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ABSTRACT

The Common Competency Identification project was conducted to find common occupational competencies across 19 technical and industrial occupational areas that provide a foundation for reevaluation of the delivery of trade and industrial (T&I) education. Instructors from the nine occupational areas accounting for the largest number of programs in the T&I area participated in an all-morning brainstorming session with vocational administrators, tech prep coordinators, and staff from the University of Missouri. They heard presentations about issues facing T&I and developed draft lists of competencies for the nine largest T&I areas. In the afternoon, each instructor reviewed the 19 T&I occupational profiles developed during the brainstorming session to identify competencies relevant to his or her own occupational area. Based on the information provided by the instructors, revised competency lists were developed and later reevaluated at a 2-day meeting of the instructors. (Appendixes constituting the largest part of this document contain the following: presentations and results from the initial meeting; draft competencies resulting from the initial analysis of materials generated by the first meeting; revised competency lists resulting from the instructors review of the initial analysis; and a final presentation and questions submitted to the project advisory committee.) (MN)

Common Competency Identification
RFP 94-133-110-5

Project Goals, Methodology, Results and Recommendations

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June 1994

Project Goals

The goal of the Common Competency Identification project (RFP 94-133-110-5) was to identify the common occupational competencies across the 19 technical/industrial occupational areas. Identifying these common skills, according to the project's Request for Funding Proposal, should provide a better understanding of the structure of T & I education programs and allow for re-evaluation of T & I education's delivery system.

Project Methodology

Instructors from nine occupational areas were selected to form the committee that would identify the common competencies. These areas were: air conditioning, heating, and refrigeration; auto collision technology; auto mechanics; building trades: drafting; electrical trades; electronics; machine shop; and welding. The rationale in choosing these nine areas was that they comprised the largest number of programs in the T & I area, and that most of the common competencies across the T & I area would probably come from these nine occupational areas.

An advisory committee consisting of the above instructors, vocational administrators, tech prep coordinators, DESE staff, and IML personnel was also created. The committee's function was to provide guidance for the project and to evaluate the results of the common competency identification carried out by the instructors. (Appendix A contains a listing of committee members on page A-1.)

The entire advisory committee met for half a day at the beginning of the project to discuss the project goals. Pat Muenks, Industrial Education supervisor, DESE: outlined the issues facing vocational education and the T & I area (including enrollment and placement figures) (Appendix A, pages A-3 through A-5); discussed the stages the project would need to progress through for completion (Appendix A, page A-6); and presented possible implications for the project's outcomes (Appendix A, page A-7). The committee then participated in a brainstorming session to identify additional related issues that might have an affect on the project (Appendix A, pages A-9 and A-10). Over lunch, instructors, administrators and tech prep coordinators discussed their primary concerns involving T & I programs (Appendix A, page A-11).

In the afternoon, the instructors met to determine which competencies their areas had in common with the other T & I areas. Each instructor was given a set of the 19 T & I occupational area profiles. These profiles were: air conditioning, heating, and refrigeration; auto collision technology; auto mechanics; building maintenance; building trades; cabinet making; commercial art; cosmetology; diesel mechanic; drafting; electronics; electrical trades; food service worker; machine shop; masonry; offset lithography; plumbing; small engines; and welding. The instructors worked

through the profiles one at a time, marking the competencies on each profile that they also teach in their own areas.

Next, the results of the instructors' work were compiled into tables, one table for each competency profile. DESE and IML staff then met to analyze the results. First, the 19 occupational areas were divided into cluster areas, based on the Missouri Trade and Technical Association's cluster areas (Appendix B, page B-2). For the purposes of this project, the graphics and manufacturing clusters were combined, and an "other" cluster was created for four occupational areas (commercial art, cosmetology, food service and offset lithography) that did not seem to have as much in common as the other 15 occupational areas did. The other clusters from the MTTA design remained essentially the same. Thus, there are five clusters for this project: construction, manufacturing (includes graphics), service, transportation and "other" (see Appendix B, page B-3).

Based on the information provided by the instructors, the competencies listed on the 19 T & I profiles were then divided into three groupings based on the degree to which they were common across the 19 occupational areas (Appendix B, pages B-5). The first group contains those competencies that are common to all (or most) of the T & I occupational areas. It represents those skills that are most basic to T & I programs and that are viewed as common in all occupational areas. The content of this group includes: blueprints/plans/diagrams; careers/orientation; documentation; electricity; measurement; safety; and tools. (Lists of specific competencies for these seven areas are in Appendix B, pages B-7 through B-24). The next group contains those competencies that are common in at least two occupational areas, but that are excluded from the first group because they do not extend across a sufficient number of occupational areas. Fourteen occupational areas share tasks in common with a minimum of one other occupational area. These shared competencies cross over cluster boundaries. This grouping could be further studied to determine how skills might be organized by categories along occupational clusters. (Lists of the competencies for this group are in Appendix B, pages B-26 through B-44). The third group contains those competencies that are related only within the clusters. (Lists of the competencies for this group are in Appendix B, pages B-46 through B-53).

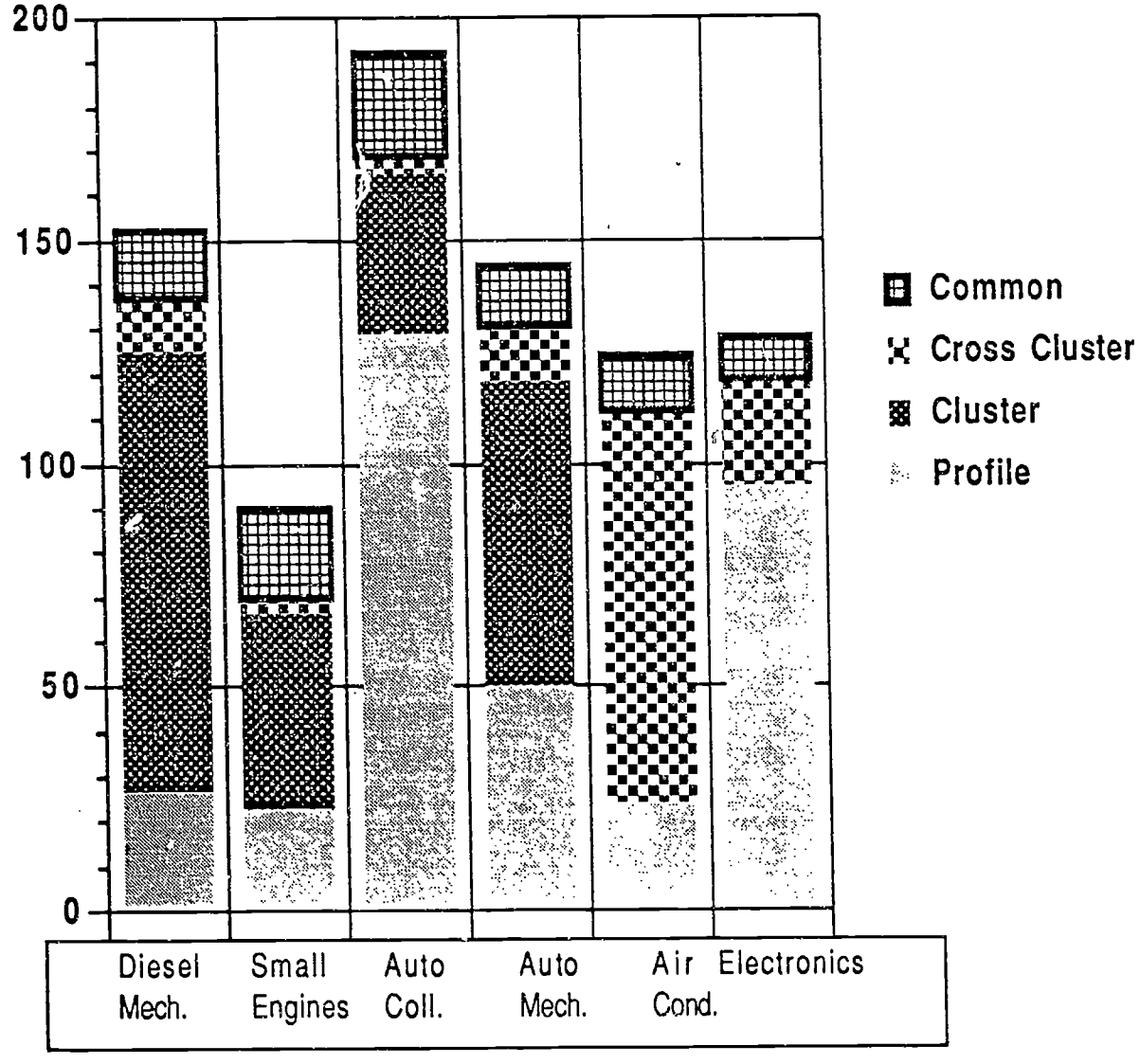
In summary of the committee's initial analysis, 1117 (roughly 45 percent) of the 2,459 competencies contained on the 19 T & I profiles were originally identified as having some commonality across occupational areas, based on the written competency statements. Additional analysis of each competency was conducted to determine further relationships.

The additional analysis took place at a two-day meeting of the instructors from the advisory committee, with the result being three revised groups of competencies (Appendix C, page C-2). The lists were examined competency by competency, with

the instructors revising and moving competencies from one list to another as necessary. Out of the first group, which included those competencies that extended across all T & I areas, the instructors developed basic competency statements that combined related statements from the original profiles (Appendix C, pages C-4 through C-7). The instructors then examined those competencies in group two that are common to at least two occupational areas to determine the degree to which clusters share common skills or tasks. There are only two clusters, transportation and service, that appear to cross over into one another. For example, these two clusters share competencies related to electrical systems and air conditioning systems. (See Appendix C, pages C-9 through C-12, for a list of the competencies.) The third group, which contains those competencies that are common to only occupational areas within the same cluster, was also revised (Appendix C, pages C-14 through C-22). Thus, the final results from this meeting were: one list of common competencies, created by combining similar competencies from all of the competency profiles; one list of competencies that cut across the transportation and service clusters; and three lists, one for each cluster that contains common competencies within that cluster.

