of Education position or policy.

COMMONWEALTH OF KENTUCKY
STATE DEPARTMENT OF EDUCATION
BUREAU OF VOCATIONAL EDUCATION

AGREEMENT OF NONDISCRIMINATION

The Kentucky Department of Education in accordance with Title VI, Title VII, Title IX of the Vocational Education Amendments of 1976, and section 504 of the Rehabilitation Act, does not discriminate on the basis of race, color, national origin, age, religion, marital status, sex or handicap in employment.

TABLE OF CONTENTS

PREFACE

This project was a result of concerns about the status of metric measurement in Kentucky Vocational Programs. Vocational Education is closely linked to industry. Programs must include metric measurements, related tools and equipment to prepare graduates for the "World of Work."

The project was designed to develop a system for assisting vocational educators to cope with metric measurement. Included in the refinement of the system were provisions for developing and/or printing various materials. These materials are available for use by educators at all levels of responsibility.

The research was a "field based" effort. That is, the system was developed with the assistance of vocational educators in four regions. Over a hundred vocational educators participated in project activities. Thus, it was possible to educate participants about metric measurement, while refining a system that can now be used to assist vocational teachers.

This research is part of a continuing effort by vocational educators to keep abreast of new innovations in business and industry. Through dissemination and further activities, it is hoped that project efforts will serve as a catalyst for action. Vocational educators need to continue to observe, research, plan for, and implement metrics in their programs to maintain relevant education.

PROJECT ABSTRACT

TITLE OF PROJECT: A SYSTEM FOR PROVIDING RELEVANT METRICS EDUCATION FOR VOCATIONAL TEACHERS IN KENTUCKY

PROJECT DURATION: Beginning Date 1 July 1978
Ending Date 1 September 1979

OBJECTIVES:

1. Develop a system for aiding teachers to adapt to metric measurement.
2. Develop ten (10) self-assessment instruments relating to metric tools, equipment and measurement.
3. Print sixteen (16) metric modules for in-depth metric education.
4. Transmit results to the Bureau of Vocational Education.

PROCEDURES: The design of the project included:

1. Working with committees of vocational teachers.
2. Offering workshops in four regions.
3. Determining the status of vocational programs by surveying educators attending workshops.
4. Making recommendations based on synthesis of results.

CONTRIBUTIONS TO EDUCATION: This project resulted in a system, supporting materials and findings from which future planners can meet student and business and industrial needs.

A SYSTEM FOR PROVIDING RELEVANT METRICS EDUCATION FOR VOCATIONAL TEACHERS IN KENTUCKY

INTRODUCTION

This report describes the products, activities, and efforts to develop a systemized approach to metrics education to meet the needs of Kentucky Vocational Teachers.

Background

In 1975, President Ford signed the Metrics Act. This Act encouraged a ten year voluntary conversion from the english to metric system of measurement. The key word in the legislation was "voluntary." It was up to business, industry, education, other organizations, and individuals to determine if metrics was necessary and economically feasible. The Act was intended to be a stimulus for change where change was warranted.

From analyzing the overall support of government and industry for the changeover, it can be concluded that metric measurement is here to stay. It is only a matter of time before the majority of industries accept metrics as the primary measurement system.

In response to metric conversion, 13 states set 1980 as the target year for teaching predominantly in the metric system (United States General Accounting Office [GAO], 1978.) Kentucky is one of these states. In a resolution, the Kentucky State Board of Education (1974) stated that metric measurement "...shall be given the major emphasis

beginning with the 1980-81 school year" (see Appendix 1.) This resolution requires vocational educators in Kentucky to evaluate metric conversion and implications for change.

In addition, vocational educators must be aware of the progress of metric conversion to meet goals of their vocational programs. The link between vocational education and industry is very strong. As industry changes to metrics, vocational education must include appropriate education in the curriculum. Present and future workers must be able to use metric measurement as required by the industries in which they are employed.

This project was initiated in response to apparent needs of vocational educators to analyze, make decisions, and implement metric education. In line with these needs, the project focused on a systemized approach to deal with concerns of paramount interest to teachers (The Center For Vocational Education, 1975.) These concerns were:

(1) To what extent is metrics being used in industry?

(2) What long range plans does industry have for converting to metric measurement?

(3) What is vocational education doing about metrics?

(4) What needs to be done in vocational education to meet implications of metric measurement?

Research and Literature

The first step in deciding what metric education should be included in vocational training, is to determine what workers are doing in industry (McMahon, 1972.)

In a metric study conducted before the Metric Act of 1975, it was concluded that large organizations tended to be more favorable toward adoption of metrics than small companies (U.S. Commerce Department, 1971.) Thusfar, this conclusion seems to have held true. Large companies, such as Ford, Catepilar Tractor, and General Motors, began changing to metric sized parts in the early 70's. Other large companies have followed the lead (3M Company, 1978.) Small businesses have exhibited more resistance. In a study by Terry Wise (1979) in Elizabethtown, Kentucky, seventy-eight (78) percent of small companies surveyed said they were not using metric measurement, and many stated that they would do so only if forced by legislation. This study is reinforced by the GAO report (1978, p. 11) that states "...more (small businesses) believe the disadvantages out-weigh the advantages for their firms."

In a survey of ninety-nine (99) large and small companies in Kentucky, the Department of Education (1977) found that twenty-nine (29) companies were not changing to metric measurement. Four (4) percent said their companies had progressed toward complete conversion. Most of the companies leaned toward responses that indicated they were not converting. The small company resistance might have had an influence on results of the survey. If so, this would have implications for industry commitment to metrics in urban and rural areas. Since most large companies are located near urban areas, it might appear that urban industry is more committed to metric measurement. Likewise, rural area industry might seem opposed to the idea of changing over to a different measuring system.

It has been theorized that industries selling products in countries that use metric measurements are more likely to accept and produce metric sized products (U.S. Department of Commerce, 1971.) Perhaps this is the reason why the building trades industry has not changed to metrics, while the automotive industry has made significant progress (GAO report, 3M, The Center for Vocational Education). Other industries seem to vary in their involvement in foreign markets, and likewise, vary in their commitment to metrics changeover.

Because attitudes are vital in influencing behavior, the progress of metric changeover has probably been affected by attitudes of producers and consumers. In a study originated by the GAO (1978, p. 34) it was found that:

- Half the people from the general public believed they would not benefit from metrics.
- Twice as many people were opposed to metric conversion than supported it.

If these findings can be generalized, a large number of people with varying occupational responsibilities are opposed to metric conversion. This point of view could provide one explanation of why like businesses seem to vary in their plans to change to metrics.

The literature and research portrayed a confusing picture of what industries were changing to metric measurement. Likewise, rates of progress for industries already committed were difficult to access. General Motors in the mid-70's gave detailed reports of progress in following their conversion plans. A few other reports of industry progress were located.

However, most companies do not advertise what they are doing about metrics. It could be concluded that the majority of businesses have no plan of action. The Kentucky State Department of Education (1977) found that eighty-four (84) percent of twenty-nine (29) surveyed companies had no target date for complete conversion. The Government Accounting Office (1978) somewhat supports this finding. They stated that countries converting to metrics learned from experience that an overall target date must be mandated by government if conversion is to become reality. This implied that mandated target dates force industry to plan and carry out conversion in an ordered fashion. At this time, it appears that the rate of changeover is rather unpredictable, and varies from industry to industry.

Findings in research and literature indicate that vocational teachers may have a difficult time in generalyzing about industry commitment to metrics. The willingness and rate of change seem to be affected by business climates, location of trade markets, size of industries, as well as pro and con attitudes. Determining what types of tasks workers perform in a particular industry may be much easier than finding out what metric measurements are made in accomplishing the tasks.

If teachers could find out what other teachers were doing, this information would help them make metric conversion decisions. There was some information available that is evidence of an availability of assistance. V-TECS catalogs of objectives (1979) and approved equipment lists from the Kentucky Department of Education (1979) contain listings of metric tools and equipment. Teachers were involved in the development of

these listings. In addition, descriptions of numerous workshops and conferences that included metric sessions were found. There was no evidence that Kentucky Vocational Teachers are taking advantage of the help.

From available information, it must be concluded that it is difficult to decide what to teach. Some articles (Jackman, 1976, Adair, 1977, Lindbech, 1976, and others) discuss what needs to be changed in specific programs if teachers decide to totally convert to metric measurement. The Center for Vocational Education (1978) published another type of material. Metric instructional modules from the Center for over fifteen (15) vocational areas were designed to meet measurement needs of students. All of the located materials contain valuable information. However, they do have limitations. The information does not guide the teacher as to the steps to take to decide teaching content and the depth of instruction that should be selected to maintain relevant education.

In conclusion, the research and literature did not help us to answer our questions about metric changeover. It was and still is difficult to assess where industry is and where they are going in converting to metrics. It is equally difficult to decide what vocational teachers are doing and what they should be doing to properly train students in metric measurement.

Scope of the Project

The project was designed to be of immediate and long-range assistance to teachers in their efforts to cope with metric measurement. Thus, input was needed from many sources to make final outcomes relevant.

Every effort was made to include input from industry. A Steering Committee participated in making timely project decisions. Teachers were asked to participate in developing and perfecting products used by teachers. The State Department of Education, Vocational Region, and Jefferson County administrative personnel added much to the quality of the project. Four (4) vocational regions were involved. Several out-of-state consultants were asked to provide additional information. In essence, as time, funds, and energies allowed, all persons and organizations that could assist were asked to participate.

As information from the literature was evaluated, it became apparent that decisions about metrics would have to be made from program area to program area. Thus, the project was designed to work with a managable group of programs. Ten (10) occupational training areas were selected by the Steering Committee as a focus of the project.

During the literature search, materials were purchased to be used and displayed in workshops.

The project was limited to Jefferson County and Vocational Region 6, along with three (3) other vocational regions. Workshops were offered in all four (4) regions.

ACTIVITIES AND ACCOMPLISHMENTS

Problem

The research and literature section support the position that vocational teachers must look closely at industries related to their training

to determine how metric conversion is progressing. Since there are many variables associated with industry conversion, it is necessary to use the best method to survey industry about metric changes. The next step is to decide what should be included in the training. Then, teachers have to decide on immediate and long-range changes to match predicted industrial conversion. These changes must consider: curriculum revision, modifying and/or purchasing new equipment and tools, and ordering additional supplies. A very complete plan must be developed to include all necessary instructional considerations.

A noted vocational educator, Rupert Evans (1974) said, "Obviously you must learn what SI (metrics) is, and is not, before you can begin to install it in your laboratories and teach it to your students." This statement supports the idea that teachers need professional development experiences in metrics in order to be able to make and implement realistic decisions. These experiences must include awareness of the total metric system, along with in-depth training in aspects of metrics needed for specific training areas.

Influences of attitudes in relation to the success of metric conversion have long been discussed. Attitudes were also an important factor in this project. Since the project was designed to assist teachers, attitudes about metric measurement were strong determiners as to whether or not teachers would participate and accept help. Mark Headrick (1976) assessed the attitudes of over 24,000 vocational and technical teachers in Missouri. He found favorable attitudes toward conversion to metrics.

Using the results of this study, we might have assumed that teachers would be very receptive to the project. However, because of the importance of attitudes in realizing project success, this was an area of concern in planning and implementing all activities.

Thus, the problems became apparent. Vocational teachers needed assistance in coping with metric conversion. They needed help in discovering the best way to find out what industry is doing at the present and in the future. Assistance was needed in deciding what metric tools, equipment, and measurements should be integrated into vocational instruction. Teachers needed professional development activities to assist them to utilize obtained information. Some teachers needed help in seeing the "good" in converting to metric measurement. In summary, the problem and sub-problem were:

Problem: What system can be used to help vocational teachers meet implications of metric conversion?

Sub-Problem: What can be done to enhance positive attitudes of vocational teachers toward metric conversion?

Methods

The project involved teachers, industry, and teacher education in an organized effort to provide metric education. More specifically, the project resulted in a system to assist individual teachers with:

(1) identifying what industry is doing in metrics, (2) assissing how vocational programs in specific occupational areas compare to what industry is doing, (3) obtaining specific metric knowledges and skills, and (4) planning for conversion, when necessary.

Literature Review--

The first step in the project was to conduct a literature review. This activity was divided into three steps: (1) to review literature, (2) to order literature to support project activities, and (3) to develop a bibliography of materials to support project intents.

An extensive literature search was conducted. Metric literature from ERIC, AIM, ARM, CJE, and the Business Periodicals Index were reviewed. In addition, textbooks, government literature listings, articles, references, and various bibliographies were searched for relevant materials.

Literature was needed to support several different activities. During the instrument development phase, several awareness workshops were offered. Various literature and materials were purchased to support these activities. As a result of the project, individualized metric modules were printed to be distributed to four regions and selected teacher education institutions. Literature was purchased to be included with the modules. All purchased materials are listed in Appendix 2.

Early in the project, it was decided that literature could serve several purposes. First, it was needed to support activities, as

previously mentioned. Secondly, literature provided information as to what happended in industry and vocational education. Therefore, the search focused on finding sources that could provide general information for several project activities, and specific information that could be disseminated to vocational teachers during workshops and other in-service activities.

Steering Committee--

A Steering Committee was selected to be representative of education and industry (see Appendix 3.) The Committee had three basic functions; (1) to select ten vocational program areas that would be the focus of project activities, (2) to select three vocational regions, in addition to region six, and (3) to evaluate project activities.

In order to select ten (10) vocational program areas, the Committee considered various evidence. A listing of programs in Region 6 was provided. The Project Director discussed what had been found in the literature about vocational programs and industry conversion. Members of the Committee shared information about programs in relation to metric measurement needs. After lengthy discussion, ten program areas needing the most assistance were selected. They were:

Air Conditioning	Food Service
Auto Body	Horticulture
Auto Mechanics	Machine Shop
Diesel Mechanic	Small Engine
Drafting	Welding

Several factors were considered when selecting three regions for field test. Each region was discussed in relation to: (1) the number of programs in the region to the ten (10) selected as the focus of the project, and (2) rural-urban characteristics. Region 5, Elizabethtown; Region 14, Lake Cumberland; and Region 15, Bluegrass; were selected. (See Appendix 4.) All of the regions expressed a willingness to participate.

As part of the Steering Committee activities, Dr. John Peterson from The Ohio State University, The Center for Vocational Education was asked to participate. Dr. Peterson was formerly involved in the development of metric instructional materials for vocational programs. His past experiences in organizing and carrying out activities were similar to what had been planned for the project. Therefore, he was asked to focus on the process of the project, with options to look at products similar to those developed in his project. The focus of his efforts were to help improve overall project quality.

Needs Assessment--

The needs assessment activities had a two-fold purpose. It was intended to develop ways to involve vocational teachers and industry in a cooperative effort to determine what industry was doing about metrics. These ways or methods would be included in the system and recommended to other vocational educators. In addition, it was a prime purpose to gain sufficient information to develop instruments that would measure what metric tools and equipment were used, and what metric measurements were made in vocational programs and industry.

A Metric Advisory Committee was selected for each vocational area (see Appendix 5.) The number of teachers selected for the Committees varies. The decision was made to allow more than one to serve on a committee if several teachers volunteered.

A definite problem in the project was how to work with teachers to develop listings of equipment and measurements. This problem was presented to the Steering Committee. They suggested that a college credit course be implemented to assist teachers to work with industry, with the final outcome being the desired listings. They also recommended that the project provide tuition as an incentive to participate. This idea was pursued by the project staff, but could not be realized because of state department policy about tuition remission. The final solution was to work with teachers during their planning period or on their own time.

The project staff developed a listing of tools and equipment, and measurements for each vocational area. The content of the listings were derived from: (1) official equipment lists from the Department of Education, Frankfort, (2) V-TECS catalog listings of tools and equipment, and (3) The Center for Vocational Education Metric Modules. (See Appendix 6 for a sample of materials.)

A meeting was scheduled with each of the committees. Teachers were requested to bring program equipment lists. When the meetings were held, the project was explained. Then, the teachers' list was compared to a listing of tools and equipment prepared by the project staff. Items

that did not seem relevant to the program were deleted. A listing of measurements was assessed for missing and extra measurements. After going over the lists, the shop was visited and various tools, equipment, and corresponding measurements were discussed. This resulted in the addition and deletion of additional items and measurements.

During each of the meetings, the involvement of industry in developing lists was discussed. Teachers were questioned about craft committees and overall relationships with industry. Suggestions were made by the project staff as to how industry could be involved. Based on the information, each committee was asked to survey industry, using the lists. They were to do this in a way that best fit unique relationships that had been established by the teacher. Thus, when the lists were returned, they should have included inputs from industry and vocational teachers.

Listings develpped by the Committee were delivered to Frankfort for review by the vocational equipment section of the Department of Education. They were also given to vocational teachers in Vocational Region 6 that attended workshops. Teachers were encouraged to comment on any wording that was not clear and to add and/or delete any items. All received information was used to arrive at finalized listings.

Instrument Development--

A recent AV Journal article by Spillman and Bruce (1976) related closely to project conditions. They said that the development of materials is much easier to accomplish than getting teachers to use

them. This thought held true for many aspects of the project. Teachers did not automatically change their points of view because individualized materials were available or in-service education was provided. Change was only realized when teachers concluded there was a definite need to upgrade themselves and their programs to match what industry was doing.

The instrument seemed to be an excellent vehicle to define upgrading needs of programs and teachers. It was intended that the instrument would utilize teacher experiences to find out what metrics was needed and how it would be effectively utilized in vocational programs. To realize the intent, a self-assessment instrument was developed. The teacher could use it to organize thoughts, derive information from the results, and decide what should be done.

Data Analysis--

Once the instruments were filled out in selected workshops, the results were to be tabulated and analyzed. The metric status of teachers and programs was to be determined. The analysis was to result in supplementary information to the instrument that could provide teachers with additional information for decision-making.

Third Party Evaluation--

A third party evaluation was planned to evaluate the impact of the project. L.S. McKinney, West Virginia Technical Institute, was asked to participate. His background included a wide-range of experiences in metrics education for vocational teachers. Mr. McKinney had tested,

educated, and assisted vocational teachers to adapt to industrial innovations in metrics. Because of his expertise, he was asked to make an in-depth assessment of the instrument and associated activities.

Also, the Steering Committee evaluated the project. They completed an instrument that was based on Mr. McKinney's evaluation and project objectives.

The evaluation from the Steering Committee and L.S. McKinney were compared. Both Mr. McKinney and the Committee knew the evaluations would be compared for commonalities and differences. The results were used to consider future metric activities.

Field Test and Review--

After instrument development and review in Region 6, the instrument and, more importantly, the system were to be tried out in the three regions selected by the Steering Committee. Workshops were chosen as a way to refine the system and assist teachers in upgrading themselves and their programs.

The workshops were designed to provide maximum assistance to teachers who were ready to make decisions about implementing metric measurement in their programs. Along with discussing program needs (tools, equipment, measurements,) a portion of the workshops was devoted to developing a plan for changeover. A large part of the workshop was desinged to provide awareness experiences. There were also opportunities for teachers to decide on further professional development needs.

Professional Development--

A metric education course was planned as part of the project. This course was designed to provide in-depth metric education for vocational teachers.

It was planned to cooperate with the professional development unit to offer other activities.

RESULTS

Objectives were written to aim the project towards developing a system for providing metric education. Therefore, the results were discussed in terms of success in meeting objectives.

Objective 1.1

Review metric literature, including literature identified through an Eric search.

This objective was met. An extensive search was carried out over the twelve (12) month period of the project.

Several bibliographies were discovered that could help educators interested in implementing metrics. Metric Education, an annotated Bibliography for Vocational, Technical and Adult Education (1974), and The Metric System: A Bibliograohy of Instructional Materials (1975) are worthy of mention. Both documents are available upon request.

Objective 1.2 Order literature needed to support project activities.

Literature was ordered and received. (See Appendix 2 for a listing.) These materials were used frequently in the project. The objective was met.

Along with supporting individualized metric instruction, reference materials were displayed at each workshop. Teachers were encouraged to look at the materials and decide if any would be useful in their programs. Although a great deal of care was taken to make an attractive display, teachers did not give much attention to materials.

Objective 1.3 Develop a bibliography of materials relevant to the intents of the project.

Three (3) documents were developed in the project. Metric References was an extensive listing compiled from a variety of sources. This document was used as the basis for a more explicit listing titled Specific Reference. The third document was a description of sixteen (16) articles titled Article Summaries. The total package of three (3) documents was developed in an effort to be of most help to educators. These can be examined in Appendix 7. The objective was realized.

These documents were helpful during the project. They were also used during several workshops. Teachers were encouraged to use them to identify references that would be of assistance. There did not seem to be a great deal of enthusiasm from the teachers about the availability of the documents.

Objective 2.1 Select a Steering Committee

The Steering Committee was selected, thus the objective was met.

It was intended to have the Steering Committee representative of industry and education. All of the educators agreed to participate. It was more difficult to find members from industry that could

participate. Many persons were contacted, all refused because they had other commitments when meetings were scheduled. Finally, Mr. Frank Buckler, Region 6, came to the rescue. He contacted numerous people from industry and located an industry person for the Steering Committee.

The cooperation of the Committee was fantastic. Good ideas were generated and used as the basis for many project decisions.

Objective 2.2 Select ten (10) vocational program areas as the focus of the project.

Ten (10) vocational areas were selected by the Steering Committee. The objective was met.

In the first few workshops, participation was limited to those from the ten (10) vocational areas. However, at the urging of several regional directors, teachers from all vocational areas were allowed to attend several workshops. Table 1 gives a breakdown of numbers of participants by vocational training areas.

It is important to note that regional directors made the requests after teachers asked if they could attend. Evidently, teachers in many vocational areas perceived the need to adjust to metric measurement and were looking for ways to meet their needs.

Objective 2.4 Select a Consultant to evaluate and make suggestions relative to project procedures.

Table 1

NUMBER OF WORKSHOP PARTICIPANTS BY VOCATIONAL TRAINING AREA
(N=115)

Training Area	Number
Auto Mechanic	19
Machine Shop	16
Welding	12
Health Careers	7
Auto Body	6
Heating and Air Conditioning	6
Carpentry	6
Electricity/Electronics	6
Business and Office	6
Food Service	5
Aricraft Mechanics	5
Agriculture	5
Drafting	3
Home Economics	2
Diesel Mechanics	2
Appliance Repair	2
Small Engine	1
Distributive Education	1
Printing	1
Others (Coordinators, Counselor, Aide)	4

Dr. Peterson, of the Ohio State University made many useful suggestions (see Appendix 8.) Table 2 list his main suggestions and responses by the project staff. The objective was met.

Table 2

CONSULTANT MAIN SUGGESTIONS AND PROJECT RESPONSES

Suggestion	Response
1. Make a more extensive literature search.	1. Enlarged the scope of the search.
2. Administer self-assessment instrument to sample groups.	2. Use workshop participants as sample groups.
3. Modify Scale 3 - Shop conversion to metrics.	3. Modified Scale 3.
4. Change title of Scale 4.	4. Title was adequate as selected.
5. Have a larger sample of teachers complete Scale 1 & 2 before workshop.	5. Good idea for a future project.
6. Begin workshops by having participants complete Scales 1 and 2.	6. Restructured workshops to reflect suggestion.
7. Have small group discussions in workshop ablut what needs to be done.	7. Restructured workshops to reflect suggestion.
8. Involve workshop participants by using measurement activities.	8. Restructured workshops to reflect suggestion.

Objective 3.1 Select a Metric Advisory Committee.

A Committee for each of the ten (10) areas was selected. The objective was met.

The Commitees of teachers, as a whole, were very cooperative and patient with the project staff. However, it is the opinion of the Project Director that much more could have been accomplished if teachers had been given more time and incentives to participate. It was difficult to accomplish everything that had to be done when time was limited and teachers could not see immediate benefits.

It was interesting to note the attitudes of teachers toward metrics. Most of the teachers were very enthusiastic and expressed the belief that--metrics is here; we need to adjust to it. One teacher, in particular, had a different view. The teacher lectured the Project Director about the evils of the metric changeover and why it would not affect the particular occupation. To check this out, the Project Director talked with several teachers of the same vocational area. They disputed this view. The teachers said metric measurement was becomming common in the occupation and should be included in the training. This difference of viewpoint was observed many times during the project. There didn't seem to be many participants that had no opinion about metric measurement. Either it was expressed as a necessity or eventuality and accepted or criticized and rejected.

Objective 3.2 Develop a listing of metric measurements that are being made in industry at the present time.

Objective 3.3 Develop a listing of metric tools and equipment needed to adapt to the present state of metrics in industry.

Listings of matric measurements (Scale 2), and tools and equipment (Scale 1) were developed. They may or may not be representative of what is going on in industry. The objectives 3.2 and 3.3 were partially accomplished.

This was the most difficult part of the project. When the project was planned, the Project Director assumed that working with industry would be easy, since vocational education is so closely linked to industry. Yet, numerous methods were tried with questionable success.

It was intended that Metric Advisory Committees of teachers could obtain industry input form their Program Craft or Advisory Committees. Yet, when this was proposed the idea was not accepted. Some said they had not yet formed a committee. Others stated that their meetings would not be held until late spring. To expand on this, the same idea was proposed to teachers in two (2) workshops. Again, there were no positive responses. For some reason, teachers were not enthusiastic about assisting the Project Director by using their Advisory Committees to obtain metric information.

Several ideas about working with industry were expressed to teachers, such as having upgrade classes or workers at professional meetings complete instruments. Some teachers agreed to assist in this manner and were provided instruments. However, there were not enough returned to include information in the report.

There may have been a good reason why teachers were not excited about obtaining metric information directly from industry. Many teachers said they had been observing industry and knew what progress they were making. If this was true for all ten (10) vocational areas, then, teacher input did represent what is happening in industry.

Objective 3.4 Develop a projection of the rate of progress of industry during the remaining years of the ten (10) year voluntary conversion period.

The projection for the rate of industrial progress for each of the ten (10) vocational areas was developed from instruments. Since there was no direct industrial involvement, as planned, the objective must be rated as partially accomplished.

Objective 4.1 Develop a metrics self-assessment instrument that measures: (1) metric professional development needs, and (2) program metric needs.

Two (2) scale instruments for ten (10) vocational areas were developed. The objective was accomplished.. (See Appendix 9.)

In addition to Scales 1 and 2, Scales 3 and 4 were developed to assist teachers in planning to meet program and individual needs. Scales 3 and 4 were used in workshops and are not considered part of the instrument.. However, a sample of the scales are included in Appendix 10.

Objective 5.1 Analyze data to determine the metric status in comparison to industry of the ten (10) selected vocational areas.

Data was analyzed to determine the status of two (2) vocational programs. It was not possible to compare the results to industry. There were not enough participants to analyze all ten (10) areas. The objective was not met.

It was proposed that ten (10) vocational areas be selected early in the project. Because the areas were so different, it was necessary to develop an instrument for each area. This was accomplished. The decision was also made to collect data in scheduled workshops, after instruments were refined.

Decisions to develop ten (10) instruments, and collect data in workshops, were best in terms of the main purpose of the project--to develop an educational system. They were also made to provide the optimum way to develop and perfect ten (10) instruments. However, these decisions were arrived at with the knowledge that workshop attendance had to be large in order to collect sufficient data. It was predicted that teachers in the ten (10) occupational areas would see the need for the workshops and attend. This did not happen. Workshop attendance was not sufficient to allow data collection and analysis in the ten (10) areas. Additional information was not developed because of the limited sample.

Only sixty-seven (67) teachers completed Scales 1 and 2. (See Table 3.) This was not enough to generalize findings to larger populations of vocational teachers in Kentucky. Thus, conclusions were presented in relation to the group that completed the instrument.

Note in Table 3 that fewer teachers completed Scales 3 and 4 than 1 and 2. This was true, because Scales 3 and 4 could not be used in several workshops, because of time limitations. The planned workshops were twelve (12) hours in duration. One workshop was three (3) hours long, several were completed in six (6) hours.

Table 4 summarizes some information from teachers of eight (8) different vocational areas. Note that teachers from three (3) of the areas responded that no metric measurements were being made in their programs. In four (4) program areas, there were no metric items selected as used now. Yet, every program area except Small Engines, said metric items were needed now.

For more complete listings of Scale responses, see Appendix II.

Auto Mechanic Programs have long been recognized for rapidly adapting to metric conversion. The data from participants (Table 5), seemed to support this recognition. Over twenty-five (25) percent of the teachers said they made some eleven (11) different metric measurements. Ten (10) different types of metric items were used. Fifteen (15) types of metric items were checked as being needed now. In addition, metric books were listed by three (3) teachers. Note that listed items were small and fairly inexpensive. No large equipment were apparently needed.

TABLE 3

NUMBERS OF INSTRUMENT COMPLETERS BY VOCATIONAL AREAS

Vocational Area	NUMBER OF COMPLETERS (N=67) Metric Items (Scale 1)	(N=67) Metric Measurements (Scale 2)	(N=43) Metric Equipment Needs (Scale 3)	(N=40) Metric Professional Development Needs (Scale
Air Conditioning	4	4	2	1
Auto Body	6	6	4	3
Auto Mechanic	17	17	9	10
Diesel Mechanic	2	2	2	2
Drafting	2	2	2	2
Food Service	3	3	5	6
Horticulture	5	5	3	1
Machine Shop	16	16	8	7
Small Engine	0	0	1	1
Welding	12	12	7	7

TABLE 4

TEACHER RESPONSES FROM EIGHT (8) VOCATIONAL TRAINING AREAS
METRIC MEASUREMENTS AND ITEMS

Training Area	Number (N) of Metric Measurements Made Now		Number (N) of Metric Items Used Now		Number (N) of Metric Needed Now	
	N of Teachers Responding	N of Different Measurements	N of Teachers Responding	N of Different Items	N of Teachers Responding	N of Different Items
Welding	12	2	12	0	7	18
Auto Body	6	0	6	0	4	9
Diesel Mechanic	2	0	2	0	2	7
Air Conditioning	4	3	4	0	2	5
Drafting	2	0	2	2	2	6
Food Service	3	3	3	5	5	7
Horticulture	5	30	5	2	3	3
Small Engines	0	0	0	0	1	0
	34	38	34	9	26	55

TABLE 5

AUTO MECHANICS

METRIC MEASUREMENTS AND ITEMS

Metric Measurements Made Now By Over 25% of Teachers N=17		Metric Items Used Now By Over 25% of Teachers N=17		Metric Items Needed Now By Over 25% of Teachers N=9	
Measurement	N	Item	N	Item	N
Spark Plug Gap	(9)	Open End Wrenches	(16)	Torque Wrenches	(8)
Torque A Fitting	(7)	Box Wrenches	(16)	Temperature Measuring Equipment	(7)
Speed of A Vehicle	(6)	Socket Set	(16)	Calipers	(6)
Crankshaft Main Journal Size	(6)	Feeler Gauge	(8)	Pressure Gauges	(6)
Valve Clearance	(6)	Midget Metric Wrenches	(8)	Drill Bits	(5)
Ring Clearance	(5)	Air Impact Wrench With Metric Sockets	(7)	Box End Wrenches	(5)
Piston Diameter	(5)	Assorted Metric Hardware (Hex, Nuts, Washers, Screws, etc.)	(7)	Impact Wrench Sockets	(5)
Piston Bore	(5)	Drill Bits	(5)	Nut Drivers	(4)
Stroke Of A Piston	(5)	Distributors Wrench	(5)	Hex Key	(4)
Diameter Of A Camshaft	(5)			Socket Sets	(4)
Bore Of A Cylinder	(5)			Tap and Die Set	(3)
				Measuring Tapes	(3)
				Pressure Testor	(3)
				Books	(3)

In Table 6, machine shop teacher responses were listed. Over twenty-five (25) percent of the teachers checked the metric measurement of screw and bolt lengths and diameters. Yet, some eight (8) metric items were used by teachers. These items seem to have greater measurement potential than the one listed measurement. The six (6) teachers indicated the immediate need for sixteen (16) different metric items.

Scale 3 of the instrument dealt with what metric items are needed now, in the next several years, and sometime in the future. Results of this scale for all areas can be observed in Tables 3-6.

Teachers must be familiar with the metric system if they are to integrate it in their programs. Table 7 lists the results of asking teachers what in-depth metric experiences they need right now to do an effective job of preparing students for the world of work. Over fifty (50) percent checked that they need professional development in length, area, volume, temperature, and pressure. Almost fifty (50) percent indicated mass was an important metric area. Velocity and energy in metric measurement were checked by a near majority of the teachers in auto mechanics, diesel mechanics, and auto body.

Objective 2.3 Evaluate Project Activities (Steering Committee.)

Objective 6.1 Select a third party evaluator to assess the impact of the instrument and associated project activities to meet the metric needs of vocational teachers and programs.

It was decided to use two (2) third party evaluators and compare the results of the evaluation for likenesses and differences. This was accomplished. Both objectives were met.

TABLE 6

MACHINE SHOP

METRIC MEASUREMENTS AND ITEMS

Metric Measurements Made Now By Over 25% Of The Teachers N=16		Metric Items Used Now By Over 25% Of The Teachers N=16		Metric Items Needed Now By Over 25% Of The Teachers N=6	
Measurement	N	Item	N	Item	N
Screw and Bolt Lengths and Diameter	(6)	Scales	(8)	Assorted Hardware	(6)
		Hex Key Sets	(7)	Micrometers	(6)
		Lath With Metric Adjustment Capabilities	(7)	Socket Sets	(6)
		Tap and Die Set	(6)	Open End Wrenches	(6)
		Calipers	(6)	Nut Drivers	(6)
		Micrometer	(6)	Tap and Die Set	(5)
		Vertical Milling Machine With Metric Adjustment Capabilities	(5)	Calipers	(5)
		Screw Thread Gauge	(5)	Feeler Gauge	(5)
				Box End Wrenches	(5)
				Allen Wrenches	(5)
				Drills and Reamers	(5)
				Screw Thread Gauge	(4)
				Metre Tape	(4)
				Punches	(2)
				Height Gauge	(2)
				Scales	(2)

TABLE 7

METRIC PROFESSIONAL DEVELOPMENT NEEDS

TEACHERS IN 9 VOCATIONAL AREAS
(N=43)

Training Area	NUMBER OF TEACHERS NEEDING							
	Length	Area	Volume	Mass	Temperature	Pressure	Velocity	Energy
Air Conditioning (N=1)	0	0	0	0	1	0	0	0
Auto Body (N=3)	3	2	3	2	3	3	2	2
Auto Mechanic (N=10)	8	4	6	4	7	4	5	5
Diesel Mechanic (N=2)	2	2	2	2	2	2	2	2
Drafting (N=2)	1	1	1	1	0	1	0	0
Food Service (N=6)	2	2	2	1	2	1	0	2
Horticulture (N=1)	0	0	0	0	0	0	0	0
Machine Shop (N=7)	5	6	6	6	6	6	1	0
Welding (N=7)	9	7	5	5	6	9	8	0
Small Engine (N=1)	0	0	0	0	0	0	0	0
TOTAL	30	24	25	21	27	34	11	

Mr. L.S. McKinney from West Virginia Technical Institute was the "outside" third party evaluator. Table 8 list his main evaluation points. See Appendix 12 for the complete report.

The Steering Committee was asked to be the third party evaluator from "inside" the project. They were asked to complete an evaluation instrument (see Appendix 13 for instrument and complete results of the evaluation.) The results of the evaluation are summarized in Table 9.

TABLE 8

SUMMARIZATION OF THE 3RD PARTY EVALUATION
(L.S. MCKINNEY)

Strengths

1. Self-assessment instruments for ten (10) occupational areas were developed.
2. Provisions for professional development activities were planned. (Objective 8.1 - 8.3.)
3. Scope of literature review was broad.
4. Used a variety of resources in the development of the instrument scale.
5. Used workshops to refine and validate instruments.
6. Projected plans for working with business and industry were good.
7. Provisions for metric awareness experiences in workshops.
8. Testing in rural as well as non-rural areas.
9. Development of a system that is congruent with sound vocational principles.

Weaknesses

1. Limited literature search.
2. Limited involvement of business and industry.
3. Limited number of teachers involved in the instrument development.
4. Limited information about the rate of metric change in industry.
5. No credit for workshops (deterrant to participation).

TABLE 9

SUMMARIZATION OF THE 3RD PARTY EVALUATION
(6 STEERING COMMITTEE MEMBERS)

Evaluation Statement	Tended To Agree	No Clear Indication	Tended Disagre
1. There was an adequate literature review.	✓		
2. Purchased literature was sufficient in quality and quantity.	✓		
3. Reference material listings will be helpful.	✓		
4. Steering Committee was representative of industry and education.		✓	
5. The ten vocational areas were good choices.	✓		
6. Suggestions by the Consultant resulted in improved project quality.	✓		
7. Metrics Advisory Committees (Teacher Committees) are representative of education and industry.	✓		
8. Metric measurement listings (Scale 1) are representative of industry changes.	✓		
9. The listing of metric tools and equipment is representative of needed changes.	✓		
10. Listings are sufficient to predict industrial rate of progress.	✓		
11. The self-assessment instruments are sufficient.	✓		
12. Data will help determine the metric status of vocational programs.	✓		

TABLE 9 (CONTINUED)

SUMMARIZATION OF THE 3RD PARTY EVALUATION
(6 STEERING COMMITTEE MEMBERS)

Evaluation Statement	Tended To Agree	No Clear Indication	Tended Disagr
13. The three selected regions were good choices.	✓		
14. The workshop increased metric awareness and enhanced program planning.	✓		
15. The plan for offering metrics courses is good.	✓		
16. Copies of the instruments and modules will be helpful to regions.	✓		
17. There was sufficient cooperation with the professional development unit.	✓		

COMMENTS

Needed more industrial input (2 members)

Need to continue program

Need to continue workshops (2 members)

Continue follow-up and evaluation of programs.

The Steering Committee seemed to be very supportive of the project in all aspects, except business and industry involvement. This was also a weakness listed by Mr. McKinney (#2 and #4.) Other weaknesses listed by Mr. McKinney (#1, #3, and #5) were areas that the Steering Committee discussed and arrived at project decisions earlier in the project.

Objective 7.1 Select three (3) regions to field test the system for providing metrics education.

Three (3) regions were selected for field test. Workshops were used to carry-out field test. The objective was met.

Because of time limitations in workshops, it was not possible to field test the total system. Much more time was necessary to develop strategies for helping teachers to work with business and industry.

After experimentation in early workshops, an agenda was developed for delivering part of the system. An agenda and workshop materials are located in Appendix 14.

Objective 7.2 Conduct a two-day credit workshop in each of the four regions.

Some workshops were offered for less than two days. College credit was not available for participation in workshops. Six (6) workshops were offered instead of the four (4) that were planned. The objective was not met.

TABLE 9 (CONTINUED)

SUMMARIZATION OF THE 3RD PARTY EVALUATION
(6 STEERING COMMITTEE MEMBERS)

	Evaluation Statement	Tended To Agree	No Clear Indication	Tended Disagre
13.	The three selected regions were good choices.	✓		
14.	The workshop increased metric awareness and enhanced program planning.	✓		
15.	The plan for offering metrics courses is good.	✓		
16.	Copies of the instruments and modules will be helpful to regions.	✓		
17.	There was sufficient cooperation with the professional development unit.	✓		

COMMENTS

Needed more industrial input (2 members)

Need to continue program

Need to continue workshops (2 members)

Continue follow-up and evaluation of programs.

The Steering Committee seemed to be very supportive of the project in all aspects, except business and industry involvement. This was also a weakness listed by Mr. McKinney (#2 and #4.) Other weaknesses listed by Mr. McKinney (#1, #3, and #5) were areas that the Steering Committee discussed and arrived at project decisions earlier in the project.

Objective 7.1 Select three (3) regions to field test the system for providing metrics education.

Three (3) regions were selected for field test. Workshops were used to carry-out field test. The objective was met.

Because of time limitations in workshops, it was not possible to field test the total system. Much more time was necessary to develop strategies for helping teachers to work with business and industry.

After experimentation in early workshops, an agenda was developed for delivering part of the system. An agenda and workshop materials are located in Appendix 14.

Objective 7.2 Conduct a two-day credit workshop in each of the four regions.

Some workshops were offered for less than two days. College credit was not available for participation in workshops. Six (6) workshops were offered instead of the four (4) that were planned. The objective was not met.

In the project proposal, three (3) workshops were planned in addition to the Region 6 workshop. Because of teacher interest, six (6) workshops were offered. Two (2) were used to refine the instruments, four (4) were used to collect data.

A two-day - six (6) hour a day workshop was planned. However, because of scheduling difficulties, the length of several workshops was altered. In Lexington, (Bluegrass region) and Elizabethtown, two-day - six (6) hour a day workshops were implemented. In Somerset (Cumberland region), a three (3) hour workshop was offered. At Bullitt and Shelby Counties (Region 6), one-day workshops were implemented.

As an incentive for attending workshops, it was planned to award college credit. Yet, upon closer examination the content and length of workshops didn't meet college course criteria. In the Bluegrass Regional workshop, two (2) continuing education credits were awarded. They were not available in remaining workshops because the duration of these workshops was much shorter.

When structuring workshops, the staff was concerned that teachers would not do the activities because they were unrelated to measurements made in specific vocational areas. Also, activities were designed to provide an awareness of metrics, and not in-depth knowledges. For a person with a great deal of experience in metric measurement, the workshop would probably not be relevant to needs. The information in Table 10 gives information related to these concerns. About seventy (70) percent of the seventy-nine (79) participants thought the objectives

were realistic (question 2.) Over fifty (50) percent agreed with the objectives, believed activities met their needs, and thought the outcomes were valuable (questions #5, #7, and #8.)

There was a concern as the project evolved that reducing the time of a workshop would limit the opportunity to work with teachers on the total system for providing metric education. This concern became reality. In one-day workshops, teachers were asked to complete Scale 1 and 2 of the instrument. Then, they completed a limited number of awareness activities. There was very little time to discuss specific programs, and no time to work with teachers to plan for a metric changeover. Although no mention was made of what they missed, teachers seemed to be aware that more was needed. On the comments section of the evaluation, statements were made such as: should have more time, need to relate metric to individual programs, and should have another workshop to help teachers of specific vocational areas.

One workshop had a large number of participants (around 60). All activities were set up in a large room. It was intended that teachers would break into small groups and work on activities for about three (3) hours. This did not work out as well as it was planned. The some fifty (50) activities may have overwhelmed teachers, or the lack of discussion and planning might have been discouraging. For whatever reason, some of the participants were obviously unhappy. The evaluations reflected this feeling. There were no indications from the evaluations that explained why the workshop did not meet their expectations.

TABLE 10

EVALUATION RESPONSES OF WORKSHOP PARTICIPANTS (N=74)

	Statements	Strongly Agree	Agree	Un-decided	Dis-agree	Strongly Disagree
1.	The purposes of the activity were clear to me	38	34			2
2.	The objectives of this activity were not realistic.	3	11	10	33	22
3.	Specific purposes made it easy to work efficiently.	33	42	4	2	1
4.	The participants accepted the purposes of this activity.	26	45	7	1	2
5.	The objectives of this activity were not the same as my objectives.	5	20	14	30	13
6.	I didn't learn anything new	0	5	4	36	35
7.	The outcome of this activity was valuable to me.	19	43	8	11	4
8.	The activity did not meet my needs.	1	12	10	32	25
9.	We did not relate theory to practice	0	3	8	40	30
10.	The schedule was too fixed	4	5	6	46	19
11.	The group discussions were excellent	17	50	12	3	1

One observation was made during the workshops by the Project Director. Participants who believed there was a need for metric conversion in their programs and wanted assistance were very receptive to workshop activities. They went above and beyond what was called for. These persons asked questions, searched for answers in the literature, and shared information with other participants. Conversely, a small number of participants didn't see any need for metrics and thought they were required to be there. These persons were not receptive to any activity. Their lack of participation seemed to dampen the enthusiasm of other participants.

Objective 8.1 Offer EDVT 520 (1-5 credit hours) to meet the metric needs of teachers in the four regions.

The Project Director offered a course in metric education for Region 6 educators during the Fall, 1979 semester. See Appendix 15 for more information. Courses are not being offered in the other three regions. The objective was not met.

The workshops were part of the planned professional development. However, in twelve (12) hours teachers could not gain necessary knowledges to work with all areas of metrics related to their programs. Thus, a metric education course was developed. Sixteen (16) individualized modules developed by Crosby and McKinney (1978) were used as the basis for instruction (see Appendix 16.)

It was planned to offer the course as an individualized metric course in each of the four (4) regions where workshops were scheduled. However, this was not possible. With the decision by the Council on Higher Education, the responsibilities of the University of Louisville are in four (4)

counties within the boundary of Vocational Region 6. It is the policy of the University to stay within the defined boundary. Additionally, it became obvious to the Project Director that management of the course in four (4) regions would not be possible. It was necessary to come up with an alternate plan.

During the project, several teacher educators expressed interest in the metric modules and course that was to be offered. As a result, the Project Director has planned to invite vocational teacher educators from all state institutions to discuss project results and possibilities of offering metric courses. Hopefully, all vocational teachers in the four (4) regions will have metric courses available in the near future.

Objective 8.2 Deliver copies of the metric self-assessment instruments and a copy of individualized metric modules to each vocational region.

Some copies have been delivered to regions at the date of the final report. Others will be mailed in the near future. This objective was considered met.

Objective 8.3 Notify the Professional Development Unit, Bureau of Vocational Education of project progress for the purpose of cooperating in other activities.

Two of the workshops were held as a result of cooperation with professional development coordinators. Others are planned for the coming year. The objective was satisfied.

Summary

Of the nineteen (19) objectives in the project proposal, thirteen (13) were satisfied, six (6) were not.

Four (4) of the objectives were not met because of the inability of the project to directly involve business and industry. The two (2) other objectives were not satisfactorily completed for a variety of reasons.

DISSEMINATION

Region 6 and the three (3) regions selected for field test were given a copy of the finalized metric self-assessment instruments for ten (10) areas. In addition, results of the literature search, selected materials from the workshops, and a set of metric individualized modules with supporting materials were delivered. A cover letter accompanied the materials.

This report was delivered to the Bureau of Vocational Education with the expectations that it would be shared with many interested educators and non-educators in the U.S. The report will be duplicated and mailed to selected persons and agencies. Also, the report availability was advertised and is sent upon request.

Many other dissemination activities are planned. The meeting with teacher educators is one form of dissemination. The plan to continue offering EDVT 520 course (Metric Education) is an effort to distribute information. Several workshops will be offered in the coming year. The Project Director intends to write an article and revise the final report, as needed, to have it included in the ERIC system. Other meetings and activities are in the discussion stages with various persons in Vocational Education. Every effort is being made to continue expanding knowledge about metrics and implementation techniques to meet evolving implications of metric measurements.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this project was to develop a system for providing vocational teachers with relevant metric education. This purpose included the development and identification of materials to support and enhance the system. Dissemination activities were designed to provide possibilities for using the system in Kentucky.

Based on all aspects of the project, the following conclusions were presented:

1. The system for providing metric education to vocational teachers should be designed to meet needs of individual teachers.

2. The system should include:

   (1) A survey of industry
   (2) A program needs assessment
   (3) Opportunities for awareness experiences
   (4) Planning for conversion to metrics
   (5) Professional development offerings with in-depth content

3. The project was not successful in directly involving industry.

4. The self-assessment instruments stimulated teachers of the ten (10) occupational areas to discuss metric tools, equipment, and measurements.

5. Workshops were effective to provide awareness experiences and an atmosphere for planning (short and long-range.)

6. Metric awareness provided in workshops was needed by the majority of participants.

7. Some teachers from vocational areas, other than the ten (10) selected areas, were interested in knowing more about metrics.

8. Vocational teachers selected for committees did not have the time and/or energies to accomplish activities of the system on their own time.

9. Displaying literature at workshops, and expecting the vocational teachers to evaluate and select pertinent parts was an unrealistic plan.

10. A number of teachers in similar vocational areas disagree on the need to change to metrics.

11. There was not enough data to generalize to teachers in Kentucky.

12. Most of the teachers surveyed, indicated they needed metric items now.

13. The surveyed teachers are making few measurements in metrics.

14. Sixteen (16) different metric items are needed now by the surveyed automotive teachers.

15. Sixteen (16) different metric items are needed now by the surveyed machine shop teachers.

16. A large percentage of surveyed teachers need in-depth professional development in metric measurement.

17. The most successful awareness workshops lasted for two-days, 6 hours a day.

18. Workshops were most effective when participants volunteered to attend.

Because of the link between business, industry, and vocational education, vocational educators should be very concerned about what business and industry are doing about converting to metrics. In relation to this thought and the results of this project, the following recommendations are presented:

It is recommended that:

1. Leadership in the Bureau of Vocational Education, Frankfort, Kentucky, accept the criticality of adapting to industry changeover to metric measurement by making metric conversion in vocational education a high priority for short and long-range program planning.

2. A Metric Advisory Committee be implemented by the Bureau of Vocational Education, Frankfort, Kentucky. The Committee should be made-up of leaders from business, industry, and education. These persons should focus on implications of metric conversion for vocational education, and corresponding recommended action.

3. A person from the Bureau of Vocational Education be given the responsibility and time to coordinate metric conversion in vocational education. Since conversion affects or will affect all vocational areas, the person should work with all vocational educators.

4. Every vocational region in Kentucky implement a system for providing metric education for vocational teachers. Systems should include successful elements of this project.

5. A study be initiated to find effective ways to work with business and industry.

6. Research be initiated to measure the metric status of all Kentucky vocational teachers in the ten (10) occupational areas.

7. Awareness workshops be continued in all vocational areas.

8. Vocational workshops and other activities related to metric measurement be expanded to include educators from all vocational areas.

9. Time be provided for teachers to plan and obtain necessary metric education.

10. Research be initiated to determine attitudes of vocational teachers toward metric conversion.

11. Funds be set aside to purchase needed metric equipment and tools.

12. Metric items be purchased for automotive and machine shop teachers.

13. Teacher education institutions be encouraged to offer in-depth metric education courses. A required course in metric education should be considered for inclusion in certification.

14. Awareness workshops be offered for lengths of time that enhance meeting workshop purposes.

15. Participation in workshops and other metric activities be voluntary.

16. Ways be found to change the attitudes of vocational teachers about metric conversion.

17. A handbook be developed to assist vocational regions to implement a system as developed in this project.

REFERENCES

Adair, Robert. "Low Cost Metric Conversion in the Machine Shop," American Vocational Journal, April, 1977, pp. 59-60.

Adams, Herbert F.R. "Teaching the Metric System: Meters, Liters, and Grams are Not Enough," Technical Education News, October-November, 1976, pp. 18-19.

Baillargeon, Jarvis H. "Think fast--and Think Metric," School Shop, October, 1975, pp. 47-49.

Bruce, Herbert, Jr. and Robert E. Spillman. "V-TECS: The Push to Competency Based Curriculum," AV Journal, September, 1976, pp. 30-32.

Cassetto, James M. "Going Metric in Industrial Arts," AV Journal, January, 1976, pp. 36-39.

Cooper, Gloria S. and Joel H. Magisos (Eds.). Metrics for (various vocational areas), instructional packages developed at The Ohio State University, 1977.

Cowley, Wayne Dixon. A Forecast for the Metric Training of Skilled Industrial Workers, Technicians, and Technologists During a Period of National Metrication. An unpublished dissertation. Texas A&M University, 1975.

Crosby, Richard K. and L.S. McKinney. Individualized Metric Modules, 1978.

Evans, Rupert N. "Three Approaches to Metrics for Teacher Trainers," School Shop, April, 1974, pp. 90-91.

Government Accounting Office. "Getting a Better Understanding of the Metric System--Implications if Adopted by the United States." A report to Congress, Washington, D.C., 1978.

Headrick, Mark L. "Attitudes of Vocational and Technical Teachers in Missouri toward Metrification," NAITTE Journal, Summer 1976, pp. 27-34.

Jackman, Arthur A. "Metric Conversion and the School Shop," AV Journal November, 1976, pp. 40-42.

Kentucky State Board of Education. "A Survey of Companies about Metric Conversion." An unpublished research summary, Frankfort, Kentucky, 1979.

Kentucky State Board of Education. "Metric Education Resolution." A Resolution adopted by the State Board, Frankfort, Kentucky, 1977.

Lindbeck, John R. "How Much does it Cost to Go to Metric," Industrial Education, November, 1976, pp. 30, 32, 34, 36.

Lindbeck, John R. Metrics in Career Education. Peoria, Ill.: Chas. A. Bennett Co., Inc., 1975.

Lorenz, Douglas. "Metrification in Vocational Education," Tempo, 1977, p. 22.

McGill, Carol Ann. A Study of the Needs of Teachers involved in the Transitional Program from English to Metric System in the Elementary Schools. An unpublished dissertation, University of Houston, Texas, 1974.

McMahon, Gordon G. Curriculum Development in Trade and Industrial and Technical Education. Columbus, Ohio: Charles E. Merrill Publishing Company, 1972.

Sargent, Gordon. "Think Metric Think Metric Think," The Kentucky Alumnus, Spring, 1978, pp. 14-15.

The Center for Vocational Education. Metric Education - An Annotated Bibliography. The Ohio State University, Columbus, Ohio, 1974.

The Center for Vocational Education. Metric Education. A position paper for Vocational, Technical and Adult Education. The Ohio State University, Columbus, Ohio, 1975.

The Center for Vocational Education. Metrics for Welding and Cutting. One of a series of modules that deal with metric measurements for specific occupations. The Ohio State University, Columbus, Ohio, 1974.

The Indiana Department of Public Instruction. The Metric System: A Bibliography of Instructional Materials. Indianapolis, Indiana, 1975.

3M Company. "The Corporation and Metrics." A Set of Transparency Masters, St. Paul, Minnesota, 1976.

U.S. Department of Commerce. The Manufacturing Industry. A U.S. Metric Interim Report, Washington, D.C., 1971.

Wise, Terry. "A Survey of Companies in Elizabethtown, Kentucky." An unpublished report, Elizabethtown, Kentucky, 1979.