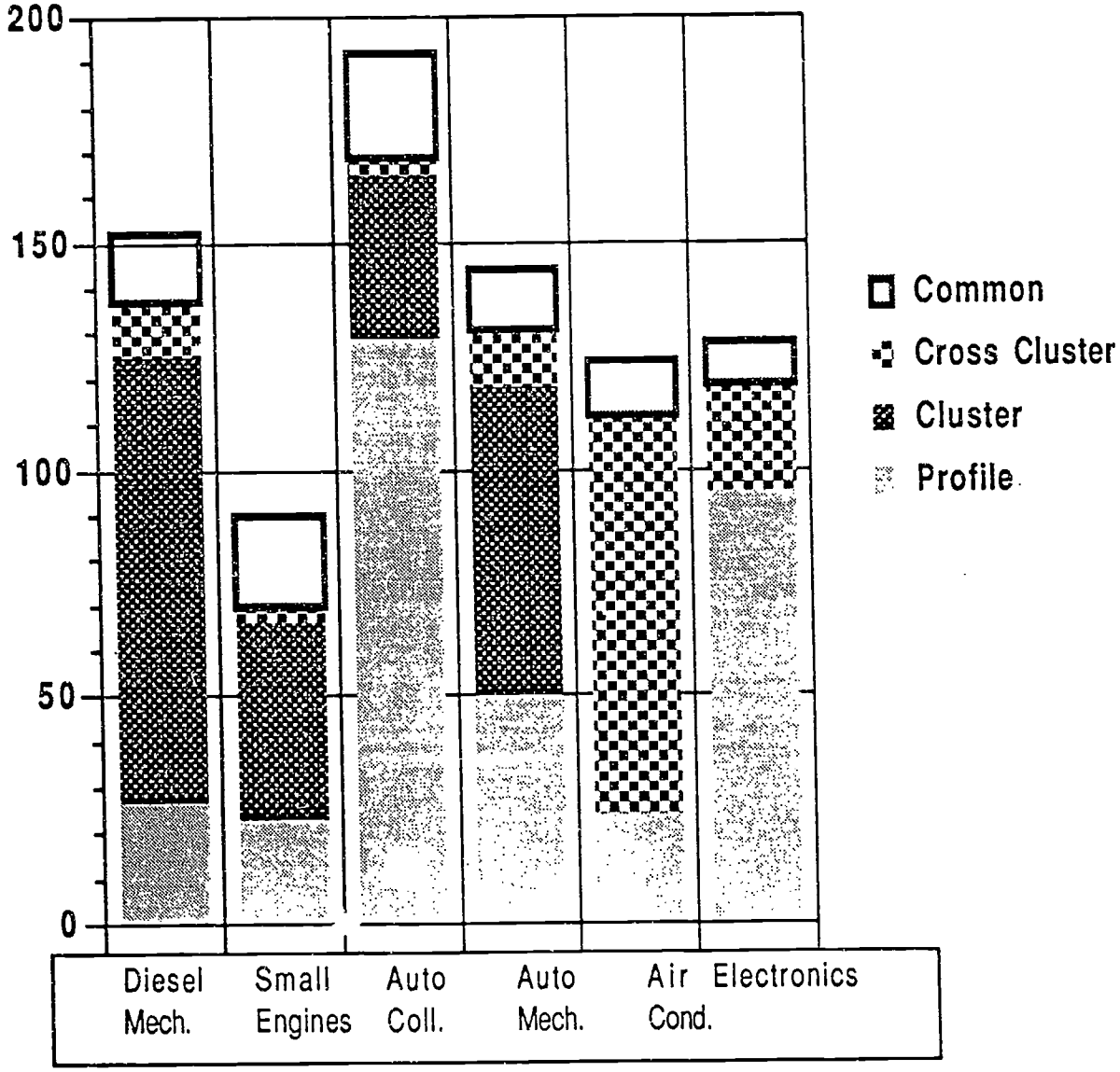
These results were mailed to the advisory committee, and a final meeting for the entire advisory committee was held to determine the implications of this information. At the final meeting, graphs that are the final result of analysis to determine the degree to which there are some common statements were presented. The graphs that pertain to the transportation and service clusters are pictured within this report to illustrate the effect that the identified common competencies have on existing occupational area profiles.

Transportation and Service Clusters: Common Cluster Level Competencies



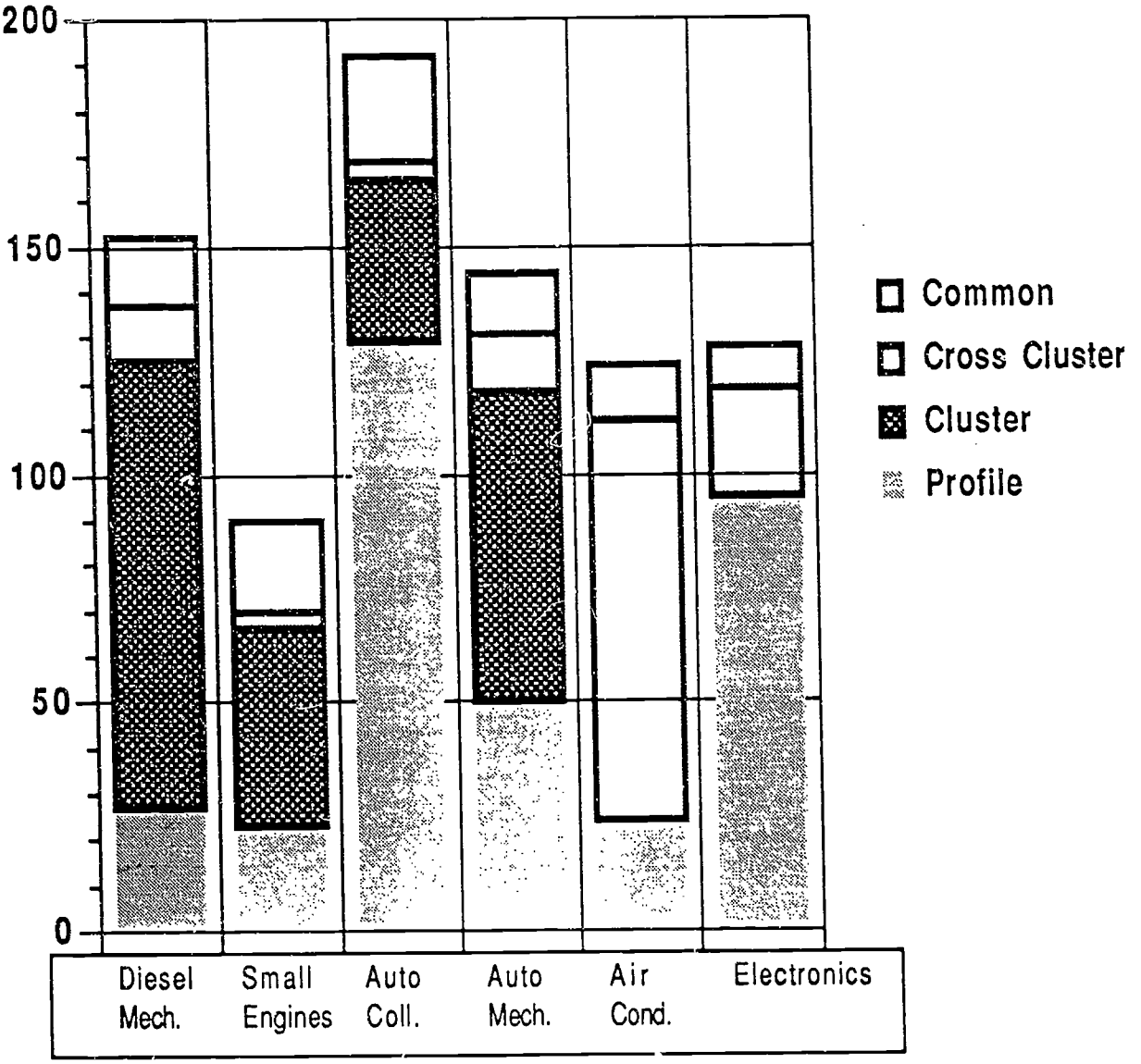
This graph shows the competencies that are common to all T & I occupational areas in the grid pattern at the top of each column. There are 15 common competencies in diesel mechanics, 20 in small engines, 23 in auto collision, 13 in auto mechanics, 12 in air conditioning, and 9 in electronics. Thus, there are 92 common competencies total in these six occupational areas.

Transportation and Service Clusters: Cross Cluster Level Competencies



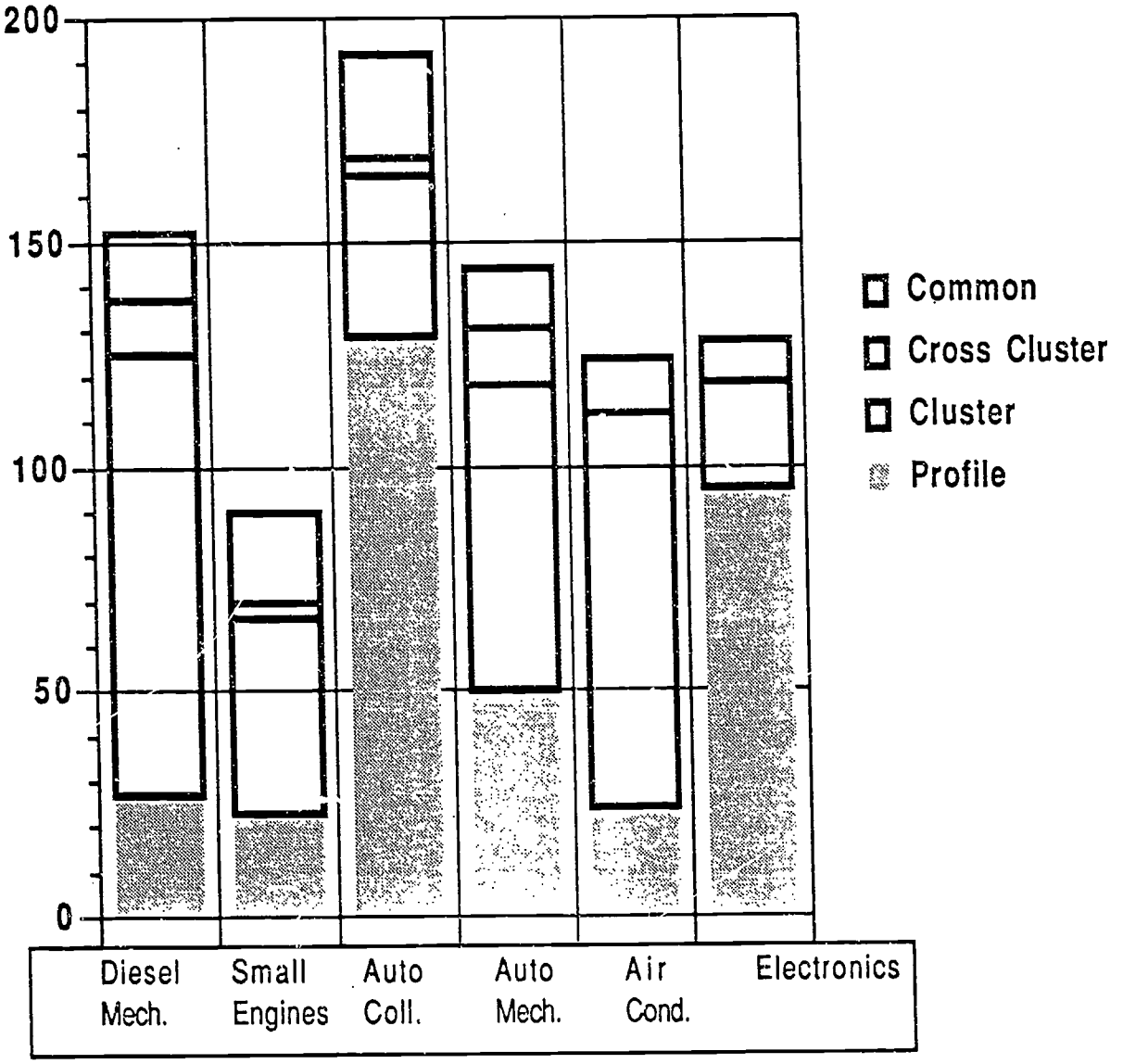
This graph shows the competencies that are shared by occupational areas within the transportation and service clusters in the checked pattern. (Note that those competencies that are common across all occupational areas, shown in the last graph, are still shown in outline at the top of the columns.) There are 12 cross-cluster common competencies in diesel mechanics, 4 in small engines, 4 in auto collision, 13 in auto mechanics, 88 in air conditioning, and 24 in electronics. Thus, there are a total of 145 competencies that are common to occupational areas within the transportation and service clusters.