APPENDIX I

RESOLUTION ON METRIC SYSTEM INSTRUCTION IN KENTUCKY SCHOOLS

Department of Education

FRANKFORT 40601

RESOLUTION ON METRIC SYSTEM INSTRUCTION IN KENTUCKY SCHOOLS

WHEREAS:

The metric measurement standards recognized and developed by the International Bureau of Weights and Measures have been adopted as the fundamental measurement standards of the United States; and

WHEREAS:

The customary units of weights and measures used in the United States have, since 1893, been based upon such metric measurement standards; and

WHEREAS:

Ninety percent of the world's population is using the metric system, and more than eighty percent of the world's production and trade is measured in metric units; and

WHEREAS:

The Congress finds that the metric system of measurement is in general use in industrially developed nations and its use is increasing; and

WHEREAS:

The increased use of such a metric system in the United States is inevitable, and such a metric system will become the dominant system of weights and measures in the United States; and

WHEREAS:

The National Education Association has resolved that teachers of all grades should teach the metric system to assure, as a national goal, the orderly transistion to the use of the metric system as a primary system by 1980; and

WHEREAS:

The National Conference of Weights and Measures has resolved that all State Departments of Education follow the recommendations of the National Education Association;

BE IT THEREFORE RESOLVED THAT:

Commencing with the 1976-1977 school year and thereafter, all schools subject to the rules and regulations of the State Board of Education shall provide instruction in the International Metric System of Measurement. Such instruction may be in addition to the present instruction concerning the system of weights and measures in the schools on the effective date of this resolution; provided, however, that the International Metric System of Weights and Measures shall be given the major emphasis beginning with the 1980-1981 school year.

BE IT FURTHER RESOLVED THAT:

The State Board of Education endorses in principle the recommendations that were adopted by the Interstate Consortium on Metric Education on October 3, 1974.

APPENDIX 2

LIST OF EQUIPMENT AND BOOKS PURCHASED BY THE METRICS PROJECT

LIST OF EQUIPMENT PURCHASED BY THE METRICS PROJECT

Quantity	Item
1	Economy Beaker Set, six graduated beakers, 50, 100, 250, 400, 800, 1000 ml. OHAUS Cat. No. 80240 (set)
1	Graduated Cylinders, set of six, 25, 50, 100, 250, 500, 1000 ml. OHAUS Cat. No. 80250 (set).
1	Large Plastic Bucket And Plan Balance, includes (2) stirrup pans and (2) large plastic buckets. OHAUS Cat. No. 80420
15	Flat Meter Stick, graduated in dm, cm, mm. OHAUS Cat. No. 80020
1	Cube-O-Gram, 1000 pc. set w/teachers guide. OHAUS Cat. No. 4264-00
1	Metric Spoon Set, (5) pc. set, 1, 2, 5, 15, 25 ml. OHAUS Cat. No. 80350
1	Dry Measure Set, (3) pc. set, 50, 125, 250 ml. OHAUS Cat. No. 80340
20	SI Relationship Rule OHAUS Cat. No. 80100
20	Primary Rule OHAUS Cat. No. 80060
1	Elementary School Balance, w/8 pc. mass set, 50g x 1g. OHAUS Cat. No. 1200-00
1	Elementary Bar Mass Sets, 7 pc. set, 50, 100, 200, 500, 1000 OHAUS Cat. No. 80470
1	Bathroom Scale, 0 to 135 kg. OHAUS Cat. No. 80440
5	Standard Science Thermometer, $-10^0 - 110^0C$. OHAUS Cat. No. 80540
1	Indoor Wall Thermometer
1	Classroom Height Measure, 100m to 2m OHAUS Cat. No. 80200

LIST OF EQUIPMENT PURCHASED BY THE METRICS PROJECT - CONTINUED

Quantity	Item
2	Windup Meter Tape, 10m length OHAUS Cat. No. 80130
10	Adhesive Conversion Tape, 1cm - 100 OHAUS Cat. No. 80160
2	Weight & Mass Metric Kit
2	Metric Stacking Weight Plastic
1	The Corporation and Metrics Instructional Unit
25	Metric Converters

LIST OF BOOKS PURCHASED BY THE METRICS PROJECT

Quantity	Item
1	Metric Education: An Annotated Bibliography for Vocational, Technical & Adult Education
1	Metric Education: A Position Paper for Vocational, Technical & Adult Education
2	Complete Set of 55 Metric Instructional Modules for Vocational-Technical Education
5	Agricultural Mechanics
5	Horticulture
5	General Office Clerk, Clerk-Typist, Typists
5	Secretarial, Stenography
15	Architectural, Civil, Mechanical Drafting
10	Offset Printing Press Operation
15	Air Conditioning & Refrigeration, Heating, Ventilating
20	Commercial, Industrial, Residential Electricity
10	Plumbing, Pipefitting
5	Dental Assistants
10	Licensed Practical Nursing
5	Nurses Aides
10	Food Preparation, Baking, Meat Cutting
10	Food Services
15	Blueprint Reading
20	Industrial Electronics, Radio-TV
5	Sheet Metal Working
5	Small Appliance Repair, Major Appliance Repair
10	Tool and Die Making

LIST OF BOOKS PURCHASED BY THE METRICS PROJECT - CONTINUED

Quantity	Item
20	Welding and Cutting
30	Auto Mechanics
5	Aviation Electronics
5	Diesel Mechanics
5	Small Engine Repair
50	Complete NBS Metric Kit
4	Ploutz, The Metric System Content and Methods
1	Vol. 1 1973 American Metric Journal SI MEPAC
1	Metric Handbook
1	Metric System Simplified
1	Metric System Beginning Lemaraic
1	Metric System Secondary Lemaraic
1	Using Metrics
1	Understanding Metric System
1	Games In Metrics
1	Metric Workshop Teachers
1	Everyday Metrics
1	Practical Metrics
1	Metric In Nutshell
1	Investigating Metric
1	Activities In Metric
1	Amusements In Metric
1	Going Metric Guides Math Book
20	Metrics In Career Education

LIST OF BOOKS PURCHASED BY THE METRICS PROJECT - CONTINUED

Quantity	Item
1	A Metric America: A Decision Whose Time Has Come
1	Commercial Weights and Measures
1	The Manufacturing Industry
1	Nonmanufacturing Businesses
1	Education
1	The Consumer
1	A History of the Metric Controversy in the United States
1	Engineering Standards
1	Testimony of Nationally Representative Groups
1	HC ED 078 202 (88pp) Bibliography
1	HC ED 104 718 (36pp) Bibliography
1	Popular Mechanics Master Shop Guide
1	Metric In A Nutshell
1	Exploring Metrics
1	Think Metric
1	Understanding The Metric System: A Programmed Text
1	Exploring The Metric System
1	Using The Metric System
1	Investigating Metric Measure
1	Activities Handbook For Teaching The Metric System
1	Amusements In Developing Metric Skills
1	Going Metric: Guidelines For The Mathematics Teacher
1	Understanding The Metric System: A Programmed Text
1	Metric Measure Simplified

LIST OF BOOKS PURCHASED BY THE METRIC PROJECT - CONTINUED

Quantity	Item
1	Metrics For Home Use
1	Everyday Metrics
1	Practical Metrics
1	Modern Metrics
1	The Metric System
1	Fun and Games With Metrics
1	Let's Play Games In Metrics
1	Metric Workshop For Teachers Book
1	Introducing The Metric System With Activities
1	Thinking Metric
1	A Metric Handbook For Teachers
1	The Metric System For Beginners
1	The Metric System For Secondary Schools
1	The Teachers Guide To The Metric System

APPENDIX 3

METRICS STEERING COMMITTEE

METRICS STEERING COMMITTEE

Mr. Bill Aiken, Director
Vocational Education
3442 Preston Highway
Louisville, Kentucky 40213

Mr. Stewart Benson
Jeffersontown Vocational School
3101 Bluebird Lane
Jeffersontown, Kentucky 40299

Mr. John Drake, Coordinator
Research Coordinating Unit
Bureau of Vocational Education
Capital Plaza Tower
Frankfort, Kentucky 40601

Mr. Bill Evans, Regional Director
Vocational Education Region VI
3101 Bluebird Lane
Jeffersontown, Kentucky 40299

Mr. Ray Farmer, Principal
Westport Road Area Vocational
Education Center
8800 Westport Road
Louisville, Kentucky 40222

Mr. Emory Gates
3442 Preston Highway
Louisville, Kentucky 40222

Ms. Pat Reed
Jefferson State Vocational-Technical
School & Manpower Skill Center
727 West Chestnut Street
Louisville, Kentucky 40203

Mr. Paul Simpson, Department Head
Adult Supplemental and Public Service
Occupations Office
111 East Kentucky Street
Louisville, Kentucky 40203

Dr. Charles Thompson
Elementary Education Department
University of Louisville
Louisville, Kentucky 40208

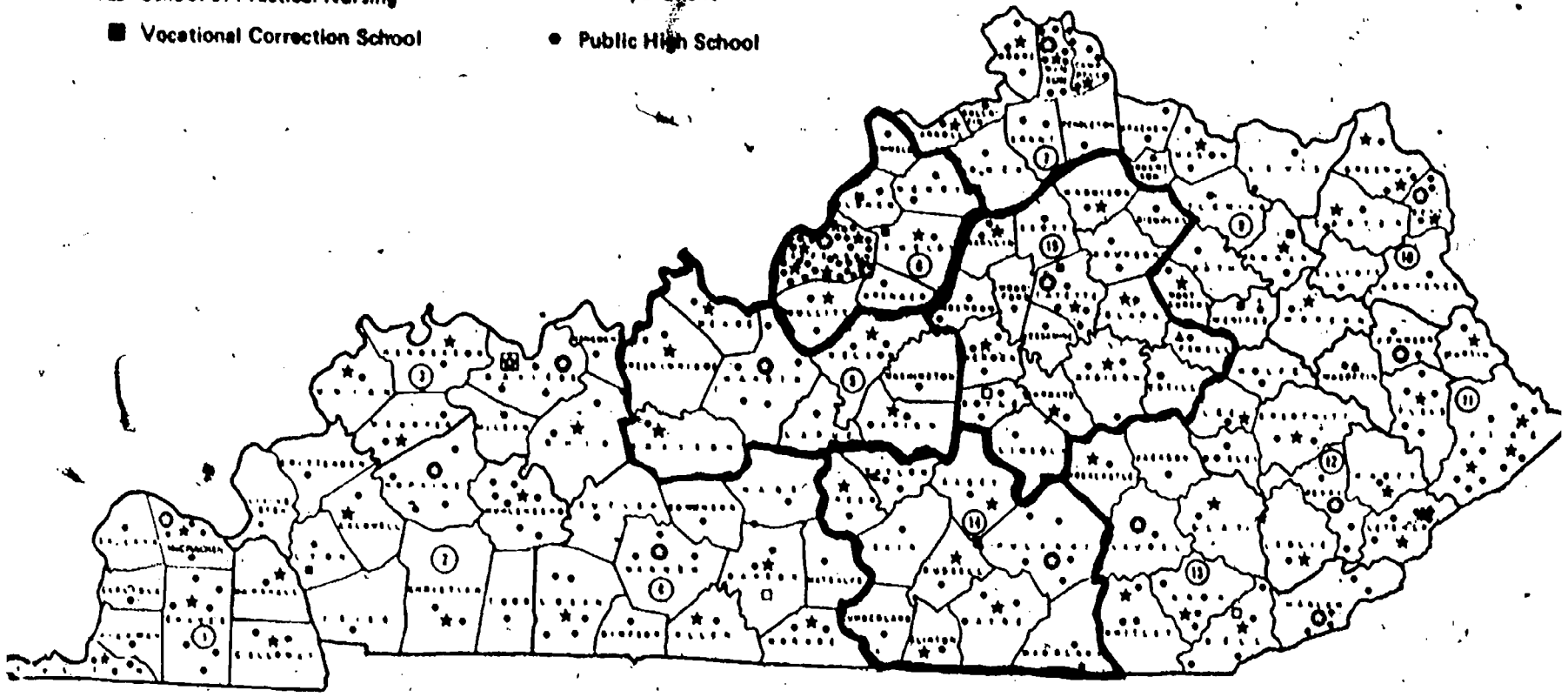
Mr. Tom James
Administrative Technical Training
Phillip Morris Company
1930 Maple Street
Louisville, Kentucky 40201

APPENDIX 4

REGIONS - DEVELOPMENT AND FIELD TEST

CODE:

- State Vocational-Technical School
- Vocational-Technical School
- School of Practical Nursing
- Vocational Correction School
- Area Vocational Education Center
- High School Vocational Education Department
- Public High School



FACILITIES OFFERING VOCATIONAL EDUCATION PROGRAMS BY REGIONS

APPENDIX 5

METRIC ADVISORY COMMITTEE

METRIC ADVISORY COMMITTEE

NAME	OCCUPATIONAL AREA	SCHOOL
Michael Johnson	Horticulture	Pleasure Ridge Park
Wallace Scott	Horticulture	Pleasure Ridge Park
Shirley Beierle	Commercial Foods	Pleasure Ridge Park
Harvey Fox	Commercial Foods	Pleasure Ridge Park
Benjamin Detraz	Refrigeration	Pleasure Ridge Park
Vincent Base	Drafting	Pleasure Ridge Park
Gerald Kordes	Drafting	Pleasure Ridge Park
Ronald Endicott	Auto Mechanics	Jefferson State Vocational Technical School
Howard Shadwick	Auto Body	Jefferson State Vocational Technical School
Harold Evans	Diesel Mechanic	Jefferson State Vocational Technical School
Arthur DeZorn	Machine Shop	Jefferson State Vocational Technical School
Joseph Craft	Welding	Jefferson State Vocational Technical School
Richard Hamblen	Small Engine Repair	Mill Creek Vocational Rehabilitation Center

APPENDIX 6

SAMPLE TOOL AND EQUIPMENT LISTS

1. Official Equipment List
2. V-TECS List
3. The Center for Vocational Education
   Metric Module Listing

OFFICIAL EQUIPMENT LIST

RECOMMENDED EQUIPMENT LIST
FOR
AUTO MECHANICS
(ITEMS OVER $50)

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
1	Aimer	Headlight Kit with Cabinet	1 kit	80.00	$ 80.00
2	Aligner	Front End, Power Rack Set	1 set	6,400.00	6,400.00
3	Analyzer	Engine with Raster Scope	1	5,177.00	5,177.00
4	Analyzer	Engine, without Raster Scope, with Removable Component Parts	1	775.00	775.00
5	Balancer	Wheel Static and Dynamics, 5HP, 208V, 1 PH, Spinner Type, with Strobe Light	1	1,200.00	1,200.00
6	Benches	Work, Steel Top, 30" x 72"	8	230.00	1,840.00
7	Bleeder	Hydraulic Brake, One Gallon Tank	1	100.00	100.00
8	Brake Shop	Mobile, for Disc & Drum	1	4,000.00	4,000.00
9	Cabinets	Steel Storage	4	68.50	274.00
10	Caliper	Micrometer Set, 0-5", Inside	1	325.00	325.00
11	Caliper	Micrometer Set, 0-5", Outside	1	325.00	325.00
12	Charger	Battery, Fast Charging 6 & 12V	2	203.00	406.00
13	Crane	Portable Hydraulic, 2 Ton Capacity	1	460.00	460.00
14	Cutting Tool	Air Impact, 90-125 PSI with Panel Cutters, Flat Chisel & Inside-Outside Chisel	1	135.00	135.00
15	Drainmobile	120 Lb. Drum, on Casters	1	128.00	128.00
16	Drill	Portable Electric, 1/2", H-D	1	95.00	95.00
17	Drill	Portable Electric, 3/8", H-D	2	75.00	150.00
18	Drill	Portable Electric, 1/4", H-D	2	55.00	110.00
19	Drill Press	15" Floor Model, 470-1950 RPM, 1/2" Chuck, 3/4 HP, 115V, Single Speed	1	315.00	315.00
20	Grinder	Pedestal, 1/2HP, 7" Wheel	1	230.00	230.00
21	Hoist	Chain, 2 Ton, with Glider Trolley, Manual for Overhead Monorail	1	475.00	475.00
22	Indicator	Dial, 2¼ Dial	1	50.00	50.00

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
23	Jack	Floor, Hydraulic, 2 Ton	3	350.00	1,050.(
24	Jack	Transmission, Floor Type, Hydraulic, 1000 Lbs.	1	275.00	275.(
25	Lubricator	Transmission, Low Pressure, 90W Grease, Manual Pump	1	200.00	200.
26	Lubricator	Chassis, High Pressure, Air Operated	1	300.00	300.
27	Machine	Valve Refacing & Seating	1	1,600.00	1,600.
28	Manuals	Motor & Instructional Materials	1	500.00	500.
29	Press	General Purpose, Hydraulic, 20 Ton	1	600.00	600.
30	Pullers	Gear, Interchangeable Set, on Board	1	350.00	350.
31	Simulator	Ignition	1	395.00	395.
32	Stand	Engine, 1 Ton	3	300.00	900.
33	Tank	Parts Washing, w/pump, ¾ HP, 6,000 GPH 65 Gallon Capacity, 115V, 1PH	1	500.00	500.
34	Tap & Dies	Set, 1/4-3/4" by 16ths, NC & NF	1 set	150.00	150.
35	Tester	Electronic Ignition	1	85.00	85.
36	Tester	Generator-Alternator	1	2,540.00	2,540.
37	Tester	Transistor Regulator	1	375.00	375.
38	Tester	Ignition Distributor	1	1,536.00	1,536.
39	Tester	Volt-Amp, w/Battery Starting & Charging Systems	1	458.00	458.
40	Timing Light	Power, 12V	2	55.00	110.
41	Tool	Camshaft Bearing Inserter & Remover, Set	1	95.00	95.
42	Tool Set	Automatic Transmission Complete	1	150.00	150.
43	Tool Set	Piston Pin with Hot Pit Accessories	1	175.00	175.
44	Vise	Machinist's, 4 or 5" Jaw Opening, Swivel Base	4	125.00	500
45	Vise	Machinist's, 6" Jaw Opening	1	150.00	150
46	Washer	High Pressure, 4GPM at 600PSI, 115V	1	810.00	810
47	Welder	Oxy-Acetylene, Complete Outfit w/Truck	1 set	250.00	250

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
48	Wrench	Air Impact, 1/2", Complete Kit	1	200.00	200.00
49	Wrenches	Box Sets, 3/8" to 1¼"	3 sets	90.00	270.00
50	Wrenches	Metric, Box Sets, 14 pieces	2 sets	130.00	260.00
51	Wrenches	Open End, 1/4" to 1¼"	3 sets	85.00	255.00
52	Wrenches	Metric, Open End, 14 pieces	2 sets	140.00	280.00
53	Wrenches	Metric, Socket Set, 1/4" Drive	2 sets	70.00	140.00
54	Wrenches	Socket Sets, 3/8" Drive	3 sets	225.00	675.00
55	Wrenches	Metric, Socket Set, 3/8"	2 sets	90.00	180.00
56	Wrenches	Socket Sets, 1/2" Drive	2 sets	250.00	500.00
57	Wrenches	1/2" Metric	2 sets	60.00	120.00
				TOTAL	$ 39,994.00

RECOMMENDED EQUIPMENT LIST FOR AUTO MECHANICS (ITEMS UNDER $50)

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
58	Brooms	Push	6	5.00	$ 30.0
59	Brake Tools	Set for Shoe Type Brakes	2 sets	30.00	60.0
60	Brake Tools	Set for Disc Type Brakes	1 set	45.00	45.0
61	Brushes	Wire	6	1.00	6.0
62	Bushing Driver	Set	1	30.00	30.0
63	Cans	Oil-Flexible Spouts	2	3.00	6.
64	Cans	Gasoline, 5 Gallon, OSHA Approved	1	35.00	35.
65	Carrier	Battery, Strap	2	1.50	3.
66	Checker	Automatic Choke	1	25.00	25.
67	Chisels	Cold, Set	1	5.00	5.
68	Chisels	Cape, Set	1	6.00	6.
69	Clamps	"C", Set, 2", 4", & 6"	1 set	30.00	30.
70	Compressor	Piston Ring	2	4.00	8.
71	Coopers	Soldering, Electric	2	12.00	24.
72	Cords	Extension, 25' 2/Ground (rubber covered)	6	5.00	30.
73	Covers	Seat and Fender	16	6.00	96.
74	Creepers	Car	8	14.50	116.
75	Drills	Twist, Set 1/16" - 1/2" by 32nds	2	45.00	90
76	Expander	Piston Ring	3	2.50	7
77	First Aid Kit	OSHA Approved	1	25.00	25
78	Flaring Tools	Copper Tube 3/16" to 5/8"	2 sets	8.00	16
79	Gauges	Spark Plug Set	3	2.00	6
80	Gauge	Tire Pressure, Incline Type	1	17.00	17
81	Gauges	Thickness, 3" Blade, .002 to .025	6	3.00	18
82	Goggles	Safety	6 pair	3.00	18

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
83	Grease Gun	Hand, Lever Type	1	5.00	5.00
84	Groove Cleaner	Piston Ring	3	8.00	24.00
85	Hacksaw	Adjustable Frame	3	3.00	9.00
86	Hammers	Machinist 1/2	6	3.00	18.00
87	Hammers	Machinist 1	2	3.00	6.00
88	Hammers	Machinist 2	2	3.00	6.00
89	Hammers	Soft Face	2	3.75	7.50
90	Hone	Pin & Bushing	2	16.00	32.00
91	Hone	Cylinder	2	12.00	24.00
92	Hose	Air with Trigger Nozzle, 25', 30PSI Regulator, with Quick Disconnect	3	22.50	67.50
93	Hose	Water, 50'	1	6.00	6.00
94	Hydrometer	Storage Battery	1	6.00	6.00
95	Knurler	Valve Guide	2	15.00	30.00
96	Lifter	Valve, "C" Type	2	16.00	32.00
97	Lifter	Valve, Universal	2	4.00	8.00
98	Light	Trouble, Reel Type, 30 ft. Cord	4	24.00	96.00
99	Nut Driver	Set	1 set	30.00	30.00
100	Pans	Oil Drain	4	4.00	16.00
101	Pans	Small Parts	12	1.00	12.00
102	Pliers	Battery	2	4.00	8.00
103	Pliers	Brake Springs	2	4.00	8.00
104	Pliers	Diagonal, 7"	4	4.00	16.00
105	Pliers	Pump, 8"	4	5.00	20.00
106	Pliers	Ring Retaining	2	10.00	20.00
107	Pliers	Sharp Nose	4	3.50	14.00
108	Pliers	Slip Joint, 6"	4	3.00	12.00
109	Pliers	Vise Grip	4	4.00	16.00

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
110	Pry Bar		1	6.40	6.
111	Reamer	Cylinder Ridge	2	12.00	24.(
112	Screwdriver	Phillips #s 1-4 ea.	3 sets	6.00	18.(
113	Screwdrivers	Assorted Sizes	3 doz.	13.00	39.(
114	Screwdrivers	Assorted Sizes with Clutch Head	5	2.25	11.2
115	Snips	Tinners, 3" Cut, Straight	1	4.50	4.5
116	Spark Tester	For 6 & 12V Systems	4	2.00	8.C
117	Stands	Jack, Adjustable, 2 Ton	12 pr.	30.00	360.C
118	Squeegee	Rubber	4	7.00	28.C
119	Tester	Antifreeze (Radiator)	1	6.00	6.0
120	Tester	Valve Spring Height & Tension	1	18.00	18.0
121	Tes[illegible]	Radiator Pressure with Radiator	1	35.00	35.0
122	Tool	Oil Filter	4	2.00	8.0
123	Tool Set	Ball Joint & Tie Rod Removers	1 set	32.00	32.C
124	Tool Set	Alternator Removing & Repair	1 set	18.00	18.C
125	Tool Set	Coil Spring Removing & Installing	1 set	42.00	42.C
126	Vise	Drill Press, 3½"	1	35.00	35.0
127	Water Can	Radiator	1	2.50	2.5
128	Wrenches	Allen	3 sets	3.50	10.5
129	Wrenches	Crescent, 6", 8" & 10"	3 (1 ea.)	5.00	15.0(
130	Wrenches	Distributor, Specialized	4 sets	21.00	84.0(
131	Wrenches	Midget Set, Box End, 1/4" - 3/16"	1	20.00	20.0(
132	Wrench	Pipe, 6" & 12"	2 (1 ea.)	12.00	24.0(
133	Wrenches	Socket Sets, 1/4" Drive	2 sets	40.00	80.0(
134	Wrenches	Spark Plug Set	6	15.00	90.0(
135	Wrenches	Torque, 3/8", 5-75 Ft. Lb.	1	30.94	30.9

ITEM NO.	ITEM	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
136	Wrenches	Torque, 1/4", 30-200 In. Lb.	1	30.94	30.94
137	Wrench	Torque, 1/2", 25-250 Ft. Lb.	1	37.18	37.18
138	Wrench	Lug Nut, Cross Type	2	8.00	16.00

Total Under $50.....	$ 2,435.71
Total Over $50.....	39,984.00
GRAND TOTAL	$ 42,419.71

THE CENTER FOR VOCATIONAL EDUCATION METRIC

MODULE LISTING

SUGGESTED METRIC TOOLS AND DEVICES NEEDED TO COMPLETE MEASUREMENT TASKS IN EXERCISES 1 THROUGH 5

(* Optional)

LINEAR

- Metre Sticks
- Rules, 30 cm
- Measuring Tapes, 150 cm
- *Height Measure
- *Metre Tape, 10 m
- *Trundle Wheel
- *Area Measuring Grid

MASS

- Bathroom Scale
- *Kilogram Scale
- *Platform Spring Scale
  - 5 kg Capacity
  - 10 kg Capacity
- Balance Scale with ___piece mass set
- *Spring Scale, 6 kg Capacity

VOLUME/CAPACITY

- *Nesting Measures, set of 5, 50 ml - 1 000 ml
- Economy Beaker, set of 6, 50 ml - 1 000 ml
- Metric Spoon, set of 5, 1 ml - 25 ml
- Dry Measure, set of 3, 50, 125, 250 ml
- Plastic Litre Box
- Centimetre Cubes

TEMPERATURE

- Celsius Thermometer

THE CENTER FOR VOCATIONAL EDUCATION
The Ohio State University · 1960 Kenny Road · Columbus, Ohio 43210

SUGGESTED METRIC TOOLS AND DEVICES NEEDED TO COMPLETE OCCUPATIONAL MEASUREMENT TASKS

In this occupation the tools needed to complete Exercises 6, 15, and 16 are indicated by "★."

- ★ A. Assorted Metric Hardware—Hex nuts, washers, screws, cotter pins, etc.
- ★ B. Drill Bits—Individual bits or sets, 1 mm to 13 mm range
- C. Vernier Caliper—Pocket slide type, 120 mm range
- ★ D. Micrometer—Outside micrometer caliper, 0 mm to 25 mm range
- ★ E. Feeler Gage—13 blades, 0.05 mm to 1 mm range
- F. Metre Tape—50 or 100 m tape
- G. Thermometers—Special purpose types such as a clinical thermometer
- H. [1] Temperature Devices—Indicators used for ovens, freezing/cooling systems, etc.
- ★ I. Tools—Metric open end or box wrench sets, socket sets, hex key sets
- J. Weather Devices—Rain gage, barometer, humidity, wind velocity indicators
- ★ K. [1] Pressure Gages—Tire pressure, air, oxygen, hydraulic, fuel, etc.
- L. [1] Velocity—Direct reading or vane type meter
- M. Road Map—State and city road maps
- ★ N. Containers—Buckets, plastic containers, etc., for mixing and storing liquids
- O. Containers—Boxes, buckets, cans, etc., for mixing and storing dry ingredients

Most of the above items may be obtained from local industrial, hardware, and school suppliers. Also, check with your school district's math and science departments and/or local industries for loan of their metric measurement devices.

[1] Measuring devices currently are not available. Substitute devices (i.e., thermome may be used to complete the measurement task.

V-TECS LIST

V-TECS AUTO MECHANICS

Equipment Number	Equipment Description	Percentage of Members Using	Number of Members Using
1	Air Blow Guns	97.09	200.
2	Air Chisel	81.07	167.
3	Air Compressor, 5 H.P.	64.08	132.
4	Air Conditioning Repair Equipment	69.42	143.
5	Air Hoses, 50 Ft. Length, ¼ In. I.D.	91.26	188.
6	Alignment Bar	39.32	81.
7	Ammeter	80.10	165.
8	Arbor Press	53.40	110.
9	Automatic Transmission Bench Fixture	43.20	89.
10	Automatic Transmission Gauges	42.72	88.
11	Automatic Temperature Control Testers	34.95	72.
12	Automatic Transmission Tool Set	44.66	92.
13	Ball Joint Checker	40.78	84.
14	Battery Carrier	59.71	123.
15	Battery Charger	88.35	182.
16	Battery Hydrometer	85.44	176.
17	Battery Jumper Cables	84.47	174.
18	Battery Servicer Kit	46.12	95.
19	Battery, Storage, 6 Volt	15.05	31.
20	Battery, Storage, 12 Volt	40.78	84.
21	Bay Lift	75.24	155.
22	Belt Tension Gauge	50.49	104.
23	Bench, Work	91.75	189.
24	Bolt Cutter	43.69	90.
25	Boring Bar	5.83	12.
26	Brake Cylinder, Hone	82.04	169.
27	Brake Drum Lathe	64.56	133.
28	Brake Pressure Bleeder, Diaphram Type	52.43	108.
29	Brake Rivet Machine	22.82	47.
30	Brake Shoe Arc Grinder	45.15	93.
31	Buffing and Wire Wheel	84.95	175.
32	Bushing Installer Set	65.53	135.
33	Calipers, Assorted	51.46	106.
34	Cam Bearing Installer	34.95	72.
35	Can, Safety, Gasoline	57.28	118.
36	Can, Water	84.95	175.
37	Carburetor-Distributor Adjusting Tool	81.55	168.
38	Carburetor Tool Kit	59.71	123.
39	Cart, Service	38.83	80.
40	C Clamps, Assorted	57.28	118.
41	Chain Fall	33.01	68.
42	Chain Wrench	28.64	59.
43	Channel Locks	96.12	198.
44	Chassis Dynamometer	7.28	15.

Equipment Number	Equipment Description	Percentage of Members Using	Number Members Using
45	Chisel and Punch Set	94.66	195.
46	Cleaner, High-Pressure Steam or Combination	30.58	63.
47	Coil Spring Compressor	45.15	54.
48	Coil Spring Spreader	26.21	54.
49	Compression Gauges	84.95	175.
50	Connecting Rod Aligner	15.53	32.
51	Continuity Light	81.55	168.
52	Cooling System Chemical Tester	64.08	132.
53	Cooling System Pressure Tester	88.83	183.
54	Crane, Rigger With Extension Boom	39.81	82.
55	Crankshaft Grinder	2.43	5.
56	Creeper, Flat	91.26	188.
57	Creeper, Seat, With Gasters	30.10	62.
58	Cylinder Dial Indicator Gauge	42.23	87.
59	Deglazer	54.37	112.
60	Diagonal Cutting Pliers	88.83	183.
61	Dial Indicators	71.84	148.
62	Differential Holder	28.16	58.
63	Diode Tester	74.76	154.
64	Diode Tool Set	51.46	106.
65	Disc Brake Lathe	54.85	113.
66	Distributor Tester	42.23	87.
67	Distributor Wrenches	80.10	165.
68	Drill Bits, Assorted	95.15	196.
69	Drill Press	30.10	62.
70	Drills, Air	58.25	120.
71	Drills, Electric, Assorted	88.35	182.
72	Drop Light	98.54	102.
73	Electric Arc Welder	53.88	111.
74	Electronic Ignition Tester	63.11	130.
75	Engine Analyzer, Complete With Scope and Emissions Tester	67.96	140.
76	Engine Oil Leak Detector	15.53	32.
77	Engine Sling, Adjustable	39.32	81.
78	Engine Stand	64.56	133.
79	Exhaust Hoses	14.08	29.
80	Exhaust Pipe Expander	51.94	107.
81	Feeler Gauges, Assorted	91.26	188.
82	Fender Covers	96.12	198.
83	Files, Assorted	92.23	190.
84	Flaring Tool Kit	87.86	181.
85	Flywheel Turner	56.80	117.
86	Fuel Pump Tester	80.58	166.
87	Gear and Bearing Pullers	80.10	165.
88	Generator-Alternator Test Bench	34.95	72.

Equipment Number	Equipment Description	Percentage of Members Using	Number Members Using
89	Glass Bead Cleaner	7.28	15.
90	Grinder, Bench	88.83	183.
91	Grinding Wheel Dresser	52.43	108.
92	Growler	51.46	106.
93	Hack Saws	96.40	199.
94	Hammers, Assorted	97.57	201.
95	Hand Jacks, Assorted	75.24	155.
96	Head Lamp Aimer	71.36	147.
97	Head Lamp Intensity Meter	51.46	106.
98	Head Surfacer	3.40	7.
99	Hose Clamp, Pliers	91.26	188.
100	Hot Tank Cleaner	7.28	15.
101	Hydraulic Press	78.16	161.
102	Hydraulic Valve Lifter Rools	48.54	100.
103	Hydrometer Float (Antifreeze Tester)	69.42	143.
104	Jack Stands	91.26	188.
105	Lathe	19.90	41.
106	Lifts	79.61	164.
107	Lubrication Equipment	72.33	149.
108	Measuring Tape	83.01	171.
109	Metal Marker, Electric	30.58	63.
110	Micrometers, Assorted	70.87	146.
111	Mirrors, Inspection	72.82	150.
112	Needle-Nosed Pliers,Assorted	96.60	199.
113	Ohmmeter	83.01	171.
114	Oil Drain Pans	86.41	178.
115	Oil Filter Wrench	78.64	162.
116	Oiling Cans	84.95	175.
117	Oil Measure	49.03	101.
118	Parts Cleaning Tank	86.41	178.
119	Pipe Wrench	64.56	133.
120	Piston Expander Tool	16.02	33.
121	Piston Pin Hole Hone	14.56	30.
122	Piston Pin Installing Kit	38.35	79.
123	Piston Ring-Compressor	68.93	142.
124	Piston Ring-Groove Cleaner	65.05	134.
125	Piston Ring-Remover and Installer	43.20	89.
126	Pressure Pack Flushing Gun	18.93	39.
127	Racks, Piston, and Connecting Rod Holders	9.22	19.
128	Regrooving Tool, Piston	16.50	34.
129	Ridge Reamer	63.11	130.
130	Scratch Awl	66.50	137.
131	Screw Driver, Clutch Head Attachments, Assorted	77.18	159.
132	Screw Drivers, Phillips	98.54	203.
133	Screw Drivers, Standard Set	98.06	202.
134	Screw Thread Gauge	50.97	105.
135	Seal Installer Set	78.16	161.
136	Seal Removers	74.27	153.

Equipment Number	Equipment Description	Percentages of Members Using	Number of Members Using
137	Seat Belt Interlock Tester	29.61	61.
138	Seat Covers	66.02	136.
139	Service Jacks, Assorted	71.84	148.
140	Slip Joint Pliers, Assorted	83.98	173.
141	Snap Rings Plier Set	95.63	197.
142	Snap Ring Truarc, Internal-External	61.17	126.
143	Snips, Tin,Assorted	70.87	146.
144	Soldering Iron or Gun	90.29	186.
145	Spark Plug Cleaning Machine	58.74	121.
146	Spring Tension	27.67	57.
147	Stamps, Steel, Letters and Numbers	38.83	80.
148	Straight Edge	68.93	142.
149	Suction Gun	57.28	118.
150	Tack Dwell Units	86.41	178.
151	Tap and Die Set	92.23	190.
152	Terminal Kit and Crimping Tool	77.67	160.
153	Test Lights-High Volt.	55.34	114.
154	Test Lights-Low Voltage	83.98	173.
155	Thermostat Tester	30.10	62.
156	Thread Chaser	79.61	164.
157	Tie-Rod End Remover	57.28	118.
158	Timing Light	88.83	183.
159	Tire Bead Expander	13.59	28.
160	Tire Gauges	76.21	157.
161	Tire Service Machine	19.90	41.
162	Tire Tube Leak Detector Tank	12.14	25.
163	Torque Converter Flusher	16.99	35.
164	Transmission Funnels	68.93	142.
165	Transmission Jack	64.08	132.
166	Tubing Wrenches	76.21	157.
167	U-Joint Press	41.26	85.
168	Undercutter	15.05	31.
169	Utility Chain With Hoods	44.66	92.
170	Valve Guide Replacement Tool	23.30	48.
171	Valve Guide Resizing Tool	21.84	45.
172	Valve Insert Tool	19.90	41.
173	Valve Reconditioning Equipment	56.31	116.
174	Valve Spring Compressor	69.42	143.
175	Valve Spring Tester	21,84	45.
176	Vise Grip Pliers	97.57	201.
177	Vise, Machinists,Assorted	73.30	151.
178	Volt-Amp Tester	83.98	173.

Equipment Number	Equipment Description	Percentage of Members Using	Number Members Using
179	Voltmeter	82.52	170.
180	Welding Equipment, Oxyacetylene	72.82	150.
181	Wheel Alignment Equipment	46.80	96.
182	Wheel Balancer, Bubble	17.48	36.
183	Wheel Balancer, Spin-Type	48.06	99.
184	Wheel Balancer, Strobe	20.39	42.
185	Wheel Lug Wrench, X-Type	33.01	68.
186	Wheel Puller	70.39	145.
187	Wrenches, Adjustable Set	85.92	177.
188	Wrenches, Air Impact	97.57	201.
189	Wrenches, Allen	96.12	198.
190	Wrenches, Box	97.09	200.
191	Wrench Drive Adapters	86.89	179.
192	Wrenches, Ignition Set	85.44	176.
193	Wrenches, Open-End and Combination Box Wrench Set	97.09	200.
194	Wrenches, Socket Set, ½ in.Drive	97.57	201.
195	Wrenches, Socket Set, 3/8in.Drive	97.57	201.
196	Wrenches, Socket Set, 3/4in.Drive	49.03	101.
197	Wrenches, Socket Set, ¼ in.Drive	96.60	199.
198	Wrenches, Torque, Inch/Lbs	75.73	156.
199	Wrench, Torque, Foot/Lbs	83.50	172.

APPENDIX 7

LITERATURE DOCUMENTS

1. Metric Reference
2. Specific References
3. Article Summaries

METRIC REFERENCE

"ANSI engineers give Congress their recommendations on metric conversion legislation," Air Con Heat & Refrig, N 128:1+, Apr. 23, 1973.

"Aerospace firms preparing for metrics," W. C. Westmore, Aviation W, 104:100-1+, June 14, 1976.

"Aerospace industry endorses U. S. switch to metric measure," Comm Today, 3:24-5, May 28, 1978.

"America is going metric," L. J. Rolland, Fin World, 140:8-9+, July 4, 1973.

"America's metrication inches along," P. S. McGrath, Conf, Bd. Rec., 10:35-8, January, 1973.

"Antitrust ambush for metric planners?," Ind W, 189:13-14, May 24, 1975.

"Antitrust immunity would ease transition to metric," Air Con Heat & Regrig, N 128:35, January 29, 1973.

"API says it will back use of metric system," Oil Paint & Drug Rep, 199:4, May 3, 1971.

"Are you ready for the metric?," J. Teresko, Ind W, 177:35-9+, May 21, 1973.

"Are your workers afraid of the metric system?," J. Teresko, Ind W, 180:28-32, Fall, November, 1974.

"Are you ready for the metric system," P. R. Trowbridge, Mgt R, 60:10-13, Spring, 1971.

"ASHRAE considers weather data change to switch to centigrade," Air Cond Heat & Refrig, N 125:39, February 14, 1972.

"Attitudes of vocational and technical teachers in Missouri toward metrification," Mark L. Headrick, NAITTE Journal, Summer, 1976.

"Automating bolt torque systems," Automotive Ind, 149:42-3, September 1, 1973.

"Autos become the metric pacesetter," Bus Week, 106+, June 9, 1973.

"B C industry sees improved '76: gears for metric panels," C. L. Shaw, Forest Ind, 103:46, March, 1976.

"Bibliography of the metric system," Eric, ED 078 202, 1973.

"Bringing S. I. metrics to vocational education," School Shop, N 37, n 1:35-37, September, 1977.

"British metric switch: easy by most yardsticks," Eng N, 185:14, September 24, 1970.

"Can business adopt meter without tripping on its feet?," G. A. Weiner, Iron Age, 212:55, November 15, 1973.

"Canada ad group foresees problems in metric switch," Adv Age, 45:25, July 29, 1974.

"Canada: moving inch by inch into the metric system," Bus W, p. 35, June 9, 1975.

"Canada's milk goes metric," Mod Pkg, 49:5+, March, 1976.

"Canadian metric conversion gets into the fall swing," I. J. Obrzat, Iron Age, 214:30-5, December 23, 1974.

"Chains disagree on U. S. metric switch," Chain Store Age Exec, 52:50B+, March, 1976.

"Chemical industry is thinking metric," J. S. Saladyga, Chem Mktg, 208:11-12+, July 28, 1975.

"Classes of units in the S. I.," Amer Journal of Physics, v 46, n 1:78-9, January, 1978.

"Clerical impact of the metric system," G. A. Studer, Journal Systems Mgmt, 28:22-3, April, 1977.

"Commerce dept asks switch to metrics within 10 years," E. E. Halmes, Jr., Air Cond Heat & Refrig, N 123:1+, August 9, 1971.

"Commerce official asks plan for inevitable metric conversion now," Mgt Adviser, 9:14, March, 1972.

"Commerce secretary outlines metric study activities," Air Cond Heat & Refrig, N120:5, June 22, 1970.

"Commercial weights and measures," U. S. Metric Study, Interim Report, Eric, ED 070 832, 1973.

The Complete Metric System, Le Maraic, 1973.

"Computer makers plan for metric conversion," Data Mgt, 14:25-9, January, 1976.

"Computer program helps U. S. factories during metric shift," Comm Today, 4:20, September 2, 1974.

"Construction to get its way on metric system," Eng N, 185:57, September 17, 1970.

"Conversion to metric system described in new RIT Book," Ed & Pub, 105:48, October 14, 1972.

"Conversion to metric system: painful, costly but useful," Ind W, 171:20-1, December 13, 1971.

"Conversion to metrics: costly and confusing," K. A. Kaufman, Iron Age, 208:45, August 5, 1971.

"Converting to metric," F. J. Versagi, Air Cond Heat & Refrig, N120:11, May 25, 1970.

"Creative classroom," Teacher, v. 94, n 1:120-24, September, 1976.

"Creative classroom," Teacher, v. 94, n 9:83-92, May-June, 1977.

"Creative classroom," Teacher, v. 94, n 5:75-82, December, 1977.

"Cupful of merchandising captivates kids," Inst/Vol Feeding, 75:65, September 1, 1974.

"Curriculum Review," Science and Children, v. 15, n5:40-3, February, 1978.

Curriculum Development in Trade and Industrial and Technical Education, Gordon G. McMahon, Charles E. Merrill Publishing Company, Columbus, Ohio, 1972.

"Data center managers should prepare for the inevitable switch to metric," B. Menkus, Adm Mgt, 36:73, Fall, 1975.

"Deere found right way to go metric," K. W. Bennett, Iron Age, 217:17-20, May 31, 1976.

"The Delaware Plan," A Merian Metric Journal, v. 5, n 5, p 145-148, 1977.

"Designing to size: which size?" Purchasing, 74:79+, June 19, 1973.

"Detroit's new metrics is not all feet," D. N. Williams, Iron Age, 208:55-6, August 5, 1971.

"Education: U. S. Metric System," Interim Report, Eric, ED 078 218, 1973.

"Engineering Standards: U. S. Metric Study," Interim Report, Eric, ED 069 883, 1973.

"Engineers inch toward S. I. measurement," Factory, 5:50, November, 1972.

"Fasteners start switch to metric," R. R. Irving, Iron Age, 208:59-6, August 5, 1971.

"Fasteners top Ford's metric plant problems," Ind W, 177:19, June 11, 1973.

"First interim U. S. metric study report calls for international standards action," Comm Today, 1:28-9, December 28, 1970.

"Pisons preparing employees for new metric world," Oil, Paint & Drug Rept, 198:5, October 26, 1970.

"Following industry's lead: nation's schools prepare pupils for metrics," Comm Today, 5:18, February 17, 1975.

"Food industry sees itself in major role if U. S. goes metric," Comm Today, 2:7-9, October 2, 1972.

"Forecast for the metric training of skilled industrial workers,, technicians and technologists during a period of national metrification," Wayne Dixon Crowley, an unpublished dissertation, Texas A & M Univ., 1975.

"French Fad," C. Cohen, Datamation, 20:77-8, June, 1974.

"G/M thinks metric," Iron Age, 217:13, April 6, 1976.

"Get ready for the metric system," K. E. Kroner, Bus Mgt, 40:16-17, August, 1971.

"Getting started in metrics," Industrial Education, v. 65, n. 9, p 38-9, November, 1976.

"Give an inch and see what'll happen," Economist, 237:71-2, November 28, 1970.

"Giving an inch to get a meter," Chem W, 109:35, August 11, 1971.

"Go metric: senate told," A. N. Weckster, Purchasing, 72:13, April 4, 1972.

"Going metric," F. Sharring, Paperboard Packaging, 56:50-1, October, 1971.

"Going metric: a costly conversion," B. LeBos, Electronic N, 18:4-5+, August 20, 1973.

"Going metric alone won't solve nation's world trade problems," L. M. Kushner, Comm Today, 3:10-13, January 8, 1973.

"Going metric doesn't seem to be a problem for workers," C. A. Nekvasil and J. H. Sheridan, Ind W, 179:16-18, October 29, 1973.

"Going metric in industrial arts," James M. Cassetto, AV Journal, January, 1976.

"Government has three ways of thrusting forward a completely voluntary conversion program," G. Bowen, Factory, 5:29-31, March, 1972.

"Going metric is easier with good planning," Iron Age, 215:43-4, March 10, 1975.

"Great metric muddle," J. R. Owen, Fuel, Oil & Heat, 32:40-1+, January, 1973.

"Going metric? the great revolution," S. P. Coke, Data Mgt, 14:17-18, Janaury, 1976.

"HVAC Refn industry underway in soft conversion to metric system," Air Cond., Heat & Regrig News, 138:17, July 19, 1976.

Handbook for Metric Usage in Home Economics, American Home Economic Association, Washington, 1977.

"Happy metric new year," B. Ancker-Johnson, Comm Am, 1:inside frontcover, January 5, 1976.

"The international metric system and how it works," Robert A. Hopkins, Polymetric Services, 1974.

"House bill calls for voluntary metric changes over 10 years," Ind Mktg, 58:22, November, 1973.

"House readies new try at passing metric bill," Purchasing, 79:, 18, August 19, 1975.

"How metric conversion affects administrative practices," Canadian Vocational Journal, v. 13, n. 2:23-25, August, 1977.

"How much does it cost to go to metric," John R. Lindbeck, Industrial Education, November, 1976.

"IFI calls for better metrics standards," Ind W, 167:21, August 3, 1970.

"IIR moves toward SI metric system despite some resistance," Air Cond Heat & Refrig News, 134:16, February 17, 1975.

"Individualized metric modules," Richard K. Crosby and L. S. McKinney, 1978.

"ISO engineering standards becoming more pro-Europe and anti-USA," Factory, 5:22-3, March, 1972.

"Impact of metrication on the can industry," W. T. Hake, Aerosol Age, 17:37, October, 1972.

"Inching along," K. Ellsworth, Ry Age, 176:58, June 9, 1975.

"Inching into metric: what it means for sales," J. D. Snyder, Sales Mgmt, 110:21-3, April 2, 1973.

"Industry adopts dual dimensions as metric system inches nearer," Comm Today, 5:5-7, November 25, 1974.

"Industry adopts metric in certain operations as U. S. awaits new law," Comm Today, 3:4-7, September 3, 1973.

"Industry looks to U. S. for metrics push," W. C. Wetmore, Aviation W, 104:44-5+, June 7, 1976.

"Industry moves to metrics--without Congress," Ind W, 184:40+, February 24, 1975.

"Industry ready for metric measure: several groups give guarded yes," Eng N, 185:16, October 15, 1970.

"Industry takes initiative on metrication," Comm Today, 3:23-5, April 2, 1973.

"Industry to get metric conversion package," Comm Today, 4:14, December 24, 1973.

"Information sources on metrication," T. B. Deck, Special Lib, 64:291-6, July, 1973.

"Iron Age metric conversion kit: measuring up to metrics," Iron Age, 214:41, September 23, 1974.

"Iron age metric teaching aids: getting a jump on metrics," J. Obrzut, Iron Age, 215:51-3, May 5, 1975.

"Issues in teaching metric (SI)," Science Teachers, v.44, 78:26-9, November, 1977.

"It's a metric world," Comm Today, 1:10-15, November 2, 1970.

"Keynote to metrication for glass industry lies in technical policy review," J. M. Sharf, Comm Today, 3:15-18, December 25, 1972.

"Label misleads Swedes," Chem W, 109:45, September 15, 1971.

"Let's do it: the neglected decimeter," Arithmatic Teacher, v. 25 n. 1:10-17, October, 1977.

"Let's see how the metric system is faring around the world," E. B. Weiss, Adv Age, 41:85+, July 13, 1970.

"Liquid containers--in the metric spirit," Mod Pkg, 49:5, April, 1976.

"Look at metrication," Graphic Arts Mo, 46:106+, Mr:88+, April, 1974.

"Low cost metric conversion in the machine shop," Robert Adair, American Vocational Journal, April, 1977.

"Major electric firm advises senate it favors adoption of metric system," Comm Today, 2:30-1, June 26, 1972.

"Making metric calipers," School Science and Mathematics, v. 77, n.8:635-8, December, 1977.

"Managing metrication in business and industry," M. Decker, American National Metric Council, Chicago, October 6-7, 1975.

"Managers plan and train for a metric future," J. Obruzut, Iron Age, 215:43-7, May 5, 1975.

"Marketers view ad opportunities in a silly millimeter longer world," J. Revett, Adv Age, 42:23, August 9, 1971.

"Measures proposes voluntary metrication," Comm Today, 2:28-30, March 20, 1970.

"Measure up, America, here comes metrics," Inst/Vol Feeding Mg, 74:61, June 1, 1974.

"Measured steps: the metric system is coming--but not overnight," M. D. Dacey, Barrons, 53:11+, May 14, 1973.

"Message is clear: get into metrics now," Ind. Distr, 64:47-9, August, 1974.

"Metric advocates to introduce bill," Electronic N, 18:18, January 8, 1973.

"Metric America?" H. M. Nelson, Automotive Ind, 147:43-6, November 15, 1972.

"Metric America: time for a decision," Comm Today, 1:4-7, August 9, 1971.

"Metric changeover is being advocated by federal agency," Oil Paint & Drug Dep, 200:4+, August 2, 1971.

"Metric competency goals for students," American Metric Journal, v. 5, n. 4:124-5, 1977.

"Metric conversion: added costs for workers?" T. Weinstein, Labour Gaz, 76:25-7, January, 1976.

"Metric conversion and the school shop," Arthur A. Jackman, A V Journal, November, 1976.

"Metric conversion costs to D.O.D. put at $18 billion," R. Barr, Electronic N, 16:39, August 2, 1971.

"Metric conversion: inching closer toward reality?" K. A. Kaufman, Iron Age, 210:21, August 17, 1972.

"Metric conversion due in calculator," Electronic N, 18:27, September 24, 1973.

"Metric conversion still inching along," Ind W, 185:24-6, April 28, 1975.

"Metric dimensions required for exports to European communities by 1978," Comm Today, 4:31, August 19, 1974.

"Metric doldrums," Engin N, 191:13, July 19, 1973.

"Metric education: trends and recommendations," Science and Children, v. 14, n.5:7-10, February, 1977.

"Metric liquor bottles this month?" Mod Pkg, 49:5-6, February, 1976.

"Metric merry-go-round," R. L. Cherry, Chem Mktg Rep, 207:9, April 7, 1975.

"Metric units number inch system days," J. Obrzut, Iron Age, 214:31-8, September 23, 1974.

"Metrication and the accountant," D. E. Webber, Mgt Acct, 57:44-50, June, 1976.

"Metrication: inch by inch," Economist, 255:104, May 3, 1975.

"Metrication is coming, but very slowly," Purchasing, 78:11+, May 20, 1975.

"Metrication's length measured again," Economist, 258:93-4, March 27, 1976.

"Metrication may pay for itself," J. M. Callahan, Automotive Ind, 151:9, July 1, 1974.

"Metrication conference stimulates few," Eng N, 196:44, April 15, 1976.

"Metrication pops up in U. S. soft drink packaging," J. F. Kalina, Mod Pkg, 47:7+, November, 1974.

The Metric Encyclopedia, A. L. Maraic.

"Metric fastener's future: now," J. B. Pond, Automotive Ind, 149:18, August 15, 1973.

"Metric guide for organizations," published by ANSI, Air Cond Heat & Refrig N, 121:34, September 14, 1970.

"Metric in preservice teacher training," American Metric Journal, v. 5, n.6:185-7, July, 1978.

"Metric mania is on the move," Ind Distrib, 62:37-9+, S 1972.

"Metric measurement and instructional television," Arithmetic Teacher, v. 25, n. 1:42-49, October, 1977.

"Metric measure gains," Chem W, 114:14, March 13, 1974.

Metric Power: Why and How we are Going Metric, Richard Deming, Nashville, Tennessee: Nelson, 1974.

"Metric proposal would pu[illegible]les in uniform bottles," Adv Age, 45:28, April 22, 1974.

"Metric recipes for classroom use," Illinois Teacher of Home Economics, v. 20, n. 3:131-33, January-February, 1977.

"Metric standards: what they will mean to the graphic arts," K. Spangler, Inland Ptr/Am Lith, 170:53-6, October, 1972.

"Metric system: a common language for the market place," N. Hartwell, Automotive Ind, 143:22-3+, November 15, 1970.

"Metric system conversion means changing both current and past computer information," L. M. Corner, Adm Mgt, 36:16, March, 1973.

"Metric system? conversion tab put at $1 billion," Oil Paint & Drug Rep, 148:3+, August 24, 1970.

"Metric system countdown begins for tooling," J. E. Sandford, Iron Age, 211:52-4, June 21, 1973.

"Metric system eyed as engineers meet," Merch W, 103:24, November 1, 1971.

"Metric system favored," Ind Res, 14:69, October, 1972.

"Metric system is adopted by editorial dept," Ed & Pub, 106:18, November 3, 1973.

"Metric system millimeters its way to adoption," J. Obrzut, Iron Age, 210:79-81, July 13, 1972.

"Metric system looms over the horizon," J. Lyndull, Fleet Owner, 68:159, January, 1973.

"Metric time," Economist, 240:43-4, August 21, 1971.

"Metrication--a two-way street," J. M. Callahan, Automotive Ind, 149:11, October 15, 1973.

"Metrication and the accountant," D. E. Webber, Mgmt Acc, 57:49-50, June, 1976.

"Metrication effects on U. S. foreign trade studied by commerce," Int Comm, 76:17, September 7, 1970.

"Metrication: give them an inch and they take your whole system," Inland Ptr/Am Lith, 169:38-9, May, 1972.

"Metrication in vocational education," Douglas Lorentz, Tempo, 1977.