Transportation and Service Clusters: Cluster Level Competencies



This graph shows the competencies that are common to occupational areas within only the transportation cluster in the dotted pattern. (Again, outlines represent the competencies from the last two graphs at the tops of the columns.) There are 98 common cluster competencies in diesel mechanics, 43 in small engines, 36 in auto collision, and 68 in auto mechanics. Thus, the occupational areas in the transportation cluster have a total of 245 competencies in common. The occupational areas in the service cluster (air conditioning and electronics) have no further common competencies beyond those competencies shown in the last two graphs.

Transportation and Service Clusters: Profile Specific Competencies



Finally, this graph represents those competencies that are so occupationally specific that they need to be taught only in a specific occupational area (shown as a solid bar at the bottom of the columns with competencies from the last three graphs in outline form at the top of the columns). There are 27 occupationally specific competencies in diesel mechanics, 23 in small engines, 129 in auto collision, 50 in auto mechanics, 24 in air conditioning, and 95 in electronics. Thus, there are 348 total competencies in these six occupational areas that would need to be taught only within individual occupational areas.

As these graphs show, within the transportation and service clusters, we identified 482 competencies (roughly 58 percent of the competencies on the six profiles involved) that had some degree of commonality. If these common competencies were organized and presented in some way to students prior to their enrollment in courses in these six areas, instructors in those courses could devote more time to the 42 percent of the competencies that are not common across occupational areas.

The presentation given to the committee at the final meeting, containing these graphs and similar graphs for the other cluster areas, is presented in Appendix D (pages D-1 through D-9). After the committee saw the graphs, they discussed questions related to the project's outcomes (Appendix D, page D-10).

Project Results

Project results include: the list of issues facing T & I education developed by the committee (Appendix A, pages A-9 and A-10); the list of committee concerns (Appendix A, page A-11); and the lists of competencies created over the course of the project (Appendix C, pages C-4 through C-23). In addition, T & I directors and supervisors in the other 49 states were surveyed to determine whether these other states were engaged in projects similar to this one. Some of them requested and were sent this report. Results from New Jersey can be found in the Missouri Vocational Resource Center.

The committee structure and project timeliness did not permit detailed occupational or task analysis required to identify specific duty bands and competencies within the common and more specific occupational cluster groups. The committee recommends that a curriculum committee be formed to further develop the common competencies, and that separate committees be formed along occupational clusters to further determine cluster-related competencies.

Project Recommendations

As a result of the project, the committee recommends the consideration of the following in future program development:

With regard to future curriculum development focusing on common skills within T & I:

1) Provide further definition of the competencies (i.e., break the competencies into tasks). Include both technical and nontechnical instructors in the definition process.
2) Analyze what existing curriculum could be used.
3) Take a practical, modular approach to developing curriculum for the common competencies.
4) Take a multi-level approach that will reach students at different levels.

5) Be non-specific about careers and occupations. Be less concerned about developing curriculum that is solely constructed to support a particular occupational area. Reinforce some of the attitudes and behavior that should be important to all T & I areas.
6) Use applied content.
7) Work across the curriculum. Design curriculum that can be used by all occupational areas.
8) Maximize flexibility. Create curriculum that can be used with other curriculum or stand alone.
9) Analyze transferability of skills. Express the skills learned in such a way that they support multiple pathways, so students can change areas without penalty.

With regard to instruction on the common competencies:

1) Study the time component.
2) Examine the degree to which facilities, equipment, etc. can be shared.
3) Focus on these duty bands first:
   - Orientation (make sure students know what they are getting into, look at career paths)
   - Health and Safety
   - Trade-related Information (including computer-based resources)/Terminology
   - Print Reading and Symbolism
   - Material Sciences

   Move on to these more specific duty bands after this first group is mastered:
   - Tools
   - Fasteners
   - Basic Electricity/Electronics
   - Precision Measurement
4) Utilize academic teachers.

With regard to pre-requisites for enrollment in T & I programs:

1) Identify what kinds of skills students should have coming into programs.
2) Identify what is viewed as the essential or critical skill level for admission to programs (vitally important).
3) Develop a recommended sequence of courses that can be used in counseling students about T & I courses.
4) Insure that recommended courses focus on content, not on course titles, and that they focus on the common competencies.
5) Expose students who wish to enroll in a T & I area to the common competencies modules prior to their enrollment in occupational area courses.
6) Promote career pathways.

Items brought up in discussion that merit further debate include:

1) Explore opportunities to work with other program areas (i.e., agriculture, business, home economics) to develop career pathways, building courses of study that reach across program areas. Content should become more closely defined once the student gets to the junior or senior year in high school and prepares for a specific career.

2) Establish measurable, competency-based entrance tests, based on those skills that the common competency lists indicate a student should have prior to enrolling in T & I classes. These tests should be used to determine individual students' readiness to learn in the T & I classes; they should be diagnostic, not eliminating. The tests would provide instructors with a chance to determine remediation, or to set up developmental courses for students who have not followed the recommended course of study. Such tests would also be helpful in modifying curriculum for special populations.

3) Work toward acceptance of practical arts courses that meet graduation requirements.

4) Identify ways to help teachers who are implementing applied academics understand how their subject matter is used in technical occupations.

5) Integrate talents and resources within T & I education. Consider team teaching, meetings of T & I instructors, joint interdisciplinary projects, and tools and lab sharing.

6) Examine time spent by T & I instructors reinforcing math, science, communication, etc. skills.

APPENDIX A:

Presentations and Results from Initial Meeting

T & I Common Competencies Advisory Committee

Instructors

Francis Barnes
Auto Collision Repair
Lake AVTS

J.D. Boyd
Auto Mechanics
Crowder College

Walter Eudaley
Air Conditioning, Heating, Refrigeration
Poplar Bluff Career Center

Ken Garthe
Electrical Trades
West County AVTS

Jeff Huff
Drafting
South Central AVTS

Bob Jewett
Building Trades
Columbia Career Center

Pete Letterman
Welding
Graff AVTS

Mark Murphy
Electronics
Mexico AVTS

Max Vath
Machine Shop
Rolla Technical Institute

Administrators/Tech Prep Coordinators

Marc Doss
Tech Prep Coordinator
Graff AVTS

Larry Gorsh
Tech Prep Coordinator
Rolla Technical Institute

Wanda McCampbell
Assistant Director
Columbia Career Center

Rick Mihalevich
Tech Prep Coordinator
Linn Technical Institute

Jim Orr
Director
Graff AVTS

Don Walker
Director
Mexico AVTS

Instructional Materials Laboratory/ Department of Elementary and Secondary Education Staff

Kristin Desborough
Project coordinator
IML - UMC

Phyllis Miller
Assistant Director
IML-UMC

Pat Muenks
Supervisor
Industrial Education, DESE

Pat Muenks Presentation - First meeting

T & I Common Competencies

Issues Facing Voc Ed and T & I Education

Tech Prep

School to Work Transition

Special Populations

Advancing Technologies

Graduation Standards

Collegiate Entrance Requirements

Facility/Instructional Aides/Curriculum

Recruitment Placement

TIME! TIME! TIME!

Academic and Occupational Credentials

Trade and Industrial Secondary Enrollments

Course Area	1992	1991	1990	1989	1988
Communications	19	21	17	11	14
Cosmetology/Personal Services	114	213	194	259	284
Law Enforcement/Fire	23	28	28	20	16
Masonry	72	59	63	69	57
Carpentry	1806	1784	1784	1978	1931
Electrical & Power Transmission	119	201	111	119	143
Building Maintenance	256	302	295	259	302
Plumbing	13	25	24	36	24
Construction Trades Other	1201	1167	1665	1496	1564
Electrical/Electronics	924	898	908	1055	1190
Heating and Air Conditioning	491	430	462	500	505
Industrial Equip Maint	10	16	32	39	36
Vehicle Mechanics and Repair	4075	4005	4081	4684	4733
Drafting	532	582	537	573	551
Graphics	694	895	878	962	929
Precision Metal Work	1419	1400	1399	1479	1456
Cabinet Making	76	77	72	76	80
Marine Mechanics	40	56	43	44	42
Crafts	19	10	10	19	8
Commercial Art	155	0	0	0	0
TOTALS	12058	12169	12603	13678	13865
Total Vocational Secondary Enrollment	55115	52940	52936	53701	50774
Fraction of Total	0.2187	0.2298	0.2380	0.2547	0.2730
T&I Special Population Enrollment	5862	5047	5835	5640	5340
Total Special Population Enrollment	18985	16170	17698	16351	14231
Fraction of Total	0.3087	0.3121	0.3296	0.3449	0.3752

Trade and Industrial Placements

	1992			1991			1990			1989			1988		
	Exit	*Rel*	*Fraction*	*Exit*	*Rel*	*Fraction*	*Exit*	*Rel*	*Fraction*	*Exit*	*Rel*	*Fraction*	*Exit*	*Rel*	*Fraction*
T&I Secondary Placements	6956	3251	0.4673663	6734	3180	0.4722304	7286	3516	0.4825693	7398	3551	0.4801243	7015	3603	0.5136136
Total Secondary Placements	24363	13259	0.5442269	24058	13151	0.5466372	26551	15256	0.5745922	27072	15761	0.5821802	25256	14778	0.5851282

Trade and Industrial Common Competencies

An Overview

Stage I Orientation and Overview
- Establish Committee Direction
- Issue Committee Work Assignments
  - -Competency Profile Review
  - -Input on Design for Integration
  - -Proponents

Stage II IML and DESE Staff Study
- -Analyze Information
- -Draw Assumptions
- -Plot Strategies

Stage III Instructor Committee Call Back
- -Call Back By Duty or Competency Area
- -Define Degree & Level of Commonality
- -Produce Matrix

Stage IV Call Back of Original Committee
- -Review Matrix
- -Discuss Integration and Implications
- -Plan of Action

T & I Common Competencies

Implications of Proposed Outcomes

Teach Across Curriculum

Occupational Specialization

Career Education

Technical Course of Study

Prescribe Preparatory Content

Applied Situations for Academic Integration

Refinement of Activity Packets for Self-Directed Learning

Committee Results - First meeting

Related Issues
(Identified by the advisory committee at the first meeting)

Industrial Arts -

Industrial Arts is changing to Industrial Technology, where students are learning less of hands-on skills and more of technical skills that have less direct application within T & I programs.