"Metrication: industry accepts the challenge," J. B. Bond, et al., Automotive Ind, 149:23-9, July 1, 1973.

"Metrication is coming: prepare for the transition," F. J. Versagi, Air Cond Heat & Refrig N, 130:36-7, n 12, November 19, 1973.

"Metrication may not be the sole answer," R. M. E. Diamant, Air Cond Heat & Refrig N, 125:11+, January 31, 1972.

"Metrication opens new options for converters," P. B. Hinkle, Paperboard Packaging, 97: 28-30+, June, 1972.

"Metrication plans: must now in heavy industries; no consumer drives yet," S. Feldman, Adv Age, 44:3+, April 2, 1973.

"Metrication problems in the construction codes and standards section," Am Metric Journal, v. 5, n. 4:112-3, 1977.

"Metrication--the changing of a system," M. Irving, Inland Ptr/Am Lith, 174:66-70, 0:77-8+, November, 1974.

"Metrics for (various vocational areas)," instructional packages developed at The Ohio State University, 1977, Gloria S. Cooper and Joel H. Magisos (Eds.).

Metrics in Career Education, John R. Lindbeck, Peoria, Illinois: Charles A. Bennett Co., Inc., 1975.

"Metrics, lumber and the shop teacher," School Shop, v. 37, n. 7:32-3, March, 1978.

"Metrics made fun: an individualized approach," Science and Children.

"Metrics: mind my meganewton," Economist, 242:69, February 12, 1972.

"Metrics with Marcel and Marcette," Arithmatic Teacher, v. 25:26-7, October, 1977.

"Metrics--why not?" S. A. Mencacci, Aerosol Age, 17:37-8+, December, 1972.

"Mounting pressure to go metric," Bus W, p 54-6, July 24, 1971.

"Move to metric costly," Chem W, 107:19, October 7, 1970.

"Moving to metrics makes dollars and sense," D. V. DeSimone, Harvard Business R, 50:100-11, January, 1972.

"Mustang II's gallop will come from 100 metric horses," R. A. Guiles, Iron Age, 211:19, June 14, 1973.

"NAW says conversion to metric system means dual stockage," Air Cond Heat & Regrig N, 121:13, October 26, 1970.

"National metric study conference--construction," Constr R, 16:4-5, November, 1970.

"New legislation may end metric debate," Ind W, 175:25-6, December 11, 1972.

"New look at the U. S. switch to metrics," G. V. Schulta, Factory, 5:27-8, March, 1978.

"Nineteen to the dozen," E. Chappen, Director, 26:402-4, September, 1973.

"1980: target date for metric conversion in U. S.," S. Wagner, Pub W, 206:12-13, November 25, 1974.

"Office skills: metric problems in the typing classroom," Business Education Forum, v. 32, n. 5:21-2, February, 1978.

"Outlook brighter for voluntary metric shift bill," R. Barr, Electronic N, 18:14, October 8, 1973.

"Package to aid shift to metrics," Electronic N, 19:67, August 19, 1974.

"Paper industry sees specs conversion big metric cost concern," Comm Today, 3:15-6, October 30, 1972.

"Planning for the metric challenge," J. C. Pokerney, System Mgmt, 24:11-5, July, 1973.

"Planning the transition to the metric SI system," R. C. Sellers, Purchasing & Materials Mgmt, 10:29-47, May, 1974.

"Plastics industry looks to government for aid in metric conversion," Comm Today, 3:15-6, November 27, 1972.

"Metric: games to help kids think metric," Instructor, v. 86, n. 8: 62-3+, April, 1977.

Prepare Now For a Metric Future, Frank Robert Dunovan, New York, 1970.

"Preparing machine tools for the metric years," J. Obrzut, Iron Age, 216:41-4, December 1, 1975.

"President's consumer expert considers metric conversion," Comm Today, 1:31, November 2, 1970.

"Problems in U. K. switch to metric system," H. T. Chambers, BSNS Automation, 17:106+, March, 1970.

"Readers favor metrication," Ind Res, 13:71, December, 1971.

"Replacing metric screws," Factory, 5:13, November, 1972.

"Resources for teaching the metric system," Journal of Business Education, v. 52, n. 3:129-131, December, 1976.

"Role of government in metric changeover spurs controversy," J. Revett, Ind Mktg, 59:16+, June, 1974.

"Rolling mill builder makes it metric," T. H. Malim, Iron Age, 207:59, May 15, 1971.

"Semi-standards groups O. K.'s metric school guides," N. Kelley, Electronic N, 19:59, March 11, 1974.

"Set UCLA parley on metrics switch," Electronic N, 18:29, June 4, 1973.

"Shift to metric system could pose problems for U. S. chemical industry," Oil & Gas J, 68:105-6+, September 14, 1970.

"Shortages spur metric use and standardization," Mod Pkg, 47:32, July, 1974.

"Should North America adopt standard metric paper sizes?" R. J. O'Brien, Pulp & Paper, 48:86-9, August, 1974.

"Should we metricate?" Office, 71:46+, May, 1970.

"So big--metric style," A. S. Colton, Graphic Arts Mo, 47:82-4, March, 1975.

"Soon it may be give a centimeter and take a kilometer," Nations Bsns, 57:88-9, April, 1971.

"Standardization and metric conversion for tunneling, underground construction, and mining: report of a symposium," Conducted by Standing Committee No. 5, International Activities of the U. S. National Committee on Tunneling Technology.

"Study of the needs of teachers involved in the transitional program from English to metric system in the elementary schools," Carol Ann McGill, an unpublished dissertation, University of Houston, Texas, 1974.

"Successful experiences in teaching metric, Part II," Am Metric J, v. 5, n. 5:150-2, 1977.

"Sun finds more like metric than don't," NPN, 67:60, January, 1975.

"Switch to metrics," Eng N, 188:12, March 16, 1972.

The Teacher's Guide to the Metric System, A. L. LeMaraic.

"Teaching metric measure," Tennessee Education, v. 7, n. 2:10-4, Fall, 1977.

"Teaching the metric system: meters, liters and grams are not enough," Herbert R. R. Adams, Technical Education News, October-November, 1976.

"Think fast--and metric," Jarvis Baillargeen, School Shop, October, 1975.

"Think metric," R. J. Dille, Mgt Acct, 52:51-2, February, 1971.

"Think metric, think metric, think," The Kentucky Alumnus, Spring, 1978.

"Think metric America," H. C. Moore, Paper Tr J, 157:37, January 15, 1973.

Thinking Metric, Thomas F. Gilbert and Marilyn B. Gilbert, New York, Wiley, 1973.

"Three approaches to metrics for teacher trainers," Rupert N. Evans, School Shop, pp 90-91; April, 1974.

"Toward metrication," R. A. Coccola, Factory, 7:23, August, 1974.

Two-Way Conversion Tables of Weights and Measures, LeMaraic.

"U. S. industry moving to inevitable metric system," Ind Mktg, 58:52+, October, 1973.

"U. S. metric system seems certain, but will it come on schedule?" Comm Today, 5:5-8, March 17, 1975.

"U. K. metrics advance," Chem W, 109:29, October 20, 1971.

"U. K. moving to metric," Ind. Res., 13:29, June, 1971.

"U. S. adoption of metric system," G. Hawley, Electronic N, 15:45, June 15, 1970.

"U. S. only industrial country not using metric system," Air Cond Heat & Refrig N, 121:29, November 2, 1970.

"USA vs the metric system," J. Steele, Fleet Owner, 65:62-7, May, 1970.

"Warning for the metric eccentrics," P. Evans, Datamation, 21:125-6, April, 1975.

"Warns metrics could be stalled by pleas for aid," Electronic N, 18:13, December 3, 1973.

"Weights, measures group pledges aggressive action toward metric changeover," Comm Today, 4:12, August 5, 1974.

"Weyerhaeuser pulp sales go metric with less trauma than anticipated," Pa Tr J, 159:23+, February 3,1975.

"What will our lives really be like under the metric system," Iron Age, 214:50, September 16, 1974.

"What's the matter with the meter?" Ind W, 167:24-8, July 13, 1970.

"What's the world reaction to our metric fastener?" J. Obrzut & R. Irwing, Iron Age, 212:45-7, July 26, 1973.

"Why metric missed by a mile," NPN, 66:63, August, 1974.

"Which way metric," Ind Res, 16:135, September, 1974.

"Will management go metric," Bsns Automation, 17:6-7, December 15, 1970.

"Wine producers in ferment over metric system conversion," Mod Pkg, 46:32-4, August, 1973.

"World trade: the millimeter monster and others," J. M Beattie, Iron Age, 210:35-6, October 26, 1972.

TITLE	K/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	USTRY TOOLS, IPMENT & MEASUREMENT	LIOGRAPHY	C
ANSI Engineers give Congress their recommendations on metric conversion legislation	J						X
Aerospace firms preparing for metrics	J			X			
Aerospace industry endorses U.S. switch to metric measure	J			X			
America is going metric	J						X
America's metrication inches along	J						X
Antitrust ambush for metric planners	J						X
Antitrust immunity would ease transition to metric	J						X
API says it will back use of metric system	J						X
Are you ready for the metric	J						X
Are you ready for the metric system	J						X
Are your workers afraid of the metric system	J			X			
ASHRAE considers weather data change to switch to centigrade	J						X
Attitudes of vocational and technical teachers in Missouri toward metrification	J	X					

SPECIFIC REFERENCES

TITLE	J/JOURNAL ARTICLE/OTHER	NATIONAL PROGRAM ACTION	NATIONAL PROGRAMS, EQUIPMENT & MEASUREMENT	RIC STATUS IN INDUSTRY	USTRY TOOLS, IPMENT & MEASUREMENT	LIOGRAPHY	X	MARKIES AVAILABLE
Automating bolt torque systems	J				X			
Autos become the metric pacesetter	J				X			
B C industry sees improved '76: gears for metric panels	J			X				
Bibliography of the metric system	ERIC					X		
ringing S. I. metrics to vocational ducation	J	X						X
ritish metric switch: easy by most ardsticks	J						X	
an business adopt meter without tripping n its feet	J						X	
anada ad group foresees problems in etric switch	J			X				
nada: moving inch by inch into the tric system	J			X				
nada's milk goes metric	J			X				
nadian metric conversion gets into the ll swing	J						X	
ains disagree on U. S. metric switch	J			X				
emical industry is thinking metric	J			X			X	

TITLE	BK/JOURNAL ARTICLE/OTHER	NATIONAL PROGRAM ACTION	NATIONAL PROGRAM U.S. EQUIPMENT & MEASUREMENT	METRIC STATUS IN INDUSTRY	INDUSTRY TOOLS, EQUIPMENT & MEASUREMENT	BIBLIOGRAPHY
Classes of units in the S. I.	J					
Clerical impact of the metric system	J			X		
Commerce dept asks switch to metric within 10 years	J			X		
Commerce official asks plan for inevitable metric conversion now	J			X		
Commerce secretary outlines metric study activities	J			X		
Commercial weights and measures	ERIC					
Computer makers plan for metric conversion	J					
Computer program helps U. S. factories during metric shift	J			X		
Construction to get its way on metric system	J			X		
Conversion to metric system described in new RIT Book	J				X	
Conversion to metric system: painful, costly by useful	J					X
Conversion to metrics: costly and confusing	J					X

TITLE	K/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	JSTRY TOOLS, IPMENT & MEASUREMENT	-IOGRAPHY		AILABLE
Converting to metric	J						X	
Creative classroom	J	X						
Creative classroom	J	X						
Creative classroom	J	X						
Cupful of merchandising captivates kids	J	X						
Curriculum Review	J	X						
Data center managers should prepare for the inevitable switch to metric	J			X				
Deere found right way to go metric	J			X				
The Delaware Plan	J	X						
Designing to size: which size	J				X			
Detroit's new metrics is not all feet	J			X				
Education: U.S. Metric System	ERIC						X	
Engineering Standards: U.S. Metric Study	ERIC						X	
Engineers inch toward S. I. measurement	J			X				
Fasteners start switch to metric	J			X				

TITLE	BK/JOURNAL ARTICLE/OTHER	CATIONAL PROGRAM ACTION	CATIONAL PROGRAM LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	USTRY TOOLS, IPMENT & MEASUREMENT	LIOGRAPHY	
Fasteners top Ford's metric plant problems	J			X			
First interim U.S. metric study report calls for international standards action	J						
Fisons preparing employees for new metric world	J			X			
Following industry's lead: nation's schools prepare pupils for metrics	J	X					
Food industry sees itself in major role if U. S. goes metric	J			X			
Forecast for the metric training of skilled industrial workers, technicians and technologists during a period of national metrification	J						X
French Fad	J						X
G. M. thinks metric	J			X			
Get ready for the metric system	J						X
Getting started in metrics	J	X					
Give an inch and see what'll happen	J						X
Giving an inch to get a meter	J						X
Go Metric: senate told	J						X

TITLE	K/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM, LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	STRY TOOLS, IPMENT & MEASUREMENT	-IOGRAPHY	AILABLE
Going metric	J						X
Going metric: a costly conversion	J						X
Going metric alone won't solve nation's world trade problems	X						X
Going metric doesn't seem to be a problem for workers	J			X			
Going metric in industrial arts	J	X					
Government has three ways of thrusting forward a completely voluntary conversion program	J						X
Going metric is easier with good planning	J						X
Great metric muddle	J						X
Going metric: the great revolution	J						X
HVAC Refn industry underway in soft conversion to metric system	J			X			
Happy metric new year	J						X
The international metric system and how it works	BOOK					X	X
House bill calls for voluntary metric changes over 10 years	J						X

TITLE	BK/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM ELS, EQUIPMENT & ASUREMENT	TRIC STATUS IN INDUSTRY	USTRY TOOLS, IIPMENT & MEASUREMENT	LIOGRAPHY
House readies new try at passing metric bill	J					
How metric conversion affects administrative practices	J	X				
How much does it cost to go to metric	J	X				
IFI calls for better metrics standards	J					
IIR moves toward SI metric system despite some resistance	J					
Individualized metric modules	BOOK	X				
ISO engineering standards becoming more pro-Europe and anti-USA	J			X		
Impact of metrication on the can industry	J			X		
Inching along	J					X
Inching into metric: what it means for sales	J					X
Industry adopts dual dimensions as metric system inches nearer	J			X		
Industry adopts metric in certain operations as U. S. awaits new law	J			X		
Industry looks to U.S. for metrics push	J			X		

TITLE	BK/JOURNAL ARTICLE/OTHER	NATIONAL PROGRAM ACTION	NATIONAL PROGRAM ILS; EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTR	USTRY TOOLS IPMENT & MEASUREMENT	LIOGRAPHY	C
Industry moves to metrics--without Congress	J			X			
Industry ready for metric measure: several groups give guarded yes	J			X			
Industry takes initiative on metrication	J			X			
Industry to get metric conversion package	J			X			
Information sources on metrication	J						X
Iron Age metric conversion kit: measuring up to metrics	J						X
Iron age metric teaching aids: getting a jump on metrics	J	X					
Issues in teaching metric (SI)	J	X					
It's a metric world	J						X
Keynote to metrication for glass industry lies in technical policy review	J			X			
Label misleads Swedes	J						X
Let's do it: the neglected decimeter	J	X					
Let's see how the metric system is faring around the world	J						X
Liquid containers--in the metric spirit	J			X			

TITLE	BOOK/JOURNAL ARTICLE/OTHER	NATIONAL PROGRAM ACTION	NATIONAL PROGRAM TOOLS, EQUIPMENT & MEASUREMENT	METRIC STATUS IN INDUSTRY	INDUSTRY TOOLS, EQUIPMENT & MEASUREMENT	BIBLIOGRAPHY
Look at metrication	J			X		
Low cost metric conversion in the machine shop	J			X		
Major electric firm advises senate it favors adoption of metric system	J			X		
Making metric calipers	J	X				
Managing metrication in business and industry	BOOK			X		
Managers plan and train for a metric future	J			X		
Marketers view ad opportunities in a silly millimeter longer world	J			X		
Measures proposes voluntary metrication	J					
Measure up, America, here comes metrics	J					X
Measured steps: the metric system is coming-- but not overnight	J					X
Message is clear: get into metrics now	J					X
Metric advocates to introduce bill	J					X
Metric America	J					X
Metric America	J					X

TITLE	</JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	JSTRY TOOLS, IPMENT & MEASUREMENT	LIOGRAPHY	
Metrication and the accountant	J			X			
Metrication: inch by inch	J						X
Metrication is coming, but very slowly	J						X
Metrications's length measured again	J						X
Metrication may pay for itself	J			X			
Metrication conference stimulates few	J						X
Metrication pops up in U.S. soft drink packaging	J			X			
Metric fastener's future:, now	J			X			
Metric guide-for organizations	J			X			
Metric in preservice teacher training	J	X					
Metric mania is on the move	J						X
Metric measurement and instructional television	J	X					
Metric measure gains	J						X
Metric Power:	BOOK					X	X

TITLE	BOOK/JOURNAL ARTICLE/OTHER	EDUCATIONAL PROGRAM ACTION	EDUCATIONAL PROGRAM TOOLS, EQUIPMENT & MEASUREMENT	METRIC STATUS IN INDUSTRY	INDUSTRY TOOLS, EQUIPMENT & MEASUREMENT	BIBLIOGRAPHY
Metric proposal would put notables in uniform bottles	J			X		
Metric recipes for classroom use	J	X				
Metric standards: what they will mean to the graphic arts	J				X	
Metric system: a common language for the market place	J					
Metric system conversion means changing both current and past computer information	J				X	
Metric system? conversion tab put at $1 billion	J					
Metric system countdown begins for tooling	J			X		
Metric system eyed as engineers meet	J				X	
Metric system favored	J					
Metric system is adopted by editorial dept.	J			X		
Metric system millimeters its way to adoption	J					
Metric system looms over the horizon	J					
Metric time	J					

TITLE	K/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	LS, EQUIPMENT & SUREMENT	RIE STATUS IN INDUSTRY	JSTRY TOOLS, IPMENT & MEASUREMENT	IOGRAPHY		ARIES AVAILABLE
Metric changeover is being advocated by federal agency	J						X	
Metric competency goals for students	J	X						
Metric conversion: added costs for workers	J			X				
Metric Conversion and the school shop	J	X						
Metric conversion costs to D.O.D. put at $18 billion	J			X				
Metric conversion: inching closer toward reality	J						X	
Metric conversion due in calculator	J			X				
Metric conversion still inching along	J			X				
Metric dimensions required for exports to European communities by 1978	J			X				
Metric doldrums	J						X	
Metric education: trends and recommendations	J	X						
Metric liquor bottles this month	J			X				
Metric merry-go-round	J						X	
Metric units number inch system days	J					X		

TITLE	BOOK/JOURNAL ARTICLE/OTHER	VOCATIONAL PROGRAM ACTION	VOCATIONAL PROGRAM TOOLS, EQUIPMENT & MEASUREMENT	METRIC STATUS IN INDUSTRY	INDUSTRY TOOLS, EQUIPMENT & MEASUREMENT	BIBLIOGRAPHY	
Metrication--a two-way street	J						
Metrication and the accountant	J			X			
Metrication effects on U.S. foreign trade studied by commerce	J						
Metrication: give them an inch and they take your whole system	J						
Metrication in vocational education	J	X					
Metrication: industry accepts the challenge	J			X			
Metrication is coming: prepare for the transition	J						X
Metrication may not be the sole answer							X
Metrication opens new options for converters	J						X
Metrication plans: must now in heavy industries; no consumer drives yet	J			X			
Metrication problems in the construction codes and standards section	J			X			
Metrication--the changing of a system	J						X
Metrics for (various vocational areas)	MODULES	X					

TITLE	K/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	USTRY TOOLS, IPMENT & MEASUREMENT	LIOGRAPHY	C	AILABLE
Metrics in Career Education	BOOK	X						
Metrics, lumber and the shop teacher	J	X						
Metrics made fun: an individualized approach	J	X						
Metrics: mind my meganewton	J						X	
Metrics with Marcel and Marcette	J	X						
Metrics--why not	J						X	
Mounting pressure to go metric	J						X	
Move to metric costly	J			X				
Moving to metrics makes dollars and sense	J						X	
Mustang II'S gallop will come form 100 metric horses	J				X			
NAW says conversion to metric system neans dual stockage	J				X			
lational metric study conference, -construction	J			X				
lew legislation may end metric debate	J						X	
ew look at the U.S. switch to metrics	J						X	

TITLE	BOOK/JOURNAL ARTICLE/OTHER	EDUCATIONAL PROGRAM ACTION	EDUCATIONAL PROGRAM TOOLS, EQUIPMENT & MEASUREMENT	METRIC STATUS IN INDUSTRY	INDUSTRY TOOLS, EQUIPMENT & MEASUREMENT	BIBLIOGRAPHY	
Nineteen to the dozen	J						X
1980: target date for metric conversion in U.S.	J						X
Office skills: metric problems in the typing classroom	J	X					
Outlook brighter for voluntary metric shift bill	J						X
Package to aid shift to metrics	J				X		
Paper industry sees specs conversion by metric cost concern	J			X			
Planning for the metric challenge	J						X
Planning the transition to the metric SI system	J			X			
Plastics industry looks to government for aid in metric conversion	J			X			
Metric: games to help kids think metric	J	X					
Preparing machine toools for the metric years.	J				X		
President's consumer expert considers metric conversion	J						X

TITLE	K/JOURNAL ARTICLE/OTHER	ATIONAL PROGRAM ACTION	ATIONAL PROGRAM LS, EQUIPMENT & SUREMENT	RIC STATUS IN INDUSTRY	USTRY TOOLS, IPMENT & MEASUREMENT	LIOGRAPHY	C
Problems in U. K. switch to metric system	J						X
Readers favor metrication	J						X
Replacing metric screws	J				X		
Resources for teaching the metric system	J	X					
Role of government in metric changeover spurs controversy	J						X
Rolling mill builder makes it metric	J			X			
Semi-standards groups O.K.'s metric school guides	J	X					
Set UCLA parley on metrics switch	J						X
Shift to metric system could pose problems for U. S. chemical industry	J			X			
Shortages spur metric use and Standardization	J			X			
Should North America adopt standard metric paper sizes	J				X		
Should we metricate	J			X			
So big--metric style	J				X		

GETTING STARTED IN METRICS

-Johnson-

This article is primarily for teachers of elementary students. This brief article has several suggestions of general application. One of the ideas is to have a metric center for the school which would house items such as bath scales, height scales, measuring tapes, and measuring containers.

GOING METRIC IN INDUSTRIAL ARTS

-Cassetto-

After a brief analysis of the extent of change metrics is bringing, the Author recounts his teaching strategy, then delineates his techniques for teaching the introduction on history of metrics, units of length, area, volume, mass capacity, and terperature.

HOW MUCH DOES IT COST TO GO METRIC

-Lindbeck-

This article describes ideas for low cost conversion of necessary tools along with suggested prices for various equipment discussion of drafting, woodworking, metal working, graphic arts, and power/energy.

LaPine's Metric Handbook

This is a good handbook for learning metrics and because of the suggested activities for various metric devices listed in the catalog. The handbook can be useful for educators at all educational levels.

METRIC CONVERSION AND THE SCHOOL SHOP

-Jackson-

This is a general overview article looking at program conversion to include metrics. The Author and other teachers in his school work with the idea that their students need to be metrics educated because the woodworking students have a need to understand measurements on blueprints developed by a drafting class. He discusses which programs will be more or less costly to develop, and how metrics is integrated within a mandatory 9th grade math course.

METRIC CORNER

-School Shop Journal-

"This is a periodic feature that will keep you informed of new events and perspectives regarding efforts to make the metric conversion." Some of the recent articles have included information on using customary measured drill bits for metrics, and how the woodworking shop will adapt to metrics with advice as to which articles will be phased-out with metrics and which can be adapted for metrics use.

METRICATION AND THE ACCOUNTANT

-Webber-

The article starts with an historical overview of metrics in general then mentions some of the usual arguments against metrication in the United States. He addressed the 10-year conversion plan, then he states the affected areas of metrication in accounting: eg. inventory valuation, intercompany comparisons, the problem of comparing historical items with current equivalents for forecasting short-term planning . . .; he then discusses the difficulties and the advantages in his conclusion.

METRICATION IN VOCATIONAL EDUCATION

-Lorenz-

This is a program announcement concerning the availability of a self-study inservice instructional guides which relate the metric system to many of the occupational areas taught in Kentucky Vocational Education.

METRICS, LUMBER AND THE SHOP TEACHER

-Craemer-

The message of this article is that soft conversion to metrics is taking place in sizing wood products. This means that actual lumber dimensions will not change, but metric units will be used to describe the sizes. The article includes several useful charts which show conversion of lumber sizes.

ON SELECTING GOOD METRIC RULES AND SCALES

-Lindbeck-

This article gives a short discussion with examples of good and undesirable measuring tapes and rules. The point is made that inconspicuous details make a great deal of difference to students with few experiences in metrics.

TEACHER RESOURCE GUIDE FOR METRIC EDUCATION

This large booklet looks at metrication as an aspect of teaching, learning, and understanding the concept of measurement. As a resource for teachers it is excellent in that it gives alternatives to purchasing many metric measurement items. The guide not only gives correct answers but also supplies a list of teaching stratagies and a listing of "don'ts".

THINK FAST AND THINK METRIC

-Baillargeon-

The article begins with a metric change-over time-table for 1975-80 that still has some application. An emphasis of the article is a well thought out basis for a metric awareness workshop. There is a step by step description which includes possible stations, needed equipment, and a suggested evaluation form. Historical information about metrics is included which could be used as a basis for introducing students to the metrics system.

THINK METRIC THINK METRIC THINK

-The Kentucky Alumnus-

Beginning with a few examples of metric measurements, the article gives a thorough background on the state of metrics conversion in the U. S. and all around the world. It also describes the history of metrics and advice for learning the metric system. It contains a few useful charts and addresses for further information.

THINK METRIC U S A

An audio tutorial mini-course.

A brief introduction to metrics - it contains a workbook and a supporting tape cassette. The topics covered are metric vocabulary, linear, liquid, temperature, volume area and mass measurements. A free sample is available.

APPENDIX 8

CONSULTANT REPORT

3993 The Old Poste Road
Columbus, Ohio 43220
March 12, 1979

Dr. Richard K. Crosby
Department of Occupational and
Career Education
University of Louisville
Belknap Campus
Louisville, Kentucky 40208

Dear Dr. Crosby:

Enclosed is a copy of the Consultant's Report for my recent trip to Louisville to consult with you and your staff on the activities relating to your project on A System for Providing Relevant Metrics Education for Vocational Teachers in Kentucky. The project appears to be well conceived and is making excellent progress, thus the report contains very few recommendations.

I hope that the report meets with your expectations. If I can be of any further assistance in the future please let me know.

Sincerely

John C. Peterson

CONSULTANT'S REPORT TO A SYSTEM FOR PROVIDING
RELEVANT METRICS EDUCATION FOR VOCATTONAL
TEACHERS IN KENTUCKY

Richard K. Crosby; Project Director

John C. Peterson, Consultant

Literature Search

A thorough literature search of all pertinent databases is critical to the successful completion of all later phases of a project. ERIC (Educational Resources Information Center) is the most widely used educational database. It consists of two main files: Research in Education, which is concerned with identifying the most significant and timely education research reports and projects; and Current Index to Journals in Education, an index to over 700 journals of interest to educators.