Career Focus -

Students at an appropriate age need to be exposed to the opportunities that technical careers can provide and to various options available to students in vocational education.

Special Populations -

Instructors need to know how to manage and present instruction and modify curriculum so that special populations learn the skills necessary to succeed in a technical occupation.

College Prep in Technology Fields -

Technology programs need to be available to students who want to pursue a 4-year college education. For example, a future engineering student who wants to take design drafting or CAD should know that this option is open to him/her.

Perceptions -

Some people do not recognize the opportunities that exist for tradespeople, or the benefits of vocational education.

Summer Internship -

Students need year-round training, such as involvement in summer internships or youth apprenticeship programs.

Product -

The training objectives for T & I programs should be established. For instance, should students be able to enter the work force as laborers, as technicians, or at some other level?

Exploration -

Sequential development of courses and career pathways should allow students to explore various technical occupations.

Image -

Public perception of T & I education needs to be improved, not only outside of the school, but also within school buildings among other teachers, administrators, etc.

Counselors -

Counselors need to understand technical occupations and the opportunities that exist for students in these occupations.

Academic Skills -

Students should have attained the basic level academic skills that are required to succeed in T & I programs prior to their enrollment in the courses.

Getting to Junior High Grades -

Career pathways and sequences of courses need to be further developed so that they permit students at the junior high level to explore technical occupation opportunities and let them know what kinds of courses are required to help them succeed in T & I, technical occupations, industry, etc.

Student Motives -

Students should have realistic goals and be enrolled in T & I courses because they have a true interest in a technical career.

Affordable Technology in the Classroom -

T & I courses should have access to the latest technologies being employed in the industries for which they prepare students.

Integrated Academics Applied -

The opportunity to reinforce or apply academics within vocational courses should be seized, and opportunities to work with academic teachers should be explored.

Accommodate Post-Secondary Students -

Articulation agreements should be in place. Adult students should be encouraged, and developmental courses that might be needed by adult students should be offered.

First- and Second-Year Students -

Instruction must be organized to accommodate both first- and second-year students who are enrolled in the same class period.

Employer Recognition of Skills Students Have -

Students' credentials need to be exhibited in such a way that employers recognize and value the training these students have received.

Student Work Attitudes -

T & I programs should help students develop work maturity.

Issues Involving T & I Education
(Identified by the advisory committee at the first meeting)

Administrator/Tech Prep Coordinators

Finances
Selling programs to parents
Making sure students are ready to learn
Designing one-year, two-year exit points
Developing career paths (transferability of skills)

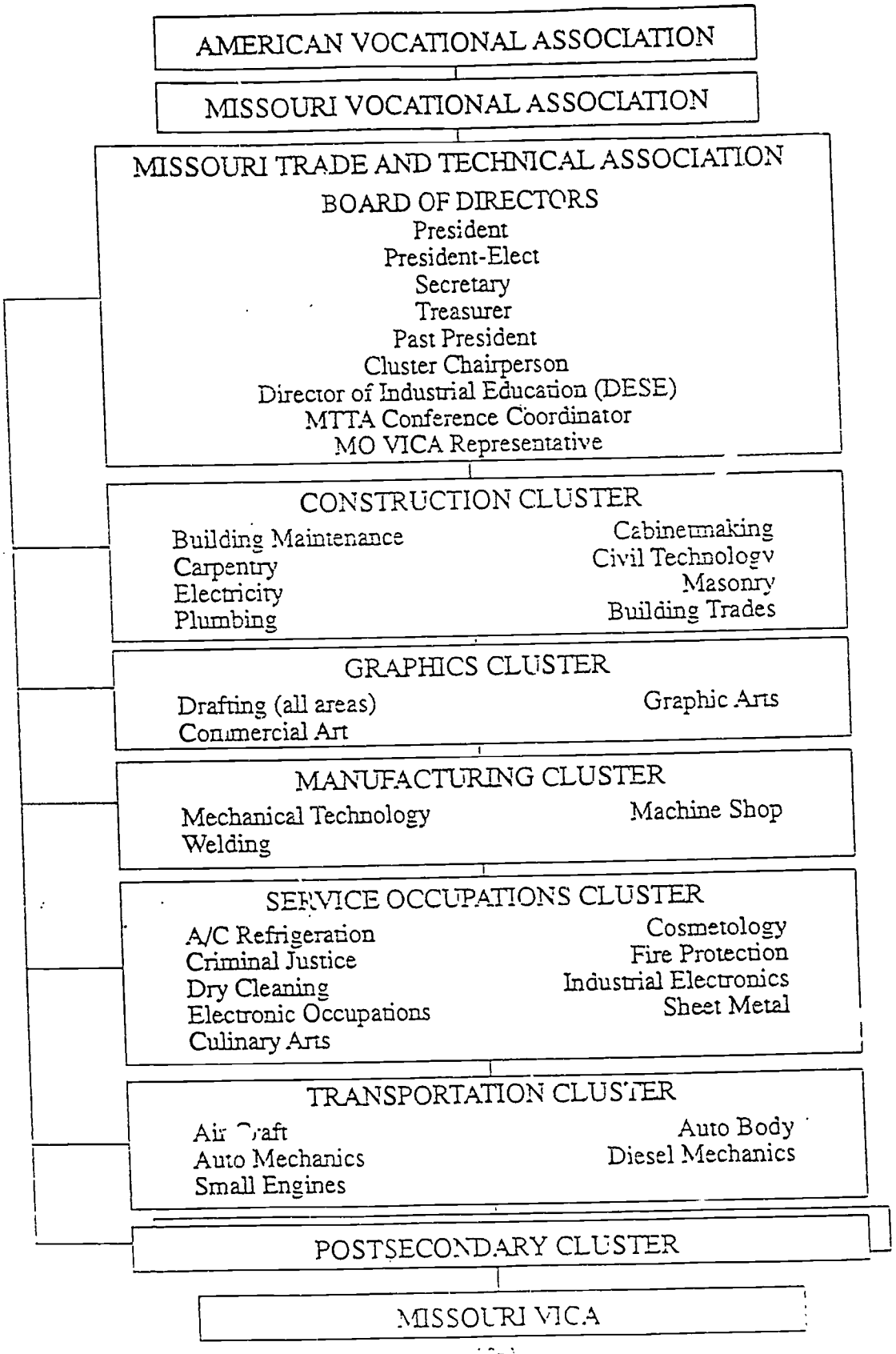
Instructors

Remediation of basic academic skills
Raising program quality
Integrating academics/shared teaching
Teaming with counselors, academic instructors
Students not prepared to learn academically (reading, math)
Defining specific prerequisite skills
Testing to insure prerequisite skills
Meeting standards for industry certification
Working with academic teachers to educate them about T & I
Defining course of study that extends to home schools
Eliminating scheduling problems
Establishing a work-bound focus
Pacing instruction (not necessarily passing students on to graduate with class in 12 years)
Building enabling competencies at lower grades (technical skills)
Shortening courses (focus solely on essential competencies)
Providing opportunities for remedial instruction
Setting specific class entrance standards (measurable)
Counselor-directed scheduling

APPENDIX B:

Results from Initial Analysis of Material Generated by First Meeting

Cluster Divisions


AMERICAN VOCATIONAL ASSOCIATION
MISSOURI VOCATIONAL ASSOCIATION
MISSOURI TRADE AND TECHNICAL ASSOCIATION
BOARD OF DIRECTORS
President
President-Elect
Secretary
Treasurer
Past President
Cluster Chairperson
Director of Industrial Education (DESE)
MTTA Conference Coordinator
MO VICA Representative
CONSTRUCTION CLUSTER
Building Maintenance
Carpentry
Electricity
Plumbing
Cabinetmaking
Civil Technology
Masonry
Building Trades
GRAPHICS CLUSTER
Drafting (all areas)
Commercial Art
Graphic Arts
MANUFACTURING CLUSTER
Mechanical Technology
Welding
Machine Shop
SERVICE OCCUPATIONS CLUSTER
A/C Refrigeration
Criminal Justice
Dry Cleaning
Electronic Occupations
Culinary Arts
Cosmetology
Fire Protection
Industrial Electronics
Sheet Metal
TRANSPORTATION CLUSTER
Air Craft
Auto Mechanics
Small Engines
Auto Body
Diesel Mechanics
POSTSECONDARY CLUSTER
MISSOURI VICA

Common Competencies Project
Program Areas Divided Into Clusters

Construction Cluster:
- Building Maintenance
- Building Trades
- Cabinetmaking
- Electrical Trades
- Masonry
- Plumbing

Manufacturing Cluster:
- Drafting
- Machine Shop
- Welding

Service Cluster
- Air Conditioning, Heating, Refrigeration
- Electronics

Transportation Cluster
- Auto Collision Repair
- Auto Mechanics
- Diesel Mechanics
- Small Engines

"Other" Cluster
- Commercial Art
- Cosmetology
- Food Service
- Offset Lithography

Competencies By Group

Groups of Competencies:
First Analysis

Group One:

Competencies common to all 19 T & I Areas

Seven Divisions:

Blueprints/plans/diagrams
Careers/orientation
Documentation
Electricity
Measurement
Safety
Tools

Group Two:

Competencies common to at least two program areas

14 Divisions (corresponding to 14 program areas where common competencies were found; other 5 had no common competencies identified beyond those in group one)

Air conditioning, heating, refrigeration
Auto collision technology
Auto mechanic
Building maintenance
Building trades
Cabinet making
Diesel mechanic
Drafting
Electronics
Electrical trades
Machine shop
Plumbing
Small engines
Welding

Group Three:

Competencies common only to one cluster area

Three Divisions (corresponding to three clusters that had cluster-related skills):

Construction
Manufacturing
Transportation

Group One Competency Lists, Draft One

Blueprints/Plans/Diagrams, etc.

Blueprints

ET	E2.	Read and measure from blueprints and specifications
P	B5.	Read and interpret a blueprint
MA	F3.	Read and interpret an architectural blueprint
BM	A8.	Read blueprints
CM	E6.	Read a blueprint
MS	D2.	Interpret blueprint
W	B1.	Read and interpret basic prints
MS	D8.	Plan sequence of part layout based on blueprint information
ET	E3.	Locate and identify residential construction components
ET	E4.	Locate and identify commercial construction components
BT	B2.	Interpret blueprint symbols

Plans/Specifications

MA	F4.	Read and interpret a set of specifications
MA	F5.	Read and interpret an electrical plan
MA	F6.	Read and interpret a structural plan
MA	F7.	Read and interpret a mechanical plan
MA	F8.	Read and interpret a site plan
MA	F9.	Read and interpret a finish schedule

Diagrams/Schematics

AC	D4.	Interpret electrical diagrams
AC	F15.	Interpret wiring diagram - refrigerator
AC	H21.	Interpret wiring diagrams - heating systems
ELEC	B17.	Interpret symbols and schematic diagrams
AC	Other Schematics	

Drawings

BT	B1.	Read and interpret working drawings
ET	D7.	Demonstrate techniques of sketching and diagramming
P	B6.	Sketch plumbing layout
MA	E6.	Draw lines and objects to scale
CM	E7.	Prepare a layout and cut sheet
MS	D3.	Make a sketch from a finished workpiece
W	B3.	Construct an exercise(s) using basic print and sketch
W	B4.	Make sketches - pictorial and orthographic
DR	C1.	Layout drawing
DR	C2.	Construct borders and information blocks
DR	C3.	Construct freehand sketches
DR	C4.	Read and transfer measurements
DR	C5.	Letter freehand (letters and numerals)

DR	D1.	Bisect lines, angles and arcs
DR	L2.	Produce simple electrical/electronic drawings and schematics
DR	O1.	Produce a simple detail and assembly drawing applying standard fits and tolerances
DR	Q2.	Produce representative sheet metal drawings

Symbols

ET	E1.	Identify trade symbols used in electrical drawings
ET	Other	Identify electrical symbols and abbreviations
MS	D1.	Interpret meaning of common drafting symbols
W	B2.	Interpret welding symbols, abbreviations and joint designs

Scales

MA	F1.	Read and interpret the architect's scale
MA	F2.	Identify the uses of the engineer's scale

Cost/Materials estimates

ET	E5.	Estimate and calculate construction costs
MA	F10.	Estimate the amount of material for a job
CM	E8.	Estimate materials and costs from a blueprint and/or cut sheet

Tolerances/Dimensions

MS	D4.	Calculate tolerances and allowances
MS	D5.	Calculate missing dimensions
MS	D6.	Use geometric dimensioning and tolerancing
W	B5.	Interpret structural shapes, sizes and weights

Others

BT	B3.	Identify the steps of the building process
DR	O2.	Develop a parts list

Careers/Orientation

Identifying Jobs/Employment Opportunities

ET	D5.	Identify job classifications and prerequisites for employment
BM	A1.	Identify building maintenance occupations and related fields
DR	A4.	Identify drafting occupations and related fields
AB	A1.	Identify opportunities in the auto body field
P	B1.	Identify employment opportunities in the plumbing trade
MA	A1.	Identify employment opportunities in the masonry trade
CM	A15.	Identify job opportunities in the area of cabinetmaking
AM	C2.	Identify auto mechanics career opportunities and the duties of a technician
FS	A1.	Identify career opportunities
FS	A4.	Identify career ladder

Finding/Keeping a Job

CA	N1.	Identify methods of finding a job
CA	N2.	Identify methods of finding a school
CA	O3.	Prepare for job interview
CA	O4.	Prepare resume
FS	A7.	Practice job seeking skills
CA	N3.	Identify methods of keeping a job

Documentation

Manuals/Catalogs/Other Books

AB	E2.	Use collision manuals
AM	B3.	Obtain appropriate repair information from shop manuals
DM	A5.	Use reference books, parts books and charts
W	A7.	Obtain and use reference books and charts
SE	A4.	Demonstrate ability to use service manuals, part catalogs and price lists
P	B7.	Read and interpret catalog information
P	B8.	Read and interpret specifications
MS	D7.	Use Machinery's Handbook to plan work

Reports/Orders/Records

AC	K1.	Fill out service report
AC	Other	Work Orders
AM	B1.	Communicate with customers and write repair orders
AC	Other	Customer Relations
DR	A5.	Apply recordkeeping procedures
COS	f5.	Perform procedures for booking appointments

Estimates

AM	B2.	Estimate time and cost of job and order parts
OL	A2.	Estimate job costs (space and utilities, labor, and supplies)
OL	A3.	Compute customer's cost (planning, scheduling)
P	B9.	Prepare a bill of materials

Understanding Laws/Standards

AC	Other	OSHA & EPA Laws
BT	A13.	Identify purposes of building codes, zoning laws, and building permits
P	B10.	Read and interpret applicable codes
DR	A3.	Identify American National Standards Institute, Inc. (ANSII) and International Standards Organization (ISO) standards (terminology)

Electricity

Electricity Concepts/Theories/Basics

DM	K2.	Demonstrate knowledge of basic electricity
AC	D2.	Describe the major concepts of electrical theory
ET	Other	Demonstrate knowledge of the basic fundamentals of electricity
BM	D1.	Identify electrical safety practices
DR	L1.	Identify electrical/electronic symbols

Related Concepts/Theories/Basics

DM	N2.	Demonstrate an understanding of basic AC theory and operation
AC	E2.	Describe concept of control theory and application
AC	E18.	Describe concept of programmable thermostats
ELEC	B1.	Describe atomic structure and its relationship to electricity
ELEC	B2.	Describe the basic physics of semiconductor materials
ELEC	B3.	Describe the relationship between electrical and magnetic properties
ELEC	B4.	Describe the electrical and magnetic properties of a magnet
ELEC	B5.	Describe the photoelectric effect
ELEC	B6.	Describe the thermocouple effect
ELEC	B7.	Describe the electrical effect of friction
ELEC	B8.	Describe the concept of resistance, voltage and current and how they relate to each other
ELEC	B9.	Describe the concept of capacitance, voltage and current and how they relate to each other
ELEC	B10.	Describe the concept of inductance, voltage and current and how they relate to each other
ELEC	C1.	Describe types of transformers
ELEC	C2.	Determine transformer requirements
ELEC	C3.	Determine rectifier (diode) specifications for specific installations
ELEC	D2.	Describe the operation of junction diodes
ELEC	D3.	Describe the operation of bipolar transistors
ET	B1.	Identify the scientific theory of electricity as it relates to basic chemical, static and magnetic forms
W	A14.	Identify basic power sources
W	E2.	Describe theory of shielded metal arc welding
W	E3.	Identify and select power source and set current for weld procedure
COS	e3.	Give the definition for atoms
COS	e4.	Give the definition for molecules
COS	e7.	Identify the physical properties of matter

Meters/Other Tools

SE	F1.	Read and interpret electrical meters
ELEC	H2.	Describe the operation and demonstrate the use of multimeters; i.e., VOM, EVM or DVM

ET	H1.	Use a volt ohmmeter
AM	D4.	Measure volts with a voltmeter or oscilloscope.
ET	H2.	Use a clamp-on ammeter
AM	D5.	Measure current with an ammeter.
ET	H3.	Use a receptacle polarity testing device
ELEC	H1.	Describe the operation and demonstrate the use of an oscilloscope
AC	Other	Servomechanisms
AC	Other	Rheostats
AC	Other	Magnetic-Electromagnetic Devices
AC	Other	Calibration Meters
AC	Other	Motor Controllers (Servos)
AC	Other	Condenser-Capacitor
AC	Other	Basic Electronic

Schematics/Tables

SE	F2.	Read electrical schematics
ET	D3.	Interpret conduit fill table using the NEC as a reference
ET	D4.	Identify and comply with local compliance codes

Calculations

ELEC	B15.	Calculate series and parallel; resistive, capacitive and inductive networks
ELEC	B18.	Calculate RC time constant circuits
ELEC	B11.	Solve AC network problems utilizing appropriate theorems and laws
ET	B2.	Solve problems using Ohm's law
ET	B3.	Solve problems using Watt's law
ET	B4.	Solve problems using Kirchhoff's law

Systems

ET	F11.	Identify parts of a breaker load center
ET	G6.	Diagram and install a single-pole switching system
ET	G7.	Diagram and install a three-way switching system
ET	G8.	Diagram and install a three-way and four-way switching system
ET	G9.	Diagram and install a GFCI (ground-fault circuit interrupter) system
ET	G13.	Design and install a residential lighting system
ET	G17.	Diagram and install a low-voltage system

Circuits

ET	Other	Determine the current-carrying capacity of circuits
ET	Other	Size and select circuit conductors, components, devices and outlet boxes
ET	Other	Divide wiring into circuits according to service and load
ET	Other	Perform appropriate tests to ensure electrical continuity, compatibility and safety

AM	D1.	Check continuity in electrical circuits using test light and voltmeter, oscilloscope, and wiring diagram.
AM	D2.	Check for shorts, opens, and grounds
AM	D3.	Measure resistance in electrical circuits using an ohmmeter
BM	D4.	Wire circuits--115 (15 and 20 amp.) 240--to code
BM	D5.	Wire low-voltage circuit
AC	Other	Control Circuits

Wiring

ET	Other	Identify wiring techniques
ET	Other	Identify wiring components and devices
AC	G18.	Interpret wiring diagram
AC	H13.	Interpret wiring diagram - cooling system
AC	H15.	Interpret wiring diagram - heat pump
AB	S3.	Splice a wire
AC	D7.	Install circuit wiring to local code
ET	D1.	Identify residential wiring practices using the National Electrical Code (NEC) as a reference
ET	D2.	Identify commercial wiring practices using the NEC as a reference

Test/Diagnose/Troubleshoot

AC	D3.	Identify and use test equipment
BM	D6.	Use electrical test equipment
DM	K3.	Perform common diagnostic tests
AC	D6.	Test capacitors
ELEC	B13.	Identify and test capacitors
AC	D9.	Test electrical components
ELEC	B12.	Identify and test resistors
ELEC	B14.	Identify and test inductors
ELEC	D13.	Test diodes
ELEC	D14.	Test transistors
AC	Other	Troubleshooting or Problem Solving Skills
AC	D5.	Trouble shoot complete electrical circuit
BM	D2.	Troubleshoot and replace outlets, switches, fuses, breakers and fixtures
AB	S4.	Diagnose and repair electrical accessories
P	G27.	Thaw frozen pipes