A comprehensive search strategy would include more than a search of ERIC. Two levels of searching will be described in an effort to assist project staff in obtaining access to all information needed in preparing the literature review. Each level is described below, with specific references to databases and organizational resources which could provide information on the metric system, metric education, and the concerns of business and industry on conversion to the metric system. The descriptions reflect the differing purposes of the overall search, and are not intended to be rigidly separated categories. Additional sources will no doubt be identified and accessed in the course of the project. Descriptions of the databases can be found in Databases and Clearinghouses: Information Resources for Education. Emphasis has been

placed on computer retrievable databases and thus some more traditional sources, such as Education Index, are not mentioned.

Level 1: Basic Informational Sources. Level 1 is an initial, retrospective search to identify all basic research and development efforts in metric education--particularly vocational education. Approximately eight databases, in addition to ERIC, could be queried to ensure retrieval of materials in this area. A sample of relevant databases available through Lockheed's DIALOG search system or System Development Corporation's (SDC's) ORBIT search program include the following:

- NTIS (National Technical Information Service): covers U.S. government-sponsored research.
- ABI/INFORM: covers all phases of business management and administration. Should contain information on business/management decisions relevant to metric conversion.
- AIM/ARM: materials on vocational and technical education including job training. No new information has been added to this database since 1977.
- COMPREHENSIVE DISSERTATION INDEX: a subject, title, and author guide to almost every American dissertation accepted at an accredited institution since 1861.
- THE INFORMATION BANK: significant news items, interpretive articles, articles of opinion or commentary, business news, and editorials from the New York Times.
- MAGAZINE INDEX: covers over 370 popular magazines (since 1977) and provides coverage of current affairs, business, and other areas.
- MANAGEMENT CONTENTS: provides current information on a variety of business and management related topics.

- NICEM (National Information Center for Educational Media): comprehensive coverage of non-print educational material.
- SSIE CURRENT RESEARCH: contain reports of both government and privately funded scientific (including social science) research projects, either currently in progress or initiated and completed during the two most recent years.

Level II: Current Awareness and Unpublished Research. Level II is designed to provide access to ongoing research projects, recently published research announced during the course of the project, and a wide variety of organizational resources, including potential research consultants.

The Smithsonian Science Information Exchange (SSIE), accessible through Lockheed, can be used to monitor current research projects funded by government and private sources. Conference Papers Index, available through SDC, can be searched to identify significant research described at professional meetings. In this way new R&D findings can be obtained prior to publication in the formal journal literature.

The National Referral Center, operated by the Science and Technology Division of the Library of Congress, abstracts and indexes organizations (and individuals) conducting research in all areas of science, technology, and the social sciences. This database and search service can be utilized to supplement normal procedure of contacting the major organizations and agencies concerned with the metric system.

After the results obtained from the search procedures have been analyzed, the databases which yielded the most fruitful information will be identified. The original search strategy employed should be saved and re-executed on these databases at periodic intervals throughout the span of the project. In this way project staff will be able to

monitor the latest published research findings so that the project will reflect the latest research and development.

There will inevitably be some duplication of references retrieved when conducting a comprehensive search across multiple databases. Nor do the specific databases mentioned above exhaust the list of pertinent information sources available for this search.

Assessment Instruments

The assessment instruments that have been developed for this project have been carefully prepared. Scale 1 and Scale 2 are well designed and should present few difficulties. As I mentioned when we met, a good precautionary measure would be to administer these two scales to a small sample of teachers and/or colleagues. In this way you might prevent some misunderstanding in the directions that has been unnoticed. You will also get an idea of the length of time required to complete each scale.

Scales 3 and 4 still need some revisions. Scale 3 could be modified so that the scale gives the list of items on the left side of the page and provides three areas on the right side for respondents to write items. Figure 1 is one version that the revision might take.

The primary change suggested in Scale 4 is in the title. When we met we concurred that "Metric Measurement Uses" was a more accurate title. Again, I would list the items from Scale 2 on Scale 4. This will prevent some confusion and allow more reliable totals.

Use of Assessment Scales

What will be described next is an ideal use of these four assessment scales. The first stage is not entirely possible because of the fact that the workshops will be held in the near future.

Scales 1 and 2 should be sent to a broad sample of vocational

Figure 1

SCALE 3: Shop Conversion to Metrics

DIRECTIONS: Read each of the metric items on the following list. If you need the item now or expect to need it in the futrue write its name in one of the sections headed NEED NOW, NEED IN NEXT SEVERAL YEARS, or NEED SOMETIME IN THE FUTURE. Do not list any metric items you will not need. To the right of each item check whether this represents a major or minor expense or modification. A minor expense or modification will cost $50 or less per item.

ITEM		minor expense or modification	major expense or modification
	NEED NOW		
	NEED IN NEXT SEVERAL YEARS		
	NEED SOMETIME IN THE FUTURE		

teachers in the ten selected vocational areas. If at all possible, have the completed scales returned at least 10 days prior to the first workshop. Tabulate the results and prepare tables showing how each of the ten groups and the total sample responded on these two scales.

Begin the workshop by having the participants individually complete Scales 1 and 2. After this has been finished distribute the composite tables that show the results of the mail surveys. Discuss the mail survey results. How did the workshop participants agree with the survey of people throughout the state?

After this discussion has been completed, have the workshop participants group themselves by the ten vocational areas. Distribute Scale 3 and ask each group to complete it and develop a composite scale for their area. Have a group discussion. What metric items do they use now, expect to need in the near future, and will use sometime in the (distant) future? What was their reasoning for the grouping? What do they anticipate not needing and why?

Scale 4 can be done individually. This scale is longer than Scale 3 but because it is an individual response rather than a group response, it may not take as much time. Some groups may need a great deal of time to discuss where each item on Scale 3 should be placed.

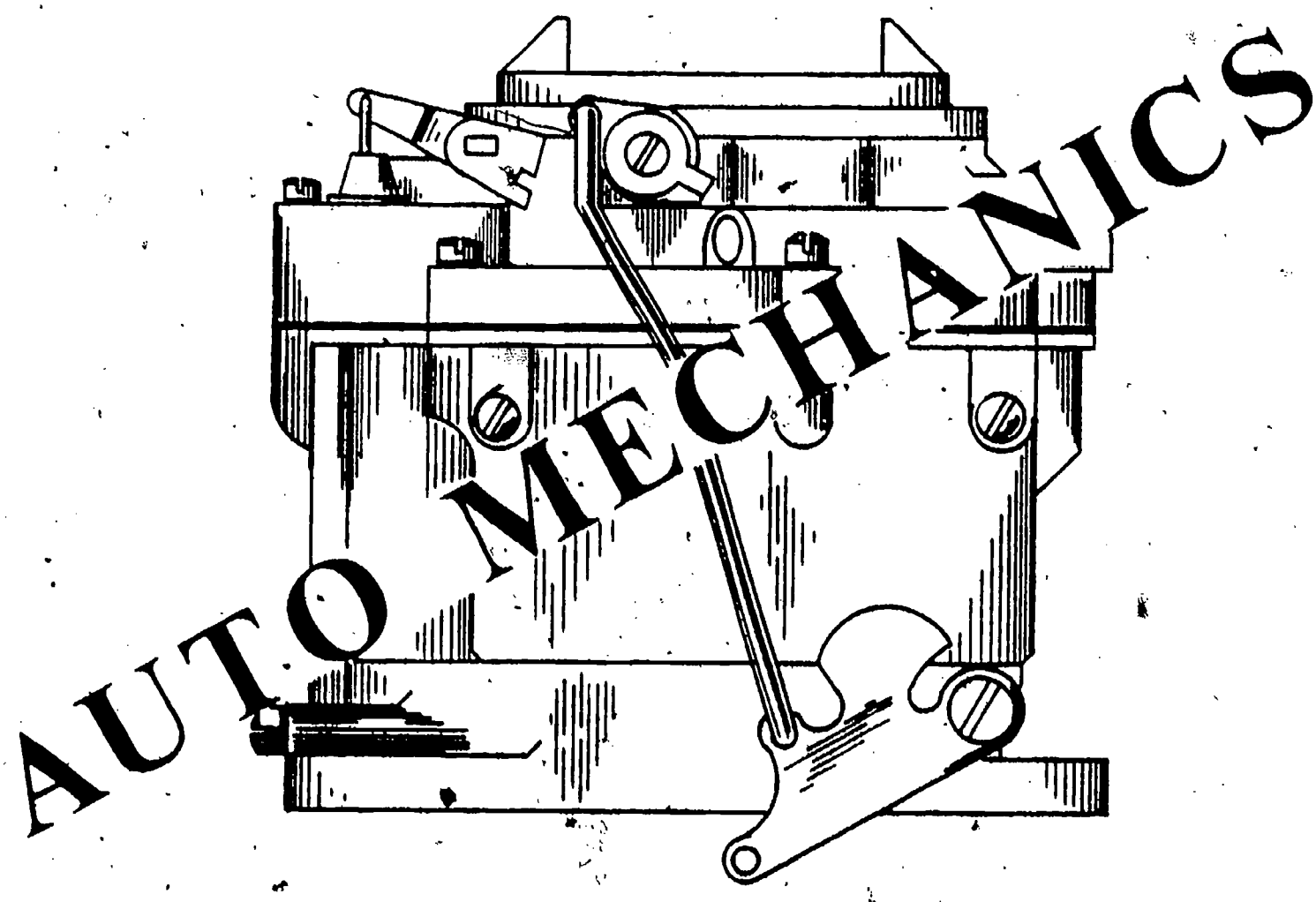
Throughout the workshop it is important to remember to keep the participants involved. A metric workshop affords an excellent opportunity for participants to be involved physically and mentally. Metric measurement activities are good ways to get people physically involved. As you know from experience, people are reluctant to use the metric system. But, get them using it, and soon they will see just how easy it is.

APPENDIX 9

SAMPLE INSTRUMENT
(1 of 10 Instruments)

METRICS

A Metric Self-Assessment for Teachers of:



DEVELOPED AND PRINTED WITH KENTUCKY STATE FUNDS

AUTO MECHANICS

SCALE 1 Metric Tools, Equipment and Devices

Directions: This scale is designed to find out what metric tools, equipment and devices are used in your instructional program. Read each of the items on the list and place a checkmark in one of the columns for each item.

Item	Don't use in my training program	Use the equivalent English item	Use this now
1. Assorted metric hardware (hex nuts, washers, screws, cotter pins, etc.)			
2. Metric drill bits			
3. Metric vernier caliper			
4. Metric micrometer			
5. Metric feeler gauge			
6. Metre tape			
7. Metric open-end wrenches			
8. Metric box wrenches			
9. Metric socket set			
10. Metric hex key set			
11. Thermometers (degree celsius)			
12. Thermostats (degree celsius)			
13. Engine temperature gauge (degree celsius)			
14. Oil temperature gauge (degree celsius)			
15. Balancer with metric weight indicators			
16. Metric pressure gauge on hydraulic brake bleeder (kilopascal unit)			
17. Oil, pressure gauge (kilopascal unit)			
18. Manifold pressure gauge (kilopascal unit)			

Item	Don't use in my training program	Use the equivalent English item	Use this now
19. Air hose pressure gauge (kilopascal unit)			
20. Cutting tool air pressure gauge (kilopascal unit)			
21. Hydraulic press pressure (kilopascal unit)			
22. High pressure washer pressure gauge (kilopascal unit)			
23. Welder pressure gauge (kilopascal unit)			
24. Analyzer pressure gauge (Kilopascal unit)			
25. Oil, fuel or gas tank volume (metric volume)			
26. Mobile brake shop with metric adjustment dial			
27. Metric-sized camshaft bearing inserter and remover			
28. Automatic transmission metric tool set			
29. Air impact wrench with metric sockets			
30. Metric bushing driver set			
31. Metric flaring tools			
32. Metric spark plug gauge			
33. Metric tire pressure gauge			
34. Metric hydrometer			
35. Metric valve spring height and tension tool			
36. Radiator pressure testor (kilopascal unit)			
37. Midget metric wrenches			
38. Metric distributor wrench			
39. Metric torque wrenches			
40. Metric lug nut wrench			

AUTO MECHANICS

SCALE 2 Measurements

Directions: This scale is designed to find out what metric measurements are being used in your instructional program. Read each of the items on the list and place a checkmark in one of the columns for each item.

Item	Don't need to make this measure-ment	Use metric measure-ment	Use English measure-ment	Use both English and metric measure-ment
1. Crankshaft main journal size				
2. Transmission clearance & adjustment				
3. Valve clearance				
4. Ring clearance				
5. Piston diameter				
6. Piston bore				
7. Stroke of a piston				
8. Length of a fuel line				
9. Length of a fan belt				
10. Diameter of a camshaft				
11. Length of air exhaust pipe				
12. Spark plug gap				
13. Brakeshoe to drum clearance				
14. Front end adjustment				
15. Carburetor adjustment				
16. Piston head area				
17. Volume of a fuel tank				
18. Capacity of an acetylene cylinder				
19. Amount of water in a radiator				

Item	Don't need to make this measurement	Use metric measurement	Use English measurement	Use both English and metric measurement
20. Volume of oil for crank case				
21. Capacity of a radiator				
22. Bore of a cylinder				
23. Brake fluid capacity				
24. Temperature of the engine				
25. Temperature of the oil				
26. Temperature of cooling system				
27. Temperature of transmission				
28. Mass of battery fluid				
29. Mass of a small engine				
30. Battery mass				
31. Weight of a vehicle				
32. Weight of truck loads				
33. Torque a fitting				
34. Spring tension				
35. Tire pressure				
36. Manifold pressure compression				
37. Air conditioning compressor				
38. Speed of a vehicle				
39. Work efficiency of an engine				

APPENDIX 10

SCALES 3 and 4

S A M P L E

SCALE 3 Shop Conversion to Metrics

Introduction: In a previous scale you were asked to check whether or not you were using listed metric tools, equipment, or devices. This scale is designed to assist you to decide what metric items you need now or in the future to continue providing relevant education. The scale should also help you to think about the cost of changing over your shop to metrics. Once you have decided what you need, when you need it, and what it will cost, you may want to share this information with your immediate supervisor.

SCALE 3: Shop Conversion to Metrics

Directions: Make a listing of the metric items you need now, those you will need in the next several years, and items you will need sometime in the future. Then place a checkmark in the column indicating whether it will be a minor or major expense.

	Minor Expense or Modification (under $50 per item)	Major Expense or Modification (over $50 per item)
NEED NOW		
NEED IN THE NEXT SEVERAL YEARS		
NEED SOMETIME IN THE FUTURE		

S A M P L E

SCALE 4 Metric Professional Development Needs

Introduction: In a previous scale you were asked to check whether or not metric measurements are being used in your instructional program. What you checked or didn't check may have meaning for what you as a teacher should know about metrics. If metric measurements are used or should be used, this indicates you need to be proficient in working with metric measurement in those areas. Where metric measurements are not used, you will have to decide what you should know based on your information of the progress of metric conversion in business and industry. This scale is designed to help you organize your thoughts about metric measurement. Upon completion, you should be able to plan for what you need to do for your own professional development in metrics.

Directions: If you feel you need in-depth education in a particular quantity of metric measurement, check to the left of that quantity on the following page. Make as many checks as necessary.

Quantity	Unit	Symbol	Use
Length	millimetre	mm	shaft size, length
	centimetre	cm	bearing sizes
Area	square centimetre	cm^2	piston head surface
Volume/capacity	cubic centimetre	cm^3	cylinder bore
	cubic metre	m^3	work or storage space
	millilitre	ml	chemicals, lubricant oils
	litre	l	oil, fuel, gasoline storage
Temperature	degree Celsius	°C	thermostats, engine operating temperature ranges, oil temperature
Mass	gram	g	tire weights
	kilogram	kg	batteries, engines
	metric ton	t	vehicles, load weights
Bending moment (moment of force)	newton metre	N·m	torque specifications
Pressure/vacuum	kilopascal	kPa	manifold pressure compression, air hose pressure
Velocity	kilometres per hour	km/h	speed of the vehicle
*Energy/work	kilowatt-hour	kW·h	work efficiency of an engine

*Note: Further metric definitions for mechanics are found in *Rules for SAE Use of SI (Metric) Units*, Society of Automotive Engineers, Inc. Available: Society of Automotive Engineers, Inc., 400 Commonwealth Dr., Warrendale, PA 15096.

APPENDIX T1

TABLES 11-19
Scale Responses

TABLE 11

AIR CONDITIONING ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
Thermometers (1)	Temperature measuring devices (2) Open-end wrenches (1) Socket wrenches (1) Thermometers (1) Box-end wrenches (1)	Assorted metric hardware (1) Drill bits (1) Measuring devices (rules, etc.) (1) Allen wrenches (1) Box-end wrenches (1) Open-end wrenches (1) Socket wrenches (1) Nut drivers (1) Temperature controls (1) Pressure controls (1)	Measuring tape (1)

*Number in parentheses indicate the number of responses.

TABLE 12

AUTO BODY ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
Thermometer (1)	Drill bits (2)	Tape measure (2)	Air pressure gauges (1)
Temperature devices (1)	Tap and die set (2)	Frame and reference books for measurements in metric (1)	Welding tank gauges (1)
Open-end wrenches (2)	Tape (2)	Punch and chisel set (1)	
Box wrenches (2)	3/8 drive socket set (1)	Pressure gauge (1)	
Combination wrenches (2)	Combination wrench set (1)	Metric containers (1)	
Socket set (2)	Box wrench set (1)	Air transformer (2)	
Metric hex key set (2)	Open-end wrench set (1)	Air operated chisel (1)	
Assorted metric hardware (2)	Hex key set (1)	Spray gun cup (1)	
Drill bits (1)	Metric containers (1)	1/2 drive socket set (1)	
Tap and die set (2)		Torque wrench (1)	
Tape (1)			

*Number in parentheses indicate the number of responses.

TABLE 13

AUTO MECHANICS ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
Assorted metric hardware (1)	Drill bits (5)	Pressure gauge (2)	Engine measuring tools (1)
Tape (1)	Tap and die set (3)	Engine analyzer (2)	Engine analyzer machine (1)
Open-end wrenches (4)	Micrometers (7)	Auto transmission tool set (3)	Control dials (1)
Box wrenches (4)	Calipers (6)	Brake tools (6)	Drill bits (1)
Socket sets (4)	Tapes (3)	Brake lathe modified for metric (5)	Micrometer (1)
Thermometers (1)	Thread gauges (2)	Tap and die set (4)	Oil fuel and gas containers (1)
Air impact wrench, metric sockets (1)	Open-end wrenches (4)	Box-end wrenches (3)	
Spark plug gauge (2)	Box-end wrenches (5)	Open-end wrenches (3)	
Midget wrenches (3)	Nut drivers (4)	Nutdrivers (3)	
Distributor wrench (1)	Hex key (4)	Hex keys (3)	
Feeler gauge (1)	Socket sets (4)	Socket sets (3)	
Key sets (2)	All metric pressure gauges (6)	Valve spring measuring tool (2)	
Vernier caliper (1)	Torque wrenches (8)	Micrometers (1)	
	Pressure tester (3)	Radiator pressure tester (1)	
	Air gauges (2)	Training charts (1)	
	Hydrometer (1)	Piston and head surface cylinder boring tool (1)	
	Impact wrench sockets (5)	Balancer with metric weights (1)	
	Compression tester (1)	Oil pressure gauge (1)	
	Transmission tools (1)	Manifold pressure gauge (1)	
	Temperature measuring equipment (7)	Bushing driver set (1)	
	Books (3)	Flaring tools (1)	
	Metric containers (1)		
	Air Transformer (1)		

*Number in parentheses indicate the number of responses.

TABLE 13 - Continued

AUTO MECHANICS ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
	Punch and Chisel set (1) Feeler gauge (1) Air hose pressure gauge (1) Valve spring height and tension (1) Radiator pressure tester (1)		

*Number in parentheses indicate the number of responses.

TABLE 14

DIESEL MECHANICS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
	Drill bits (1)		
	Tap and die set (1)		
	Calipers (1)		
	Micrometers (1)		
	Socket set (1)		
	Hand tools (1)		
	Measuring tools (1)		

*Number in parentheses indicate the number of responses.

TABLE 15

DRAFTING ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
Tape (2)	Scales for drafting machine (1)	Micrometers (1)	
Drafting machine scale (2)	Rules (1)		
	Tapes (2)		
	Vernier caliper (1)		
	Micrometer (1)		
	Triangular scale (1)		

*Number in parentheses indicate the number of responses.

17

TABLE 16

FOOD SERVICE ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
	Thermometer (1)	Measuring cans (2)	Thermometers (1)
	Temperature gauge (1)	Measuring scales (1)	Temperature gauges (1)
	Measuring cups (2)	Measuring spoons (1)	Air pressure gauges (1)
	Measuring spoons (3)	Measuring cups (1)	Water pressure gauges (1)
	Metric sized pans (2)	Liquid measuring containers (2)	Steam pressure gauges (1)
	Bakers scale (3)	New shop machines (1)	Metric meat slicer (1)
	Liquid measuring containers (2)	Metric storage containers for liquids (1)	Metric temperature gauges for grill, fryer, refrigerator, ovens (1)
		Metric sized pots and pans (1)	
		Metric containers (1)	
		Metric buckers (1)	
		Metric cans (1)	
		Disposable products and bowls (1)	
		Temperature gauges or meat thermometers (1)	

*Number in parentheses indicate the number of responses.

TABLE 17

HORTICULTURE ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
Open-end wrenches (1)	Tapes (1)		
Box wrenches (1)	Measuring cups (1)		
Socket sets (1)	Scales (1)		
Platform scale (2)			
Rain gauge (1)			
Barometer (1)			
Humidity Indicator (1)			
Wind velocity indicator (buckets and containers with metric) (1)			
Capacities for mixing and storing liquids (boxes, cans, buckets, etc., for mixing and storing dry ingredients (1)			
Metric sized watering can (1)			
Set of metric measuring cups (1)			
Dairy scale (1)			
Measuring spoon set (1)			

*Number in parentheses indicate the number of responses.

TABLE 18

MACHINE SHOP ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
Drill bits (3)	Tap and die set (5)	Milling machine collet set (1)	Hoist (1)
Tap and die set (3)	Assorted metric hardware (6)	Numerical control unit (1)	Torque wrench (1)
Open-ended wrenches (2)	Micrometer (6)	Flexowriter (1)	Drills (1)
Socket sets (2)	Calipers (5)	Milling cutters (1)	Metric Comparator (2)
Hex key sets (4)	Feeler gauge (5)	Drill sleaves (1)	Lathe with metric adjustments (2)
Square (2)	Punches (2)	Metric height gauge (1)	Lathe metric collet set (2)
Scales (3)	Screw thread gauge scales (4)	Radial drill with metric adjustments (1)	Lathe metric micrometer stop (1)
Milling cutters (1)	Milling cutter (1)	Machines in shop that will work in the metric system (all kinds) (1)	Vertical milling machine with metric capabilities (2)
Drill sleeves (1)	Drill sleeves (1)	Conversion kits for old machines (5)	Grinder with metric capabilities (2)
Height gauge (1)	Height gauge (2)	Cutting tools (drills, reamers, taps, dies, etc.) (1)	Socket wrenches (1)
Thermometer (celsius scale) (1)	Meter tape (4)	Assorted metric hardware (1)	Hex wrenches (1)
Lathe with metric adjustment capabilities (2)	Open-end wrenches (6)	Height gauge (2)	
Calipers calibrated in metrics (1)	Socket sets (6)	Metric dials and gears (3)	
Feeler gauge (1)	Scales (2)	Digital read-out for mill (1)	
Micrometer (3)	Box-end wrenches (5)	Drill reamers (1)	
Thread gauge (2)	Allen wrenches (5)		
Screw thread gauge (2)	Metric charts for conversion (1)		
Comparator with metric adjustment capabilities (2)	Books on metric (1)		
Lathe with metric adjustment capabilities (2)	Drills and reamers (5)		
Vertical milling machine with metric adjustment capabilities (2)	Nut drivers (6)		
	N.C. unit with metric capabilities (1)		
	N.C. flexometer with metric capabilities (1)		

*Number in parentheses indicate the number of responses.

TABLE 19

WELDING ITEMS

Metric Item(s) Used Now	Metric Item(s) Needed Now	Metric Item(s) Needed In Several Years	Metric Item(s) Needed Sometime In Future
	Hand tools (1)	Pressure regulators and gauges (4)	
	Metric tape (2)	Guide bend and feasible testing equipment (1)	
	Framing square (3)		
	Socket set (2)		
	Box-end wrenches (2)		
	Drill bits (2)		
	Tap and die (6)		
	Assorted metric hardware (4)		
	30cm rule (3)		
	10 meter rule (3)		
	Metric fry square (1)		
	Pein punches (1)		
	Fillet weld gauge (1)		
	Metric training aids (1)		
	Training aids (1)		
	Drill bits (1)		
	Gas regulator (1)		
	Temperature gauges (1)		

*Number in parentheses indicate the number of responses.

APPENDIX 12

3rd PARTY EVALUATION REPORT

EVALUATION REPORT

Submitted To:

DR. RICHARD K. CROSBY,
PROJECT DIRECTOR

For

"A SYSTEM FOR PROVIDING RELEVANT METRICS EDUCATION FOR VOCATIONAL TEACHERS IN KENTUCKY"

Submitted by:

L.S. McKinney
Department of Vocational
Technical Education
West Virginia Tech
Montgomery, West Virginia 25136

EVALUATION REPORT

General Evaluation

The on-site evaluation visit with the Project Director and Staff revealed evidence to support the following general and specific statements concerning the attainment of project objectives.

Objective 1 - The metric self-assessment instruments for ten (10) vocational areas were produced and explained. The development, field testing and revision of these instruments was reviewed and found to be in compliance with the stated project activity intents.

Objective 2 - The projected plans of the project concerning the attainment of information relative to industrial conversion efforts were carried out. The results of the effort were limited, although results were obtained. The limits of project funds and time were a constraint in implementing alternate plans that would have yielded the desired results. This finding has implications which are discussed in more detail below. The objective of obtaining information relative to educational metric conversion efforts was successful through the development and application of scales to determine the tools and equipment being used in school shops and an examination of the measurements being made in the shops.

Objective 3 - The objective of providing professional development opportunities to selected teachers in four vocational regions had not been completed at the time of the on-site evaluation. However, plans were being made and the materials were available. It seemed that there would be no major barriers to the full implementation of this objective.

Objective 4 - The provision of individualized metric modules to the designated recipients had not been done at the time of the evaluation review. The modules were available and ready for printing; therefore, there should be no difficulty in the full attainment of this objective.

Literature Review

The process and product of the literature review were presented to the evaluator by the project staff.

Strengths of the literature review were: (1) That it was included as a part of the basic project, (2) that a comprehensive listing in bibliography form has been developed, (3) plans were in evidence to categorize the listing to facilitate its use, (4) plans were also made to prepare annotations for many of the more pertinent listings, (5) copies of projects to in-service vocational teachers in metrics from other states had been requested (this seemed to be promising). It is concluded that the measureable objectives stated on page seven (7) of the project proposal concerning the literature review have been met.

Implementations for improvement of the project based on the literature review are: (1) Obtain copies of the Final Report of the Western Michigan University Metric Education Project, (2) obtain copies of the Industrial Math Problems in Metrics produced in Oregon, (3) review the requested projects on workshops in Pennsylvania concerning development of materials to be used by vocational teachers in teaching their students the metric system.

This indicates that a great deal of additional work could be done through the continuation of this project with modifications.