Repair/Replace

SE	F4.	Test, repair, and/or replace safety interlock
SE	F5.	Test, repair, and/or replace charging system components
SE	F6.	Test and replace sending units
SE	L1.	Test and repair starter solenoid
DM	K6.	Repair and/or replace starter
SE	L3.	Repair or replace related electrical components including safety devices

AC	E3.	Install, replace and adjust electrical controls
AC	E6.	Install and replace solid-state control
AC	E8.	Install, repair, replace and adjust time control
AC	E14.	Install and replace current relay
AC	E15.	Install and replace potential relay
AC	E16.	Install and replace control relay
AC	E17.	Install and replace transformer
AC	F5.	Repair and replace condensor
AC	F7.	Repair and replace metering devices
ELEC	L4.	Test and repair electromechanical control devices
ELEC	L5.	Test and repair analog electronic control devices
ELEC	L6.	Test and repair digital electronic control devices
P	G23.	Replace gas water heater thermocouple
P	G24.	Replace electric water heater
P	G25.	Replace electric water heater elements
P	G26.	Replace electric water heater thermostats
AM	G4.	Repair or replace charging system components.
AM	H2.	Repair or replace lights, sockets, wires, and switches.
AM	I1.	Diagnose and repair gauge and warning circuits.
AM	I2.	Diagnose and repair electrical accessories (horn, wiper, motor).
AM	Ee3.	Inspect, adjust, and replace sensors, cables, and actuators.
BM	D7.	Change light bulbs and perform minor electrical repairs
BM	G4.	Service thermal couple and pilot light
BM	G8.	Replace thermostats/electrical controls

Motors

AC	D8.	Describe the major concepts of electric motor theory
AC	H24.	Install and replace electric motor
BM	G3.	Repair and/or replace electrical motors
AM	F2.	Remove, clean, and inspect starter motor and components.
SE	L2.	Repair or replace starter motor
ELEC	L1.	Test and repair a DC motor
ELEC	L2.	Test and repair an AC motor (single and polyphase)
AC	F10.	Replace motor control devices

Batteries

AM	E1.	Clean and inspect battery clamps, cables, and connectors.
AM	E2.	Perform battery condition tests.
AM	E4.	Charge and install a battery.
AB	S2.	Service a battery
BM	I10.	Service battery
SE	F3.	Test, service, and/or replace battery

Measurement

Measurement Tools

BT	A3.	Read a rule
MA	E3.	Read a rule
CM	A4.	Read a rule
MA	E4.	Read a spacing rule
MA	E5.	Read a modular rule
AB	B1.	Read a rule, fractional-inch and metric
BM	A7.	Identify measuring instruments
BT	A2.	Identify and use measuring and layout tools
CM	A3.	Identify and use measuring and layout tools
P	B3.	Read measuring devices
DM	A10.	Use precision measurement tools
SE	A3.	Demonstrate ability to work accurately with precision tools and instruments
AC	H9.	Adjust metering device
MA	E8.	Set up and adjust the builder's level
MS	B4.	Use calculator to perform mathematical operations

Care for Tools

MS	C1.	Care for precision instruments
SE	B4.	Demonstrate the proper use and care of precision measuring tools and equipment

Measurements

SE	C2.	Measuring bolts and threads, SAE grade and metric
MA	E9.	Lay out footings and foundations
MS	C2.	Measure workpiece with tape measure
MS	C3.	Measure workpiece with pocket rule
MS	C4.	Measure workpiece with slide caliper rule
MS	C5.	Lay out work with combination square
MS	C6.	Transfer measurement with dividers
MS	C7.	Lay out workpiece with hermaphrodite calipers
MS	C8.	Measure workpiece with spring calipers
MS	C9.	Measure workpiece with vernier calipers
MS	C10.	Measure workpiece with depth gages
MS	C11.	Measure workpiece with micrometers
MS	C12.	Measure workpiece with dial calipers
MS	C13.	Measure workpiece with telescoping and small hole gages
MS	C14.	Check work with gages; i.e., plug and ring gages
MS	C15.	Measure workpiece with height gages
MS	C16.	Lay out workpiece and measure on surface plate
MS	C17.	Measure workpiece on surface plate

MS	C19.	Measure workpiece with dial indicators and attachments
W	D1.	Make layout of material for plate, structural and pipe fabrication
OL	B3.	Indicate percentage of enlargement or reduction required on photos
AM	O3.	Check and record short block measurements.
AM	O4.	Check and record component measurements.
AM	Other	Reading Micrometers
AM	Other	Calipers
AC	B7.	Test temperatures
ELEC	E8.	Measure frequency response of amplifiers
DR	H7.	Apply geometric dimensioning and tolerancing techniques
DR	S1.	Apply basic mathematic principles
DR	S2.	Apply basic geometric principles
DR	S3.	Apply basic trigonometric principles

Calculations

P	B4.	Perform general mathematical calculations
MA	E1.	Solve basic mathematical calculations
DM	A6.	Perform basic mathematical calculations
AM	Other	Basic Math
BM	Other	Demonstrate math & measuring to 1/16" using fractions & decimals
MS	B1.	Convert common fraction to decimal fraction and vise versa
MA	E2.	Solve basic ratio and proportion problems
AB	B2.	Solve problems involving volume and ratios
MS	B12.	Calculate measurements of right triangles
MS	B13.	Calculate plane geometry/math applications
W	A8.	Apply math to solution of welding problems- whole numbers, fractions, decimals, geometry and trigonometry
BT	A7.	Estimate square feet
CM	A6.	Calculate square feet
BT	A8.	Estimate linear feet
CM	A5.	Calculate linear feet
BT	A9.	Estimate cubic feet
CM	A7.	Calculate board feet
ET	D6.	Calculate allowable ampacities for various conductors using the NEC as a reference
MS	B2.	Calculate tap drill size with formula and charts
MS	B6.	Calculate part and feature dimensions and locations
MS	B8.	Calculate feeds and speeds
MS	B10.	Calculate sine bar set-up
MS	B3.	Convert customary measurements to metric and vice versa
MS	B7.	Convert revolutions per minute (RPM) to surface feet per minute (SFPM)

DR	H5.	Read and convert measurements
DR	H3.	Identify use and application of dimensioning practices
DR	H4.	Identify tolerancing
DR	H6.	Identify geometric dimensioning and tolerancing techniques
BT	B4.	Estimate labor costs
FS	B2.	Recognize labor costs
CM	A8.	Calculate material costs
MS	B5.	Calculate amount of stock required
FS	B4.	Recognize profits/loss

Safety

Identify Shop Safety

AB	D2.	Identify general safety rules
BM	A2.	Identify safe shop procedures/practices
DM	A2.	List shop safety rules and regulations
MA	B1.	Complete a safety checklist
COS	A6.	Complete safety test

Inspect Shop For Safety

DM	A3.	Inspect work areas for safe work environment
MS	A4.	Inspect work area for safe work environment
AC	A2.	Inspect shop for hazards
P	A6.	Identify and report potential safety hazards
W	A1.	Identify and correct or report safety hazards
ELEC	A2.	Identify electrical hazards
ELEC	A6.	Identify hazard of RF radiation devices
W	A4.	Identify ventilation hazards and take corrective action

Protective Clothing/Equipment

AB	D3.	Use protective clothing and equipment
P	A9.	Wear required safety equipment; i.e., safety glasses, protective clothing, ear plugs, and hard hat
AM	A4.	Identify the safe use of protective clothing and equipment
ET	A3.	Identify and demonstrate proper personal safety procedures, i.e., clothing, jewelry, personal grooming

Fire Prevention/Protection

ET	A4.	Identify techniques and practices of fire prevention
W	A2.	Identify and utilize proper storage for flammables
P	A13.	Practice fire safety when operating heating equipment or hot materials
AB	D4.	Identify the proper use of fire protection equipment
AM	A5.	Identify the safe use of fire protection equipment
BM	A4.	Identify fire safety equipment
AC	A1.	Identify types, purposes, and operation of fire extinguishers
ELEC	A1.	Identify various types, purposes and operation of fire extinguishers
P	A12.	Identify types of fire extinguishers and their proper use
MA	B4.	Identify types of fire extinguisher and their uses
W	A3.	Identify and demonstrate correct use of fire extinguishers
FS	D9.	Use fire extinguishers
COS	A3.	Operate a fire extinguisher

First Aid

ET	A5.	Identify appropriate first aid procedures
BM	A3.	Identify emergency first aid procedures
FS	D10.	Use first aid
COS	A4.	Qualify in basic first aid procedures
COS	A5.	Pass Red Cross First Aid test
FS	D11.	Perform Heimlich Maneuver
FS	D12.	Use CPR

Safety Practices - Various Categories

BM	C1.	Identify plumbing safety practices
BM	D1.	Identify electrical safety practices
BM	E1.	Review carpentry safety practices
BM	F1.	Identify finishing safety practices
BM	H1.	Identify masonry safety practices
BM	J1.	Identify grounds maintenance safety procedures
P	A14.	Demonstrate safe practices when using flux
ET	A2.	Identify safe and unsafe practices when working with electricity

Operate Safely - General

DM	A1.	Operate safely in the workshop
MS	A1.	Operate safely in the workshop
AC	A3.	Work cautiously and safely
MA	B2.	Demonstrate the ability to work safely
COS	A1.	Demonstrate the ability to work safely
ELEC	A3.	Identify and practice shop safety
SE	A1.	Demonstrate proficiency in general safety practices
AC	C2.	Demonstrate safety procedures and precautions
BT	A1.	Demonstrate good safety practices
P	A1.	Demonstrate good safety practices
CM	A1.	Demonstrate good safety practices
W	C1.	Demonstrate safety procedures
DR	A1.	Apply safety policies and procedures

Follow Safety Rules and Regulations

P	A5.	Observe safety signs and color codes
ET	A1.	Apply shop rules and regulations
AM	A7.	Follow Environmental Protection Agency (EPA) and Occupational Safety and Health Act (OSHA) regulations
W	A5.	Observe and adhere to safety labels

Maintaining Work Area

P	A4.	Maintain work area properly

AM	B4.	Practice clean and orderly work habits (vehicle, tools, and work area)
MA	B3.	Demonstrate the ability to keep a clean, orderly and safe work area
COS	A2.	Demonstrate the ability to keep a clean, orderly, and safe work area

Body Mechanics Proper Lifting

FS	D4.	Use correct body mechanics
P	A2.	Demonstrate proper techniques for lifting and carrying
MA	B5.	Demonstrate proper techniques for lifting and carrying

Tools (General, Hand, Pneumatic, Power)

AC	C8.	Use tools and instruments safely
W	A6.	Maintain, use and safely work with machines, tools and equipment
AB	C1.	Demonstrate safe use and maintenance of general hand tools
AM	A2.	Identify the safe use of hand tools
ELEC	A5.	Demonstrate safe and proper use of hand tools
P	A10.	Demonstrate safe procedure when using hand tools
AB	C3.	Demonstrate safe use and maintenance of electric and pneumatic hand tools
BT	A6.	Use pneumatic tools safely
P	A8.	Safely operate fuel-air torch
AM	A3.	Identify the safe use of power tools
P	A11.	Demonstrate safe procedures when using power tools
ET	A6.	Demonstrate safe use of tools and related power equipment
AB	C4.	Demonstrate safe use and maintenance of electric, pneumatic, and hydraulic equipment
MS	G1.	Employ power saw safety guidelines consistently
MS	K1.	Employ grinder safety guidelines consistently
MS	K2.	Clean and lubricate grinders
MS	K3.	Select and apply cutting fluids
MS	K4.	Inspect grinding wheel
MS	K5.	Balance grinding wheel
MS	K6.	Select and mount grinding wheel
MS	K7.	Dress and true machine tool grinding wheel
MS	K8.	Grind workpiece on magnetic chuck using power feed
ELEC	A4.	Identify and practice safe soldering methods

Equipment

AM	A6.	Identify the safe use of shop equipment
BM	B3.	Identify safety rules for erecting scaffolding
MA	B6.	Demonstrate proper installation and use of scaffolding
P	A7.	Practice ladder and scaffold safety

BM	B2.	Identify safety rules for carrying and erecting a ladder
ET	A7.	Apply techniques of lifting and climbing with ladders
P	A3.	Exercise extreme caution working around electric lines and equipment
AB	C5.	Describe proper fitting and jacking techniques
ELEC	A7.	Demonstrate safe and proper use of AC line operated equipment; i.e., isolation transformers, grounding, GFI
BM	G1.	Identify safety practices for servicing environmental control systems
BM	I1.	Identify safety practices for servicing grounds maintenance equipment

Supplies

AB	S5.	Use chemicals safely
AM	A1.	Identify the safe use of chemicals
AB	D6.	Identify environmental effects of chemicals
AB	D7.	Identify proper chemical disposal techniques
AB	D8.	Identify information on and importance of MSD sheets
AB	D9.	Identify important toxic substances
FS	D6.	Use and properly store hazardous products
AC	A5.	Demonstrate knowledge of safe refrigerant handling

Tools

Identify

SE	B1.	Identify common hand tools
MA	C1.	Identify common hand tools
BM	A5.	Identify hand tools
W	A9.	Identify basic hand tools
CM	A9.	Identify and properly use hand tools
P	C1.	Identify and use common hand tools
DM	A4.	Identify and use hand and power tools
BT	A4.	Identify proper use of power and hand tools
MA	C2.	Identify common power tools
BM	A6.	Identify power tools
SE	B5.	Identify and use related power tools
P	C2.	Identify and use common power tools
SE	B3.	Identify precision measuring tools and equipment
SE	B7.	Identify common cutting tools
SE	B9.	Identify and use tools to restore threads on fasteners
AC	C7.	Identify and use related tools and instruments - tubing and connections
AC	F17.	Identify and use related tools and instruments - domestic refrigeration
AC	H30.	Identify and use related tools and instruments - commercial cooling/heating

Selecting

W	A10.	Select, use and care for hand tools
MA	C3.	Select and use appropriate hand tools according to the job
MA	C4.	Select and use appropriate power tools according to the job
ET	Other	Demonstrate skill in the selection, use and care of electrician's hand/power tools
MS	H4.	Select proper drill type based on job requirements

Care For

MS	L2.	Perform care and maintenance
SE	A2.	Use proper techniques in the care and use of tools and equipment
CM	A14.	Maintain/service hand tools
SE	B2.	Demonstrate the proper use and care of hand tools
MS	E1.	Use and care for hand tools
SE	B6.	Demonstrate the proper use and care of related power tools
CM	B11.	Maintain/service power tools and equipment
SE	B8.	Demonstrate the proper use and care of cutting tools
MS	H18.	Sharpen drills with grinding attachments and/or specialized grinders

MS	L3.	Inspect grinding wheels
MS	L4.	Select and mount grinding wheel
MS	L5.	Dress and true grinding wheel

Safety

MS	L1.	Employ safety guidelines
W	A11.	Use power machinery, grinder, drill press and power saw safely/correctly
AC	Other	Power Tool Safety
AC	Other	Air Tool Safety
MS	H1.	Employ drill press safety guidelines consistently

Hand Tools

BT	C1.	Use Builder's level
ET	C3.	Set up and use a hacksaw
MS	E2.	Cut materials with hand hack saw
ET	C4.	Use a hole punch
ET	C5.	Use pouch tools
ET	C6.	Operate brace and bit
MS	E3.	Bench file/deburr workpiece
MS	E6.	Cut threads with die
MS	E7.	Cut threads with hand tap
MS	E8.	Ream holes with hand reamer
MS	E12.	Grind using appropriate hand grinder
MS	E13.	Remove damaged screws
MS	E14.	Remove broken drills and taps
MS	E15.	Remove and install dowel pins

Power Tools

ET	C7.	Operate common electrical power tools
ET	C8.	Operate common hydraulic power tools
P	C13.	Operate a reciprocation saw
CM	B7.	Set up and operate band saw safely and accurately
CM	B2.	Set up and operate table saw safely and accurately
CM	B3.	Set up and operate radial arm saw safely and accurately
P	C12.	Operate a right-angle drill
MS	H8.	Drill holes to specification using manual feed
CM	B4.	Set up and operate drill press safely and accurately
MS	H3.	Set up and clamp workpiece to drill press table
CM	B10.	Set up and operate bench grinder safely and accurately
MS	E9.	Dress and true grinding wheels on pedestal/bench grinder
MS	E10.	Grind and shape tools on pedestal/bench grinder

Pneumatic Tools

CM A10. Use pneumatic tools safely

CM B1. Demonstrate safe use of portable air/electric tools

Group Two Competency Lists, Draft One

Color Codes:

Blue - Occupations in the CONSTRUCTION Cluster
Peach - Occupations in the MANUFACTURING Cluster
Yellow - Occupations in the SERVICE Cluster
Green - Occupations in the TRANSPORTATION Cluster
Gray - Occupations in the OTHER Cluster

BM	B7.	Clean windows
BM	C2.	Cut and glue plastic pipe
BM	C3.	Cut and solder copper pipe
BM	C4.	Cut and thread pipe
BM	C5.	Form a flare
BM	C6.	Install a compression fitting
BM	C10.	Locate and repair leaks in pipes and lines
BM	C11.	Clean traps, drains and vents
BM	C12.	Clean and sanitize plumbing fixtures
BM	E11.	Clean and refinish floors
BM	E12.	Clean walls
BM	F2.	Prepare surface for finish
BM	F3.	Select correct finishing materials
BM	F4.	Stir or shake finishing materials
BM	F7.	Apply finish with paint sprayer
BM	F8.	Clean and properly store finishing equipment and materials
BM	G2.	Adjust/replace belts
BM	G5.	Clean and/or replace heating elements
BM	G6.	Clean condensing unit
BM	G7.	Clean an evaporator coil
BM	G9.	Clean and check flues
BM	G10.	Replace a furnace or cooling filter
BM	I2.	Change oil, filters, and service breather
BM	I3.	Remove, service, and replace spark plugs
BM	I4.	Sharpen and balance blades; lubricate spindle assemblies
BM	I5.	Select and add fuel
BM	I9.	Adjust and/or replace belts
BM	I11.	Service trimmer
BM	J8.	Identify procedures for use of pesticides
BM	Other	Chemicals

BT	A5.	Identify and use nails and fasteners
BT	A11.	Identify methods and materials for thermal insulation
BT	C2.	Establish elevation reference points from Bench Mark
BT	H2.	Install chimney flashing
BT	H3.	Install step flashing
BT	H5.	Install roof vent
BT	H6.	Install drip cap

Cabinet Making
Cross-Cluster Common Competencies, Draft One

CM	A2.	Demonstrate safe housekeeping practices
CM	A11.	Identify and use nails and fasteners
CM	A13.	Identify types and grades of sheet material
CM	C2.	Lay out, cut, and construct a butt joint
CM	C5.	Lay out, cut, and construct a lap joint
CM	D2.	Use clamps (e.g., bar, hand-screw, C. webbing and spring) during gluing operations
CM	E3.	Draw cabinetmaking plans for a kitchen
CM	E4.	Draw cabinetmaking plans for a bathroom
CM	H1.	Identify types and grades of abrasive materials
CM	H2.	Sand and prepare for finishing
CM	H3.	Identify stains and application procedures
CM	H4.	Identify finishes their uses and precautions
CM	H5.	Apply finishes
CM	I3.	Apply laminate adhesives

Electrical Trades
Cross-Cluster Common Competencies, Draft One

ET	C1.	Cut and ream conduit
ET	C2.	Bend conduit to predetermined specifications using conduit bender
ET	F5.	Identify common screws, bolts, nuts and nails
ET	F6.	Identify common connectors, terminals and lugs
ET	F8.	Determine type and size of electrical wire
ET	F13.	Apply the use of trade catalogs and publications
ET	Other	Read architectural prints and wiring plans

Plumbing
Cross-Cluster Common Competencies, Draft One

P	B11.	Identify basic framing members
P	C3.	Operate a three-way threader (by hand)
P	C4.	Operate the drop-head rachet threader (by hand)
P	C5.	Operate an adjustable 1-2" rachet threader (by hand)
P	C6.	Assemble fittings using two pipe wrenches
P	D6.	Construct a soil, waste and vent assembly of PVC-DWV (polyvinyl chloride-drain waste vent)"
P	C11.	Cut a plastic pipe using handsaw
P	C12.	Cut plastic pipe using tubing cutter
P	E1.	Construct a soft tubing assembly with flare fittings
P	E2.	Construct a soft tubing assembly with compression joints
P	E3.	Construct a soft tubing assembly with solder joints
P	E4.	Install a water distribution system of galvanized steel
P	E5.	Install a water distribution system of hard-drawn copper
P	E6.	Install a water distribution system of CPVC (chlorinated polyvinyl chloride)
P	E18.	Apply 50/50 solder system
P	E19.	Apply 95/5 solder system
P	E20.	Apply lead-free solder system
P	E21.	Apply sil-braze system
P	E23.	Perform an air-pressure test
P	G28.	Insulate water lines
P	G29.	Repair solder joint
P	H3.	Install red-head anchors
P	H4.	Hang pipe using wire pipe hooks
P	H5.	Hang pipe using perforated straps
P	H6.	Hang pipe using clevis hangers