Steering Committee

Evidence was presented that indicated that the measurable objectives on page seven (7) of the project proposal had either been met or were currently in progress. This evidence included written lists of members of the Metrics Steering Committee and the ten (10) vocational subject areas to be assessed.

Possible areas for improvement included (1) the provision and (2) the need for alternate means for business-industry input. These two areas of improvement were also identified as existing in the activities of needs assessment and instrument development listed below.

Needs Assessment

The project plans for industry and education involvement is one of the strongest points in the project. Although Advisory Committees were established, industry involvement was limited. This was a major disappointment in the project in terms of meeting objectives 3.2, 3.3, and 3.4. However, some input was obtained directly from industry as well as from vocational teachers. This finding indicates that other alternatives must be found for involving industry or greatly increasing project funding and staff to assure that this function is successful!

One possible alternative for industry involvement would be a mail survey using the instruments developed through the workshops with vocational teachers. That is, scale 1 and scale 2 could be modified for an industry survey if the project is continued. This is, of course, only one possible alternative.

The development of scale 1 and scale 2 was certainly an innovative approach to needs assessment. The use of a variety of resourses in the development of these scales is a very strong point in favor of the project.

Instrument Development

Scales 3 and 4 represent the development of the metrics self-assessment instrument that measures metric professional development needs and metric program needs. Evidence was presented to verify the development of this instrument which meets objective 4 of the project. The process of instrument development focused on the use of several sources of written information as well as input from practicing vocational teachers with some limited input from business and industry.

The use of the workshop in the area of the University to refine and validate the instruments prior to using them in the other regions was a strength of the project. It would have been desirable to use more teachers in each vocational area; however, scheduling of time and teacher attitude were understandable barriers.

It was reported that some anti-metric attitudes were exhibited during the conduct of the workshop. This verifies and confirms the need for metrics awareness and professional development programs in metrics.

Data Analysis

The analysis of the instruments and data generated by them indicated that instruments were needed for each occupational area. Therefore, data analysis was limited to each occupational area. This consisted mainly of summaries etc. The outcomes of data analysis resulted in supplementary information for the instrument development which enables any teacher in each of the ten vocational areas (occupations) to determine their present metric need.

The possible area of improvement concerning data analysis objective attainment is the need for strengthening the direct link with the rate of change over by business and industry. This is essential in predicting future metric needs in vocational programs.

Field Test and Revision

Evidence was presented to verify the development of the instrument and revision based on meetings and workshops conducted in Region 6. The three additional regions had been designated with plans for conducting the workshops being finalized. There was a question about teachers receiving credit for attending the workshops. If credit is not available, it may be a deterrant to participation. Plans were also made for final revision of the instruments based on the field tests in the other regions. This is advisable in that the selection of the additional regions was made to include rural as well as rural-industrial areas. Basic attainment of the objectives concerning the field test and revision seem to be assured.

Professional Development

The objectives for professional development are to be implemented through providing two summer workshops and offering a one (1) to five (5) credit hour course on an individual basis next fall. Plans were also in evidence to deliver copies of the metric modules. Therefore, the objectives for professional development included in the project will be met. The process of providing professional development is excellent.

Summary

In summarizing this evaluation report the most important point to be made is that a system has been developed through this project that provides vocational educators in Kentucky with the methods and materials needed to provide in-service and pre-service metric education to vocational teachers that will enable them to prepare vocational students for entry into employment in the changing world of work. It is hoped that the Bureau of Vocational Education, Vocational Teacher Educators, Vocational Administrators, and Vocational Teachers will use this system and improve it through refinement and revision on a state-wide basis.

The Project Director is to be commended for designing and implementing this project based on sound vocational principles and philosophy. The University of Louisville and the Bureau of Vocational Education also deserve praise for supporting the project and providing needed leadership in this important segment of our changing environment.

The project could certainly be continued and further refined. However, an important beginning has been made with immediate implications for vocational teacher and student learning in the modernized metric system.

APPENDIX 13

STEERING COMMITTEE EVALUATION

EVALUATION OF PROJECT ACTIVITIES
STEERING COMMITTEE - METRIC EDUCATION PROJECT

Directions: Please circle a number in the appropriate column after each of the following statements. If you wish to make additional comments, a space is provided for that purpose on the last page.

For the statements below - 1 - Strongly Disagree (SD)
2 - Disagree (D)
3 - Undecided (U)
4 - Agree (A)
5 - Strongly Agree (SA)

	SD	D	U	A	SA
Literature Review					
1. An adequate review of literature was accomplished during the project	1	2	3	4	5
2. The purchased literature was sufficient in quantity and quality to support project activities	1	2	3	4	5
3. The listing of reference materials in the final report will be helpful to vocational educators	1	2	3	4	5
Steering Committee					
4. The Steering Committee is representative of industry and education	1	2	3	4	5
5. The ten vocational program areas selected at the beginning of the project were a good choice	1	2	3	4	5
6. Suggestions by the Consultant have resulted in improved quality of project outcomes	1	2	3	4	5
Needs Assessment					
7. The Metrics Advisory Committee is representative of education and industry	1	2	3	4	5
8. Metric measurements for the ten areas are representative of what's being done in industry	1	2	3	4	5
9. The listing of metric tools and equipment is representative of what is needed to adapt to the present state of metrics in industry	1	2	3	4	5
10. The listings of needed tools and equipment are sufficient to predict the rate of progress of industry during the remaining years of the ten year voluntary conversion period	1	2	3	4	5
Instrument Development					
11. The metrics self-assessment instruments for the ten areas are sufficient to measure (1) program metric needs and (2) metric professional development needs	1	2	3	4	5

	SD	D	U	A	SA
Data Analysis					
12. The data obtained during the workshop will help determine the metric status of the ten (10) selected vocational programs in comparison to industry	1	2	3	4	5
Field Test and Revision					
13. The three selected regions to field test the system for providing metrics education were good choices	1	2	3	4	5
14. The two-day workshop conducted during the project increased teachers' metric awareness as well as enhancing program planning for the metrics changeover	1	2	3	4	5
Professional Development					
15. The plan for offering the metric course during the Fall 1979 Semester is a good method to continue helping teachers to adjust to metrics	1	2	3	4	5
16. The copies of the self-assessment instrument and a copy of individualized modules will be helpful to vocational educators in the regions	1	2	3	4	5
17. There was sufficient cooperation with the professional development unit during the project	1	2	3	4	5

STEERING COMMITTEE RESPONSES

3rd Party Evaluation

For the responses below - 1 - Strongly Disagree (SD)
2 - Disagree (D)
3 - Undecided (U)
4 - Agree (A)
5 - Strongly agree (SA)

	SD	D	U	A	SA
	1	2	3	4	5
Literature Review					
1.			1		5
2.				4	2
3.				3	3
Steering Committee					
4.		2	1	3	
5.				3	3
6.			1	4	1
Needs Assessment					
7.	1		1	3	1
8.		1		4	1
9		1		2	3
10.	1		1	2	2
Instrument Development					
11.			1	3	2
Data Analysis					
12.		1		2	3
Field Test and Revision					
13.			1	2	3
14.				2	4

Steering Committee Responses - Continued

	SD	D	U	A	SA
Professional Development					
15.				3	3
16.				1	5
17.			1	1	4

Comments:
Regional VEPD funds are available
Continued workshops will be most helpful
Continued follow-up and evaluation with industry is a necessity
Need more industry involvement and less education involvement
Need more industry input
Continue the program
Metrics is here to stay

APPENDIX 14

WORKSHOP AGENDA AND MATERIALS

WORKSHOP - METRIC EDUCATION

First Day

9:00 - 9:30	Overview of PROJECT
9:30 - 10:00	Self-Assessment Explanation - Scale 1 and 2
10:00 - 11:30	Orientation Experiences - Length
12:30 - 3:30	Orientation Experiences - Area and Temperature
3:30 - 4:00	Summarization of Day's Activities

Second Day

9:00 - 10:00	Self-Assessment Explanation - Scale 3
10:00 - 11:30	Orientation Experiences - Volume
1:00 - 1:45	Self-Assessment Explanation - Scale 4
1:45 - 3:30	Orientation Experiences - Mass
3:30 - 4:00	Summarization of Workshop

METRIC ACTIVITIES

The activities on the pages which follow are suggestive of the content and style of instruction in metrication which will teach people to think metrically. These sample activities touch upon four kinds of measure problems: length, area, volume and mass. They have been used with students in grades 3 - 9 (with appropriate modification by the instructor) and with adults. The writers hope that they will help you to generate many other activities especially adapted to the learners with whom you work.

Three sample items used as materials are included at the end of this packet. These are (1) an ant neighborhood "map" for Activity L. 8, (2) a copy of a curve for use in Activity A. 5 and (3) a sheet of centimeter-square graph paper. You may wish to produce variations on the first two items; the third (graph paper) can be duplicated for use in many of the activities.

by: Bob Kansky
University of Wyoming
and
Chuck Thompson
University of Louisville

Activity L 1

Activity: Use the metric height chart to find your height to the nearest centimeter. (Do this on about the same day of each month during the school year).

Activity L 2

Activity: Find at least two personal examples of each of the following lengths:

a centimeter
a decimeter
a meter

(For example, the width of the nail on the little finger of my right hand is about one centimeter.)

Make a note of what these "personal examples" are, as you will need to use those examples later.

Activity L 3

Activity: Here are some familiar objects you might find around the house or classroom.

*For the shorter objects, estimate their lengths to the nearest centimeters. For the longer objects, estimate their lengths to the nearest decimeter.

*NO TAPES OR RULERS ALLOWED UNTIL AFTER YOU'VE MADE AN ESTIMATE!

Activity L 4

Activity: Using a tape measure, find your body measurments to the nearest whole centimeter. No fudging!

A. foot length (shoeless)

B. foot width (shoeless)

C. hips

D. waist

E. chest (bust)

F. neck

G. head (around)

H. arm (shoulder to wrist, with arm bent)

Activity L 5

Activity: 1) The distance, as the crow flies, from Dog Walk to Oddsville is 125 kilometers. Using that piece of information, guess the distance, as the crow flies, from:

A. Oddsville to Bear Wallow

B. Bear Wallow to Lovelaceville

C. Monkeys Eyebrow to Tip Top

D. Monkeys Eyebrow to Lovelaceville

2) Now, use any of the objects lying about to help you check your guesses

Activity L 6

Activity: A. Wrap a tape measure around the outside of the wheel. How far is it around the outside of the wheel?

B. 1. Take a trundle wheel and hold it by the handle.

2. Push the wheel along the floor until you hear a click.

3. Then pull the wheel back toward you until it stops. Now the wheel is in the "jammed position."

4. Starting with the wheel in the "jammed position," roll the wheel forward until you hear a click. The distance the wheel rolls between clicks is 1 meter.

5. Use the trundle wheel to measure the length of the _____. Be sure the "Start Arrow" on the trundle wheel points to where you want to begin measuring.

C. 1. Estimate the length of the room in meters.

2. Use the trundle wheel to check your estimate.

Activity L-7

Activity: Use the strips of masking tape to practice taking steps that are 1 meter long.

When you're ready, start at the strip of tape furthest from the wall. Face the wall and close your eyes. Then take 5 1-meter steps toward the wall. (How's your nose?)*

*Keep trying until you're within a foot-length of the wall.

Activity L 8

Activity: In earlier exercises, you found your heights and certain "personal examples" of one centimeter, one decimeter and one meter. Using these examples only, guess some measures such as the following:*

A. the height of a friend (or enemy)

B. the length, width and height of a desk or table

C. the height of this room

D. the length and width of a window

E. the length and width of a door

F. the waist measure of a friend

G. the neck measure of a critic

Check your guesses using the tapes and rulers

*NO TAPES OR RULERS ALLOWED UNTIL AFTER YOU'VE MADE AN ESTIMATE!

Activity L 9

Activity: The picture of this station shows the homes of three ants: Alphonse, Boris and Clyde. The paths between the ants homes wiggle around rocks, clumps of grass and the homes of other insects.

1. If the ants always travel along these paths, guess how far in centimeters Alphonse travels in going to see Boris. After recording your guess, check that guess using the materials provided.

2. Repeat procedure in 1 to guess-and check the distance Boris travels to visit Clyde and the distance Clyde must travel to visit Alphonse.

Activity L 10

Activity: The measures of several items are given below except for the fact that the unit of measure has been left out in each case. (This is indicated by a ? in each example.) For each item, tell which unit of measure (METER, DECIMETER, or CENTIMETER) seems reasonable.

1. Abraham Lincoln was about 19 ? tall.
2. The width of many living rooms is about 3 ?.
3. Few earthworms are longer than 2 ?.
4. Most dining tables are about 70 _____ high.
5. Some of the world's biggest snakes (pythons, anacondas, etc.) grow to a length of about 8 ?
6. Miss America has a waist measure of about 61 ?.
7. A man's foot is about 3 ? long
8. A new piece of chalk is about 1 ? long.

Activity L 11

Activity: Below is a list of things some people might have to measure in their jobs. For each measurement, tell which unit of measurement (METER, DECIMETER, CENTIMETER) you think they would use.

1. The length and width of a vegetable garden.
2. The circumference (distance around) a watermelon.
3. The length and width of windows.
4. The height (floor to shoulder) of dogs.
5. The thickness of boards used to make furniture.

Activity L 12

Activity: Cover one face of a wooden stick with black plastic electrical tape. Cut 1 decimeter lengths of yellow plastic tape and place them atop the black tape, leaving 1 decimeter intervals of black. Do not put any numerals on the stick.

DO NOT STRETCH THE TAPE BECAUSE IT WILL THEN "SHRINK" BACK TO ITS NORMAL LENGTH

Note: USE THE FLAT SIDE OF THE STICK.

THE ORANGE RODS ARE 1 DECIMETER LONG.

Activity L 13

Activity: Cover one face of a wooden stick with a 20-centimeter strip of tape.

Note: NOW COVER THE OTHER FACE WITH A 2 DECIMETER STRIP OF TAPE. YOU'LL NEED TO DISCARD 10 CENTIMETERS OF THE ROLL OF TAPE OUT OF EVERY 50.

Activity A 1

Activity: 1. The piece of paper at this station is 1 meter along each side and thus has an area of 1 square meter. Using this paper as a guide, estimate the area (in square meters) of the ceiling in this room.

2. Now, use a trundle wheel to check your guess.

Activity A 2

Activity: Guess the area in square meters (i.e., steres) of each wall in this room. Check your guess.

Activity A 3

Activity: The big square sheet of paper has an area of one square meter. The smaller square has an area of one square decimeter.

1. How many square decimeters are there in one square meter?
2. How many square centimeters are there in a square meter?

Activity A 4

Activity:
1. Draw an outline of your left hand on the square centimeter grid paper. Find the approximate area of your hand by counting the squares.
2. Estimate the area of your foot (with shoes off). Now, outline your foot and count the squares to check your guess.

Activity A 5

Activity: Guess the area (in square centimeters) of the shaded area under the curve. Use the white and orange rods to check your guess.

Activity A 6

Activity:

1. Pick one of the pictures and guess its area (in square centimeters). Now check your guess by using the plastic grid.
2. Guess-and-check the area (in square centimeters) of each of the other pictures.

Activity A 7

Activity:

1. The grid at this station has an area of 1 square decimeter. Using it as a guide, estimate the area (in square decimeters) of each of the objects indicated below.

2. Now use the decimeter-band meter sticks to check your estimates.

Activity A 8

Activity: Use the plastic grid paper to find the area (in square centimeters) of each figure.

1. For figures A-E you should be able to get an exact measure.

2. For figures F and G get as good an approximation as you can.

212

Activity A 9

Activity: Find the area (in square centimeters) of the outside (sides, top, and bottom) of each container.

Activity A 10

Activity: A 1. Without measuring, cut out a rectangle which is not a square and which has an area of about 100 SQUARE CENTIMETERS.

2. Use the plastic grid to check the area of your rectangle.

(a) If you are "off" by 20 SQUARE CENTIMETERS or more, throw away the rectangle and try again.

(b) Keep trying until your are "off" by less than 20 SQUARE CENTIMETERS.

B. 1. Without measuring, cut out a nonsquare rectangle which has an area of about 150 SQUARE CENTIMETERS.

2. Use the plastic grid to check the area of the rectangle.

3. Keep trying until you are "off" by less than 30 SQUARE CENTIMETERS.

C. 1. Without measuring, cut out a triangle which has an area of about 50 SQUARE CENTIMETERS. (Your work in Part A should help here.)

2. Check your estimate.

Activity A 12

Activity: Below is a list of things some people might need to measure. For each measurement, tell which unit of measurement, (square centimeter, square decimeter, square meter) you think they would use.

1. The carpeting for your living room.
2. The amount of material for a blouse.
3. A regular sheet of typing paper.
4. The top of a "pringles" can.
5. A dollar bill.
6. A half dollar.
7. The roof of your house.

Activity VI

Activity:

1. Pour what you think is one liter of water into one of the large, plastic buckets. Check your guess by using the graduated container. Keep trying until your guess is within 50 milliliters of one liter.
2. Pick a container and pour what you think is 50 milliliters of water into it. Check your guess. Keep trying until you miss by less than 50 milliliters.

Activity V2

Activity:

1. Guess the volume of each of the containers which are marked with letters.
2. Use the graduated containers and water to check your guesses.

Activity V3

Activity:

1. Use the ruler and pen to draw a line straight down the side of the glass. Let it dry for a minute or two.
2. With the help of the funnel, pour 25 MILLILITERS of colored water into the 50 MILLILITER measuring cylinder.
3. Pour the 25 MILLILITER of water into the glass. Use the pen to mark the height of the water on the side of the glass.
4. Write "25" (for 25 MILLILITERS next to the mark you made on the glass.
5. Add another 25 MILLILITERS of water to the glass. Mark the new water height and label it "50" (for 50 MILLILITERS).
6. Add another 25 MILLILITERS of water to the glass. Mark the water height and label it "75" (for 75 MILLILITERS).
7. Continue the procedure until you have a 250-MILLILITER measuring container.

Activity V4

Activity:

1. With the help of one or two other people, use the meter sticks and "corners" to build the frame of a "box" which has a volume of one cubic meter.
2. Use your frame to help you guess the volume of the room.
3. Take a look at your instructor. About how many persons of that size could be squeezed inside your frame? What is the approximate volume of your instructor?
4. Disassemble the frame you built.

Activity V5

Activity:

1. The little white cube has a volume of one milliliter ($\frac{1}{1000}$ of a liter).
2. Guess the volume of each container and then use the materials given here to find the approximate volume of the containers.

Activity A6

Activity: A. 1. For each pair of objects, estimate which of the two has the greater volume. Write the name of that object in the space provided in the chart.

2. If you think that two objects of a given pair have the same volume, write "SAME" in the space provided.

B. Now use containers A and B, the funnel and the colored water to check the estimates that you made in Part 1. Here is how you do it:

1. Put containers A and B side by side.
2. Pick one of the pairs of different-shaped objects and fill each member of the pair with colored water.
3. Pour the water from one member of the pair into container A.
4. Pour the water from the other member of the pair into container B.
5. In the space provided in the chart, record the name of the object which you found to have the greater volume. If you found that they had the same volume, write "SAME".
6. Empty containers A and B. Repeat the five steps above to check each pair of objects.

Activity V7

Activity:

A. 1. Dip up a heaping teaspoon of salt.
2. Holding the spoon over the paper towel, gently use the edge of the ruler to scrape off the extra salt, (that is, to make a level teaspoon of salt.)
3. With the help of the funnel, pour the level teaspoon of salt into the measuring cylinder.
4. What is the volume, in MILLILITERS, of the level teaspoon of salt?

B. 1. Put 3 level teaspoons of salt into the measuring cylinder.
2. From the answer you just got for 3 teaspoons of salt, what must be the volume of 1 teaspoon of salt?

C. 1. Put 10 level teaspoons of salt in the measuring cylinder.
2. What is the volume of 10 teaspoons?
3. From the answer you just got, what must be the volume of 1 teaspoon?
4. How does your answer compare to the answer from part B? Why?

D. 1. Put one level tablespoon of salt into the measuring cylinder. What is the volume, in MILLILITERS, of a tablespoon?

E. 1. Put 3 level tablespoons of salt into the measuring cylinder. What is the volume of 3 tablespoons?
2. Based upon the answer you just gave, what must be the volume of one tablespoon?

F. 1. How many teaspoons of salt are in one tablespoon of salt? Justify your answer.

Activity:

A. 1. Pick a container and pour what you think is 100 MILLILITERS of water in it.
2. Use the funnel and graduated container to check your estimate.

B. 1. Repeat the process of Part A using the other container.

C. 1. Repeat Parts A and B for a volume of 50 MILLILITERS.

D. 1. Repeat Parts A and B for a volume of 250 MILLILITERS. In this case, keep trying until you miss by at most 20 MILLILITERS.

Activity V9

Activity: One upon a time, cereal manufacturers all sold a "family-sized" package of their cereal. Moreover, most of these manufacturers used the same size and shape box for their "family-sized" portion. Then, for some reason, many started to change the shape of the box used.

A. You have been given a cereal box. Suppose that all manufacturers used this same box for their "family-sized" package.

1. Now suppose that the manufacturer of Bloatie Oaties introduces a new "family-sized" package which is one CENTIMETER thicker than the old box but which is also 2 CENTIMETERS shorter. Which package would hold more Bloatie Oaties, the old or the new?

2. How many MILLILITERS more (or less) would the new package hold?

B. 1. Suppose the manufacturer of Crunchy Creatures also changed its box from the size you have been given to one that is 1 CENTIMETER thinner but 3 CENTIMETERS taller. Which package (old or new) would hold more Crunchy Creatures?

2. How many MILLIMETERS more (or less) would the new package hold?

3. Which size package would sell best?

Extension: Suppose that the manufactureres of Gram Flakes made its package 2 CENTIMETERS thinner. How much taller would it have to be to make its new package so that the new package (although it would look different) would hold about the same volume of Gram Flakes as the old package?

Activity:

A. 1. Cut along the edges of the shape on the cut-out sheet.

2. Now fold along the heavy lines of the shape to form a box.

3. Then put tape along each edge of the box. The result should look like the box pictured at the left.

B. The box you just made has a volume (capacity) of one LITER. If the box were made of stronger stuff, we could use it to measure things which are sold by volume. For instance,
a LITER of soft drink (large bottle)
a LITER of motor oil (a small car engine holds about 4 liters)
a LITER of gasoline (a small car holds about 40 LITERS).

1. What is the length (to the nearest CENTIMETER) of each edge of the box?

2. a. Use the little cubes to make a "floor" inside the box. (That is, make a layer of cubes--one cube high--which covers the bottom of the box). How many cubes are on the floor?

3. b. Make another layer (floor) on top of the first. How many cubes are in that floor?
c. How many floors can the box hold?
d. How many cubes would be in each floor?
e. How many cubes can the box hold?

C. Each little cube is said to have a volume of one MILLILITER (which means 1/1000-liter). Why is one MILLILITER a good name for the volume of one of the little cubes?

Activity M 1

Activity: 1. Place a 1 gram weight on one side of the balance. Then place enough paper clips on the other side to balance it. You may have to cut off part of a paper clip. Then put the paper clips all together in a loop.

2 Place a 5 gram weight on one side of the balance. Then place enough paper clips on the other side to balance it. You may have to cut off part of a paper clip. Then put all of the paper clips together on one clip.

3. Repeat for a 10 gram weight.

Activity M 2

Activity: 1. Find and record the mass (to the nearest gram) of each U.S. coin.

2. Prepare a list of U.S. coins, from the lightest to the heaviest.

   a) Which has the greater mass, a penny or a nickel
   b) Can you tell which of two U.S. coins is worth more if all you know is the mass of each coin?
   c) If coins were exchanged according to their masses, how many nickels should be exchanged for 1 quarter?

3. List 5 different combinations of coins which would total 30 grams.

Activity M 3

Activity: Use rock salt to make your own set of weights. Put rock salt into a "baggie" until it balances a 50 gram weight placed on the other pan of the balance. (Be sure to put a twist-tie on the balance too.) Repeat with 100 gram and 500 gram weights. Take the weights with you.

Activity M 4

Activity:

1. Cut off a wad of clay which you think has a mass of one kilogram. Check your guess by using a balance. If you missed by more than 50 grams, put back the clay and try again.
2. Now try to cut off a wad which has a mass of 100 grams.. Check your guess. Keep trying until you're off by less than 10 grams.
3. Please return the clay (unbagged) and knife to the big container when you're finished (Squash the clay together.)

Activity M 5

Activity: 1. Using the metric bathroom scale, find your weight to the nearest kilogram.

2. Guess someone's weight. Check your guess by having him/her use the scale. If you were off by more than 5 kilograms, find someone else to work with. Keep going until your guess of someone's weight is off by less than 5 kilograms.

Activity M 6

Activity: 1. Pick up one of the items and hold it in your left hand. With your right hand, pick up weights until you think the mass of the weights in your right hand is the same as the mass of the object in your left hand. Now use the balance to check your guess. Describe "how far off" your guess was.

2. Repeat the procedure described in A, using each of the objects at this station.

Activity M 7

Activity: 1. Pick up one of the items and guess its mass (in grams). Use a balance and weights to check your guess.

2. Repeat the procedure describer in A, using each of the items at this station.

Activity M 8

Activity: Each of the small weights has its mass etched on it. Use them to find the weights of some familiar objects you might have at home or in your classroom.

Activity M 9

Activity: A. Do not use the balance for this part of the activity.

1) Pick item A with one hand and item B with the other. Using your arms like a balance, estimate which item has the greater mass.

2) Repeat the procedure for each pair of items listed in the chart.

B. Checking your estimates with the balance.

1) Use the pan balance to compare each pair of items listed on the chart.

Activity M 12

Activity: Pennyweights are no longer used to find the mass of objects. Things are now measured in grams. Each of the weights used in this activity has a mass of 1 gram.

1. Use the balance and the cubes to find the mass, in grams, of each object. Record the name and mass of each object.

2. Are there any other objects or things in your classroom that have the same mass as any of these objects?

Activity M 13

Activity: While the 1-gram weights are useful when finding the masses of small or light objects, they are not so useful when finding the masses of heavier objects. The weight marked "20" has the same mass as 20 1-gram weights and should be used when measuring the heavier objects.

1. In one pan of the balance place two of the weights marked "20" and one of the weights marked "10". What single weight should be placed in the other plan to make them balance?

2. What 5 weights will equal a 500-gram weight?

3. Place a 100-gram weight in one pan of the balance. Make the pans balance by placing exactly ten weights in the other pan.

4. What other combinations of weights will balance with 100 grams?

5. The weight marked "1000" is 1000-gram weight. It is also called a kilogram weight (where "kilo" means "1000").
   a. Place a kilogram weight in one pan of the balance. Make the pans balance by placing exactly six weights in the other pan. What weights did you use.
   b. Check your answer to the last question against those of other people in the room.

Note: A set of metric weights (metal, plastic and/or clay) should contain the following:

MASS	QUANTITY
1000 gram	1
500 gram	2
100 gram	5
50 gram	2
20 gram	5
10 gram	10
1 gram	25-50

Warn your pupils that the balance may not be perfect but will be "close."

Activity M 14

Activity: Each bag contains a portion of something to eat. There is the same kind of thing in each bag, but no two bags contain the same amount. For any two bags, the bag with the greater mass contains the larger portion.

Your task is to place the six bags "in order" according to their masses. That is, you are to place the six bags in a line like this:

so that the bag with the smallest portion (least mass) is in position 1. The bag you place in position 2 should have a larger portion (more mass) than the one in position 1 but should have less mass than any bag to its right. The bag with the greatest mass should be in position 6. Use the balance to get the bags in order.

Note: A total of about 800 grams of candy is required. Use small candies.

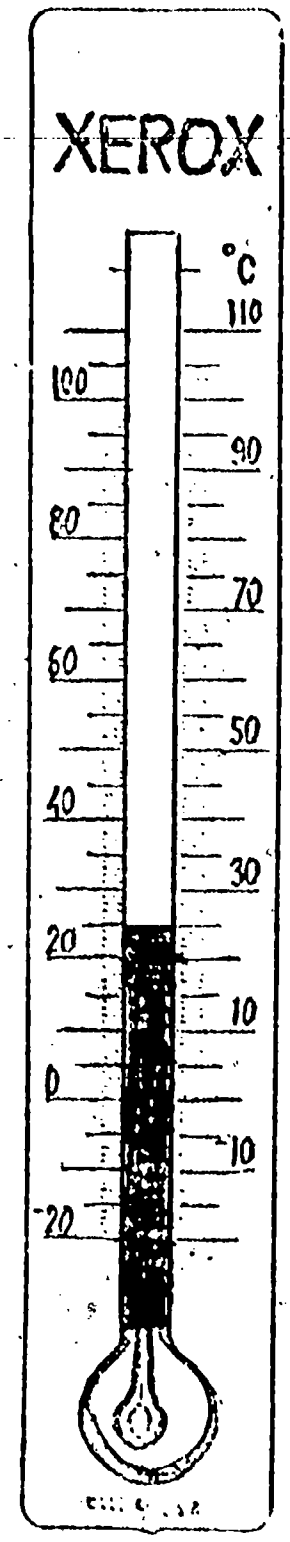
Directions for preparing the bag of goodies:

1. Use sealed bags (same size).
2. Use paper or colored plastic bags so the students cannot see the contents.
3. Let your experience (and budget) be your guide with regard to contents. Candy, nuts or cookies are standard fare.
4. Place the same kind of thing in each bag.
5. For each group (3 to 4 pupils in each group), prepare six (or more if you want to make the exercise difficult) bags. Use the same six masses for each group but label (A, B, C, D, E, F) the bags differently. Be certain to keep a record of the order for each group so that you can quickly check the results.
6. Here is a suggested arrangement for six groups of six bags of candy.

Mass in bag (in grams)	Label on the Bag					
	1	2	3	4	5	6
36	C	B	C	B	E	C
33	F	E	B	F	C	A
32	A	C	F	A	B	F
30	D	F	A	D	F	B
28	B	A	D	E	A	D
27	E	D	E	C	D	E

ACTIVITY T 1

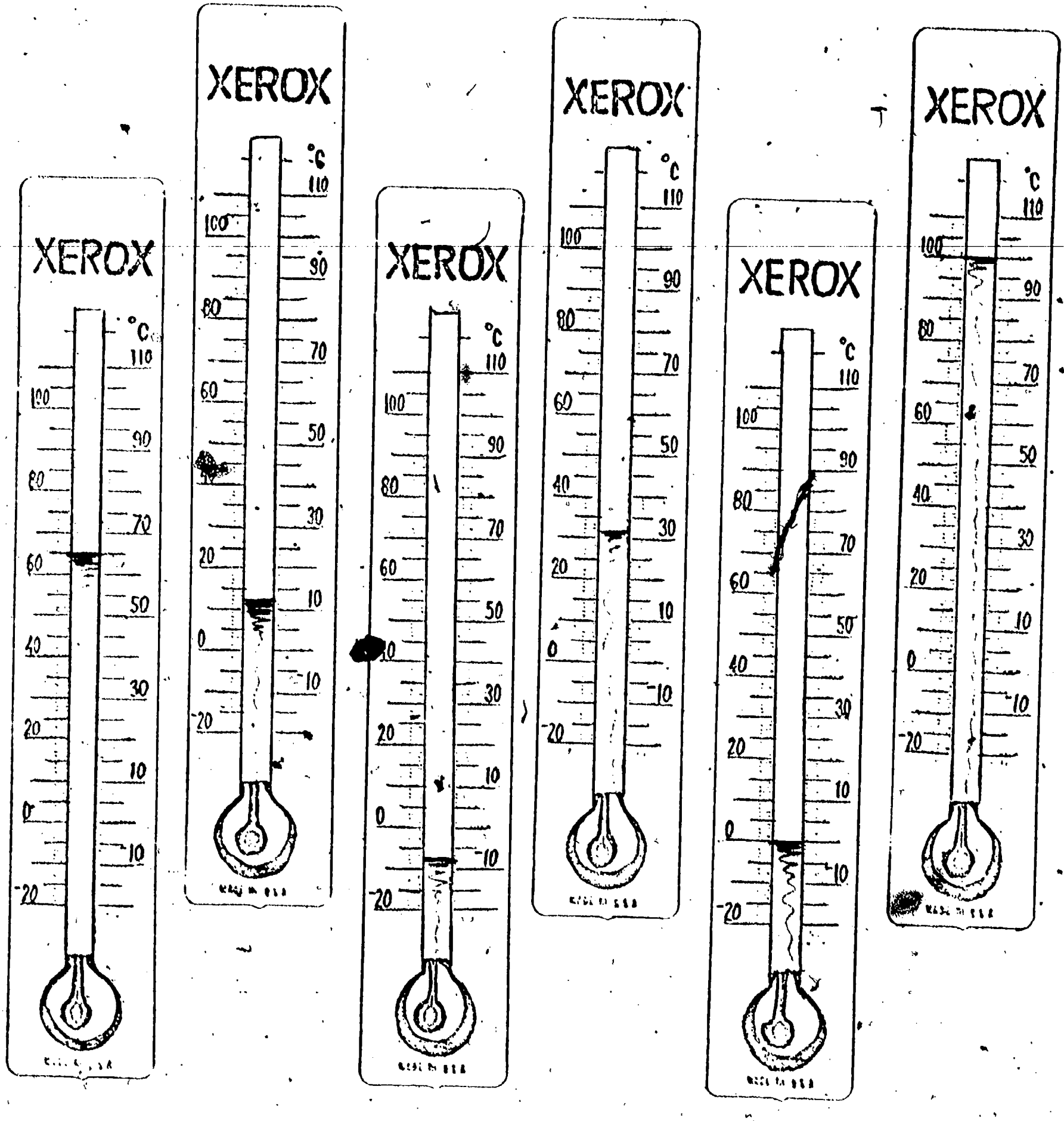
ACTIVITY: SIX (6) CELSIUS THERMOMETERS ARE PICTURED ON THE ATTACHED WORKSHEET. EACH LOOKS SOMETHING LIKE THIS:



THE SHADING IN THE THERMOMETER INDICATES A TEMPERATURE OF 25 DEGREES CELSIUS, SO A "25" SHOULD BE WRITTEN IN THE BLANK BELOW THE THERMOMETER.

TEMPERATURE: _____ DEGREES CELSIUS

CELSIUS TEMPERATURES
WORKSHEET



ACTIVITY T 2

ACTIVITY: ON THE DEMONSTRATION THERMOMETER, FIND THE FOLLOWING TEMPERATURES:

BODY TEMPERATURE	_____ C
FREEZING POINT OF WATER	_____ C
AVERAGE ROOM TEMPERATURE	_____ C

ACTIVITY T 3

ACTIVITY: PEOPLE OFTEN SPEAK OF THE TEMPERATURE OF A ROOM. IN THIS ACTIVITY WE WILL INVESTIGATE WHETHER TEMPERATURE IS THE SAME EVERYWHERE IN A ROOM.

1) PLACE THERMOMETER IN A LOCATION IN THE ROOM. CONSIDER SUCH PLACES AS NEAR A WINDOW, NEAR A HEATER, IN THE CENTER OF THE ROOM, NEAR THE FLOOR, NEAR THE CEILING, ETC.... (USE THE TAPE TO HOLD THE THERMOMETER IN PLACE IF NECESSARY).

2) AFTER SEVERAL MINUTES, RECORD THE TEMPERATURE AT THE LOCATION.

ACTIVITY T 4

ACTIVITY: PLACE THERMOMETERS IN A LOCATION OUTDOORS. YOU MIGHT WISH TO CONSIDER ONE OF THE FOLLOWING LOCATIONS:

EYE-LEVEL IN THE SUN
EYE-LEVEL IN THE SHADE

OTHER POSSIBLE LOCATIONS WOULD BE ON THE GRASS, ON A SIDEWALK OR ON A TAR SURFACE. (YOU THINK OF SOME)

ACTIVITY T 5

ACTIVITY: USING ONE (1) OF THE CELSIUS THERMOMETERS, TAKE A TEMPERATURE READING FROM A DRINKING FOUNTAIN IN THE BUILDING.

APPENDIX 15

METRIC EDUCATION COURSE

UNIVERSITY OF LOUISVILLE
LOUISVILLE, KENTUCKY 40208

DEPARTMENT OF OCCUPATIONAL
AND CAREER EDUCATION

BELKNAP CAMPUS

TO: VOCATIONAL ADMINISTRATORS AND TEACHERS IN:

Jefferson County
Trimble County
Bullitt County
and
Oldham County

FROM: Dr. Richard K. Crosby
Department of Occupational and Career Education

DATE: August 3, 1979

A course in metrics education will be offered to vocational teachers during the Fall '79 semester by Dr. Richard K. Crosby, Department of Occupational and Career Education. The course (EDVT 530 - Special Topics: Metrics) will be 2 or 3 credit hours, graduate or undergraduate credit.

The course will count towards certification and degree work at U of L. Persons enrolled in other universities should check with their advisors.

The first session will be held at Scott Detrick Vocational Education Center on August 29, at 3:00 p.m.. Students will be registered during class at the first session. Tuition is $23 per credit hour for undergraduates and $26 for graduate students.

Instruction is individualized. The amount of credit and course responsibilities will be worked out with each student the first night of class.

The course will be rotated between four locations. The schedule is as follows:

Scott Detrick Vocational Education Center	Westport Road Vocational Education Center	Jefferson-State Vocational-Technical School	Mill Creek Vocational Rehabilitation Center
Aug. 29	Sept. 5	Sept. 12	Sept. 19
Sept. 26	Oct. 3	Oct. 10	Oct. 17
Oct. 24	Oct. 31	Nov. 7	Nov. 14
Nov. 21	Nov. 28	Dec. 5	

Each student must attend at least 5 sessions. Sessions will run from 3:00 - 5:30 p.m.. During the sessions, the resource person (R. Crosby) will assist students to complete the modules and will provide final Check-Out Activities.

The course is limited to 25 students. If you wish to enroll, call Virginia Ellis at (588-6667 - ext. #4) now so your name can be added to the class list.

If you have any questions, please contact (R. Crosby) at 588-6667 - ext. #3.

Richard K. Crosby
DR. RICHARD K. CROSBY
Assistant Professor

RKC/ve

MODULES COMPLETED - EDVT 520 SPECIAL TOPICS

Name - School - & Occupational Area	Module Number	Date Assigned	Date Completed (Checked-Out) Grade	Mid-Term Exam Grade	Final Exam Grade	Final Grade
Name:	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
School:	9					
	10					
	11					
	12					
Occupational Area:	13					
	14					
	15					
	16					

METRICS - EDVT 520 SPECIAL TOPICS

Class Schedule (E = Explain C.O. = Check-Out)

Module #	Aug. 29	Sept. 5	Sept. 12	Sept. 19	Sept. 26	Oct. 3	Oct. 10	Oct. 17	Oct. 24	Oct. 31	Nov. 7	Nov. 14	Nov. 21	Nov. 28	De 5
1	E	C.O.	C.O.			C.O.	MID								
2	E	C.O.	C.O.			C.O.	TERM								FIN
3		E	C.O.	C.O.		C.O.	EXAM								EX
4			E,C.O.	C.O.	C.O.	C.O.									
5				E,C.O.	C.O.	C.O.									
6					E,C.O.	C.O.	C.O.								
7						E,C.O.	C.O.	C.O.							
8							E,C.O.	C.O.	C.O.						
9								E,C.O.	C.O.	C.O.					C.O
10									E,C.O.	C.O.	C.O.				C.O
11										E,C.O.	C.O.	C.O.			C.O
12											E,C.O.	C.O.	C.O.		C.O
13												E,C.O.	C.O.	C.O.	C.O
14													E,C.O.	C.O.	C.O
15														E,C.O.	C.O.
16														E,C.O.	C.O.

APPENDIX 16

METRIC MODULE SAMPLE
"1 of 16 Modules"

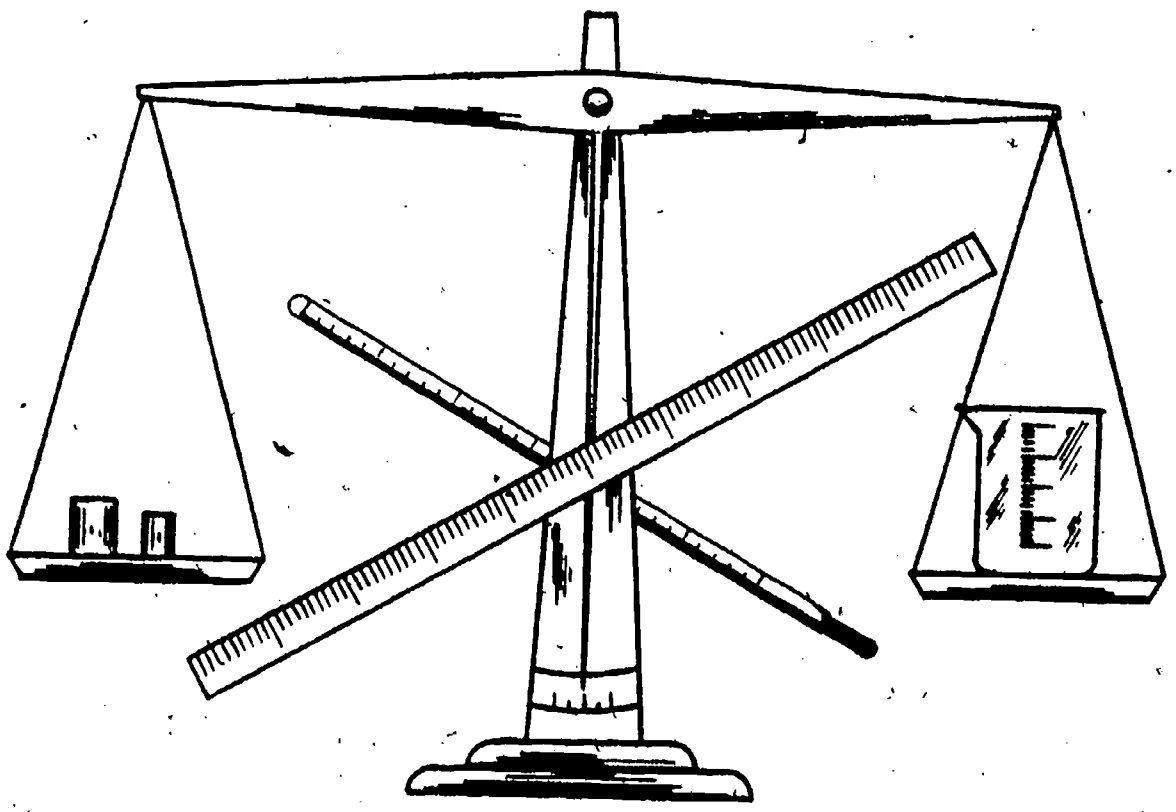
METRIC EDUCATION

SAMPLE - ONE (1) OF SIXTEEN (16) MODULES.

MODULE

4

Conversion of Units in the Metric System



DEVELOPED BY:

Richard K. Crosby

L. S. McKinney

PRINTED WITH KENTUCKY STATE FUNDS

METRIC EDUCATION

CONVERSION OF UNITS IN THE METRIC SYSTEM

Introduction

This module will present a method for the conversion of measurements expressed in a given unit of length to an equivalent measurement expressed in a different unit of length in the metric system. Conversion of area and volume units will be included in modules on area and volume respectively.

Read the following objective. If you think you are already able to perform these tasks, check with your instructor to complete the Check-Out Activity,

or

Directions

If you need to complete learning activities in order to be able to do the tasks, find the Learning Activities in this module and go through them in the order listed.

Objective(s)

Given a listing of metric measurement problems, at least 90% of the problems will be answered correctly. The problems will require the problem solver to:

- Convert millimetres to centimetres and metres.
- Convert centimetres to millimetres and metres.
- Convert metres to millimetres, centimetres, decimetres, dekametres, hectometres, and kilometres.
- Convert kilometres to hectometres, dekametres, and metres

LEARNING ACTIVITIES

1 → READ Instruction Sheet I, CONVERSION OF UNITS IN THE METRIC SYSTEM.

(or) _____

2 → READ Ploutz, Paul F., The Metric System, p. 39-52.

(or) _____

3 ✓ CHECK YOUR KNOWLEDGE by completing Measurement Activity I, MEASURING WITH METRIC UNITS AND CONVERSION.

4 ✓ CHECK YOUR KNOWLEDGE by completing Student Self-Check I, CONVERSION OF UNITS IN THE METRIC SYSTEM.

5 ✓ ARRANGE with your instructor to complete the module by going through the CHECK-OUT ACTIVITY listed on the back page.

INSTRUCTION SHEET I

CONVERSION OF UNITS IN THE METRIC SYSTEM

When computations, including conversions, are made with measurements which are expressed in specific units of measure, the units may be carried through the calculations and the answer expressed in a given unit of measurement if the answer is a measurement.

An example of this is, if you add 3 ft. and 6 ft. the answer is 9 ft. Not just 9.

However, if you wish to know how many times 5 ft. is contained in 25 ft. then the answer is a number not a measurement. The number tells the number of times the 5 ft. is contained in the 25 ft.

$\frac{25 \text{ ft.}}{5 \text{ ft}} = 5$, not 5 ft.

The ft. unit in the divisor cancels out the ft. unit in the dividend.

Other examples of computing with units with which you are possibly familiar are:

3 in. + 12 in. = 15 in.
115 volts + 115 volts = 230 volts
9 ft. - 3 ft. = 6 ft.
440 yd. - 120 yd. = 320 yd.

2 ft X 4 ft. = 8 sq. ft. or 8 $ft.^2$
(Notice that addition and substraction of like units gives a measurement in the same unit of measure, but when you multiply measurements you have square units or units of area.)
6 metres X 10 metres = 60 sq. m or 60 m^2.

$$\frac{18 \text{ sq ft}}{3 \text{ ft}} = \frac{18}{3} \frac{\text{ft. ft}}{\text{ft.}} = 6 \text{ ft.}$$

$$\frac{60 \text{ ft.}}{12 \text{ ft}} = \frac{60}{12} \frac{\text{ft}}{\text{ft}} = 5$$

(Notice the cancellation of units.)

4 ft X 5 lb = 4 X 5 X ft X lb. = 20 ft-lb

$$\frac{30 \text{ ft}}{10 \text{ sec}} = \frac{30}{10} \frac{\text{ft}}{\text{sec}} = \frac{3 \text{ ft}}{\text{sec}} = 3 \text{ ft/sec} = 3 \text{ fps}$$

$$\frac{45 \text{ lb}}{15 \text{ ft}} = \frac{45}{15} \frac{\text{lb}}{\text{ft}} = 3 \frac{\text{lb}}{\text{ft}} = 3 \text{ lb/ft} = 3 \text{ lb per foot}$$

Instruction Sheet I (p. 2)

The principle of carrying the unit of measure along with the measurement during calculations becomes very useful in converting measurements from one unit of measure to another unit of measure.

The chart of the most used measurements of length in the metric system follows:

METRIC LENGTH

Unit Name	Symbol	Relationship of Units
millimetre	mm	1 mm = 0.001 m
centimetre	cm	1 cm = 0.01 m = 10 mm
decimetre	dm	1 dm = 0.1 m = 10 cm
metre	m	1 m = 100 cm = 1000 mm = 10 dm
dekametre	dam	1 dam = 10 m
hectometre	hm	1 hm = 100 m = 10 dam
kilometre	km	1 km = 1000 m = 100 dam = 10 hm

A careful study of the relationship of units in the metric system will show that they are related in multiples of ten, therefore, changing from one unit of measure to another simply requires the multiplication or division by ten or some multiple of ten.

The only remaining questions are- how do you know when to divide or multiply and by what multiple of ten?

To answer this question we must define a ratio. A ratio is a relationship between two similar units of measure that tells the number of times one unit contains the other. By similar units we mean that they both must be units of length, area, volume or any other type of measurement.

The Metric Length Chart relationship of units column defines many ratios of the units of length in the metric system. With this information you can convert from any given metric measurement defined to any other.

The principle to use follows:

Since there are 1000 m in one (1) km, this can be stated 1000 m = 1 km as 1000 m represents exactly the same distance as 1 km. If we divide one by the other the answer is one (1).

$$\frac{1000\ m}{1\ km} = 1 \text{ or } \frac{1\ km}{1000\ m} = 1$$

Remember that when you divide one measurement by an equal measurement the quotient is one. This principle means that you may use all of the definitions in the relationship of units as conversion factors. That is as numbers to use in converting from one unit of measure of length to another unit of measure of length.

EXAMPLES:

How many cm are in 5 m?

The relationship between m and cm is -

$$1 \text{ m} = 100 \text{ cm} \text{ or } \frac{1 \text{ m}}{100 \text{ cm}} = 1 \text{ and } \frac{100 \text{ cm}}{1 \text{ m}} = 1$$

Since we have 5 m and want to know the number of cm, choose the ratio $\frac{100 \text{ cm}}{1 \text{ m}} = 1$, so that the m units will cancel.

$$5 \text{ m} \times \frac{100 \text{ cm}}{1 \text{ m}} = 500 \frac{\text{m} \times \text{cm}}{\text{m}} = 500 \text{ cm}$$

How many km are there in a distance of 250 m?

$$1 \text{ km} = 1\,000 \text{ m}$$

$$\text{or } \frac{1 \text{ km}}{1\,000 \text{ m}} = 1 \text{ and } \frac{1\,000 \text{ m}}{1 \text{ km}} = 1$$

$$250 \text{ m} \times \frac{1 \text{ km}}{1\,000 \text{ m}} = \frac{250}{1\,000} \times \frac{\text{m} \times \text{km}}{\text{m}} = 0.25 \text{ km}$$

The ratio $\frac{1 \text{ km}}{1\,000 \text{ m}}$ was chosen so that the m units would cancel leaving the km length.

This principle will permit you to convert from any length expressed in one unit to a length in any other unit as long as you have the relationship of the two units. Other examples are:

37 mm - ? cm

$$37 \text{ mm} \times \frac{1 \text{ cm}}{10 \text{ mm}} = 3.7 \text{ cm}$$

390 mm = ? m

$$390 \text{ mm} \times \frac{1 \text{ m}}{1\,000 \text{ mm}} = \frac{390 \text{ m}}{1\,000} = 0.390 \text{ m}$$

36 cm = ? mm

$$36 \text{ cm} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 360 \text{ mm}$$

Instruction Sheet I (p. 4)

2 m = ___?___ mm

$$2\ m \times \frac{1\ 000\ mm}{1\ m} = 2\ 000\ mm$$

3.5 m = ___?___ cm

$$3.5\ m \times \frac{100\ cm}{1\ m} = 350\ cm$$

1 m = ___?___ dm

$$1\ m \times \frac{10\ dm}{1\ m} = 10\ dm$$

6 m = ___?___ dam

$$6\ m \times \frac{1\ dam}{10\ m} = 0.6\ dam$$

300 m = ___?___ hm

$$300\ m \times \frac{1\ hm}{100\ m} = 3\ hm$$

0.5 km = ___?___ hm

$$0.5\ km \times \frac{10\ hm}{1\ km} = 5\ hm$$

3 km = ___?___ dam

$$3\ km \times \frac{100\ dam}{1\ km} = 300\ dam$$

These principles of conversion are applicable to the conversion of all units in any system of measure. Try a few in the customary system on your own.

MEASUREMENT ACTIVITY I

MEASURING WITH METRIC UNITS AND CONVERSION

Measure the lines below in cm or mm and then perform the indicated conversions.

1. _____

   _____cm = _____mm = _____m

2. _____

   _____mm = _____cm = _____m

3. _____

   _____cm = _____mm = _____m

4. _____

   _____mm = _____cm = _____m

5. _____

   _____cm = _____mm = _____m

Answers:

1. 3.3, 33, 0.033
2. 79, 7.9, 0.079
3. 11.2, 112; 0.112
4. 53, 5.3, 0.053
5. 8.9, 89, 0.089

Student Self-Check

CONVERSION OF UNITS IN THE METRIC SYSTEM

1. 1.8 m = _____ mm
2. 9 m = _____ cm
3. 6.3 m = _____ dm
4. 320 m = _____ hm
5. 80 m = _____ dam
6. 160 m = _____ km
7. 2.8 cm = _____ mm
8. 3.5 km = _____ m
9. 55 km = _____ hm
10. 3.8 km = _____ dam
11. 2.3 cm = _____ mm
12. 180 cm = _____ m
13. 11.2 mm = _____ cm
14. 1.6 m = _____ cm
15. 280 mm = _____ m
16. 5.5 dm = _____ cm
17. 3.8 hm = _____ m
18. 2.0 dam = _____ m
19. 45 mm = _____ cm
20. 3260 mm = _____ m

Answers

1. 1 800
2. 900
3. 62
4. 3.20
5. 8
6. 0.16
7. 28
8. 3 500
9. 550
10. 380
11. 23
12. 1.80
13. 1.12
14. 160
15. 0.280
16. 55
17. 380
18. 20
19. 4.5
20. 3.26

CHECK-OUT ACTIVITIES

The statements below explain the activities you must be able to complete in order to finish this module. As you go through each activity, your instructor will rate your performance using the Instructor's Final Checklist, CONVERSION OF UNITS IN THE METRIC SYSTEM.

✓ Your instructor will provide you with a list of fifteen (15) conversion problems. Solve the problems and return the list to the instructor.

Instructor's Final Checklist

CONVERSION OF UNITS IN THE METRIC SYSTEM

Check the student's performance in the following elements of Conversion of Units in the Metric System.

Place an X in the appropriate box indicating not accomplished, partially accomplished, or fully accomplished. If, because of special circumstances, the item was impossible to complete, place an X in the "Not Applicable" box.

Performance Level: at least 13 items must receive a rating of FULLY ACCOMPLISHED (or Not Applicable). If more than 1 item is rated less than fully accomplished, the student and instructor will discuss this and decide which learning activities must be repeated

	Student Performance			
	Not Applicable	Not Accomplished	Partially Accomplished	Fully Accomplished

In conversion of units in the metric system the student:

1.	Converted millimetres to centimetres . .	( )	( )	( )	( )
2.	Converted millimetres to metres	( )	( )	( )	( )
3.	Converted centimetres to millimetres. . .	( )	( )	( )	( )
4.	Converted centimetres to metres	( )	( )	( )	( )
5.	Converted metres to mm	( )	( )	( )	( )
6.	Converted metres to cm	( )	( )	( )	( )
7.	Converted metres to dm	( )	( )	( )	( )
8.	Converted metres to dam	( )	( )	( )	( )
9.	Converted metres to hm	( )	( )	( )	( )
10.	Converted metres to km	( )	( )	( )	( )
11.	Converted km to hm	( )	( )	( )	( )
12.	Converted km to dam	( )	( )	( )	( )
13.	Converted km to m	( )	( )	( )	( )