Drafting
Cross-Cluster Common Competencies, Draft One

DR	B2.	Demonstrate proper use and care of drawing instruments and equipment
DR	K2.	Produce simple floor plan and elevation drawings
DR	N1.	Identify structural steel shapes
DR	O3.	Identify use and application fasteners
DR	Q3.	Identify sheet metal layout procedures
DR	R1.	Identify vocabulary
DR	R2.	Identify hardware and basic functions/operations
DR	R4.	Store and retrieve data

Machine Shop
Cross-Cluster Common Competencies, Draft One

MS	A2.	List machine shop safety rules and regulations
MS	E4.	Mark locations with prick and center punches
MS	E5.	Locate holes with transfer screws and transfer punches
MS	E11.	Use abrasives/whetting/polishing/lapping
MS	E16.	Install a helical coil thread insert
MS	E17.	Straighten workpiece on arbor press
MS	E18.	Assemble and disassemble workpiece with arbor press
MS	E19.	Broach workpiece with broaching tool
MS	E20.	Assemble and disassemble precision parts
MS	F1.	Identify types of metals and related materials
MS	F5.	Perform heat treatment process
MS	G2.	Perform care and maintenance
MS	G3.	Select proper blade type for sawing operations and materials
MS	G8.	Select and apply cutting fluids
MS	H2.	Perform care and maintenance
MS	H6.	Set up drill press to obtain calculated feeds and speeds
MS	H7.	Select and apply cutting fluids
MS	H14.	Power ream hole to size
MS	H15.	Use drill jigs and bushings
MS	H16.	Hand tap hole using drill press
MS	I12.	Center workpiece in four-jaw chuck
MS	I13.	Drill holes
MS	L6.	Set up machine

Welding
Cross-Cluster Common Competencies, Draft One

W	A12.	Properly store electrodes and filler materials
W	A15.	Perform a weld test (destructive/nondestructive)
W	C2.	Identify types of fuels and their application
W	C3.	Handle, make preliminary safety inspection and store cylinders properly
W	C4.	Identify, select and set up oxy-fuel welding and cutting equipment
W	C5.	Light and adjust flame for welding and cutting
W	C6.	Pierce holes and cut slots
W	C7.	Make straight 90 degree and beveled cuts on mild steel plate and pipe
W	C8.	Make circle cuts - off hand and with guide
W	C11.	Run stringer bead and joints with filler metal in vertical position
W	C13.	Run stringer bead and joints with filler metal in vertical position
W	C14.	Run stringer bead and joints with filler metal in overhead position
W	C16.	Braze weld cast iron
W	C17.	Prepare weld for testing and pass visual test
W	C18.	Identify welding and cutting problems, their causes, and take corrective action
W	C19.	Identify and select correct welding brazing rod
W	D2.	Prepare material for weld procedure
W	E1.	Demonstrate safety procedures
W	E4.	Identify and make proper electrode selection for base material and material thickness
W	E5.	Identify joint design and prepare material for weld procedure
W	E6.	Identify welding problems, their causes and take corrective action
W	E10.	Build pad of beads in horizontal position with E-6010 or E-6011
W	K1.	Demonstrate safety procedures
W	K2.	Set up and operate plasma cutting equipment
W	K3.	Lay out and make straight line cuts on nonferrous metal
W	K4.	Lay out and make bevel cuts on nonferrous metal
W	K5.	Layout and make circular cuts on nonferrous metal
W	K6.	Layout and make pattern cuts on nonferrous metal
W	K8.	Lay out and cut square and round solid stock on nonferrous metal
W	K9.	Identify, select and safely handle cutting grass
W	L1.	Demonstrate safety procedures
W	L2.	Identify the classification and physical properties of ferrous and nonferrous metals
W	L3.	Identify and apply principles of preheating and postheating
W	K6.	Layout and make pattern cuts on nonferrous metal

Air Conditioning, Heating, and Refrigeration
Cross-Cluster Common Competencies, Draft One

AC	A4.	Demonstrate removal procedures from an electrical conductor
AC	B1.	Identify principles of refrigeration
AC	B2.	Use high and low manifold gauge
AC	B3.	Leak-test and evacuate system
AC	B4.	Identify sealed system components
AC	B5.	Identify sealed system accessories
AC	B6.	Resolve high and low suction discharge pressure problems
AC	C1.	Identify different types of tubing and fittings
AC	C3.	Install, repair and replace copper tubing
AC	C4.	Install, repair and replace aluminum tubing
AC	C5.	Install and replace plastic tubing and pipe
AC	C6.	Braze tubing
AC	E4.	Install and replace temperature pressure control
AC	E5.	Adjust temperature pressure control
AC	E7.	Replace, calibrate and adjust temperature control
AC	E9.	Install and replace water regulating valve
AC	E10.	Adjust water regulating valve
AC	E11.	Install and replace oil pressure safety control
AC	E12.	Install and replace pneumatic controls
AC	E13.	Install, replace, and repair magnetic starter and components
AC	F2.	Test compressor efficiency
AC	F3.	Install and replace compressor
AC	F4.	Install and replace access valve
AC	F6.	Repair and replace evaporator
AC	F8.	Replace components of defrost system
AC	F9.	Replace temperature controls
AC	F11.	Replace heaters
AC	F12.	Perform cleanup of a contaminated system
AC	F13.	Charge refrigeration system
AC	F14.	Perform preventative maintenance
AC	F16.	Check and adjust air flow
AC	G1.	Test compressor efficiency
AC	G2.	Install, replace and repair compressor
AC	G3.	Install and replace condensing unit
AC	G4.	Install, repair and replace stem-type valve
AC	G5.	Install, replace and test control valves
AC	G6.	Repair and replace condensor
AC	G7.	Repair and replace evaporator
AC	G8.	Replace and repair metering device
AC	G9.	Adjust metering device
AC	G10.	Replace defrost system components

AC	G11.	Replace heaters
AC	G12.	Perform cleanup of a contaminated system
AC	G13.	Charge refrigeration system
AC	G14.	Check and adjust air flow
AC	G15.	Identify and use related tools and instruments - commercial refrigeration
AC	G16.	Pump down unit
AC	G17.	Perform preventative maintenance
AC	H2.	Test compressor efficiency
AC	H3.	Install and replace compressor
AC	H4.	Install and replace condensing unit
AC	H5.	Repair and replace condensor
AC	H6.	Repair and replace evaporator
AC	H7.	Install, replace and test control valves
AC	H8.	Replace and repair metering devices
AC	H10.	Perform cleanup of a contaminated system
AC	H11.	Charge air conditioning system
AC	H12.	Check capacity of cooling system
AC	H14.	Describe operation of a heat pump
AC	H16.	Check capacity of heat pump
AC	H17.	Replace defrost system components - heat pump
AC	H20.	Identify and describe operation of heating system components
AC	H23.	Check and adjust air flow
AC	H25.	Repair, replace and service electronic air cleaner
AC	H26.	Perform preventative maintenance
AC	H27.	Pump down unit
AC	H28.	Remove and replace drier cartridge
AC	H29.	Clean, repair and maintain cooling tower
AC	I1.	Perform systematic problem solving of an air system
AC	I2.	Perform systematic problem solving of an electrical system
AC	I3.	Perform systematic problem solving of a fuel system
AC	I4.	Perform systematic problem solving of a refrigerant system
AC	J1.	Interpret psychrometric chart
AC	J2.	Solve psychrometric problems
AC	J4.	Describe concept of air treatment
AC	J5.	Describe concept of heat loss and heat gain factors

ELEC B16.	Identify and replace parts and components on printed circuit boards and chassis
ELEC B19.	Describe and identify filter networks
ELEC D1.	Identify schematic design symbols for semiconductor devices
ELEC D4.	Construct circuits using bipolar transistors
ELEC D5.	Describe the basic operation of a JFET
ELEC D6.	Describe the basic operation of a MOSFET
ELEC D7.	Describe the basic operation of a UJT
ELEC D8.	Describe the basic operation of a PUT
ELEC D9.	Describe the basic operation of a DIAC
ELEC D10.	Describe the basic operation of a SCR
ELEC D11.	Describe the basic operation of a TRIAC
ELEC D12.	Describe the basic operation of a VDR
ELEC D17.	Demonstrate the proper replacement techniques for semiconductor devices
ELEC F1.	Describe the basic operation of oscillators
ELEC H3.	Describe the operation and demonstrate the use of signal generators; i.e., audio, RF or function
ELEC I2.	Identify the levels of computer languages
ELEC I3.	Describe the purpose of operating systems
ELEC I4.	Analyze simple programs using computer instruction sets
ELEC J2.	Identify types of photodetectors and emitters
ELEC K1.	Identify and convert number systems and codes for binary, hex, octal and BCD
ELEC K2.	Identify and describe the operation of basic logic gates
ELEC K3.	Develop truth tables defining circuit design
ELEC L7.	Explain the proper connection of Delta and Wye motor connections
ELEC L8.	Describe the operation of motor speed control
ELEC L9.	Describe the operation of programmable controllers
ELEC M1.	Breadboard circuits
ELEC M3.	Solder/desolder circuits
ELEC M4.	Select and install proper components for specific use
ELEC M5.	Repair printed circuit boards
ELEC N2.	Identify problem area by symptom

Auto Collision Common Competencies
Cross-Cluster Common Competencies, Draft One

AB	F1.	Identify auto body welding processes
AB	F2.	Use MIG welding safety procedures
AB	F3.	Set up equipment for MIG welding
AB	F4.	Prepare metal for MIG welding
AB	F6.	Construct a MIG plug weld
AB	F7.	Construct a MIG continuous weld
AB	F10.	Identify oxyacetylene welding safety procedures
AB	F11.	Set up and use equipment for oxyacetylene welding
AB	F12.	Set up and use equipment for oxyacetylene cutting
AB	F13.	Use protective clothing and equipment
AB	G2.	Clean the exterior surface
AB	M7.	Select and apply appropriate primer/primer surfacer/sealant
AB	N1.	Identify types of bolts and nuts, US and metric
AB	N2.	Identify types of rivets
AB	N3.	Identify types of screws
AB	N4.	Identify types of clips
AB	S1.	Identify electrical system components
AB	V1.	Identify air conditioning systems components and service procedures
AB	V2.	Replace condenser
AB	V3.	Remove and reinstall compressor
AB	V4.	Test the system for leaks
AB	V5.	Repair leaks in air conditioning system
AB	V6.	Evacuate and charge system using vacuum pump or charging system
AB	V7.	Check and service air conditioning hoses
AB	V8.	Inspect, flush, and replace heater core
AB	Y4.	Perform stress relief using heat

Auto Mechanics
Cross-Cluster Common Competencies, Draft One

AM Q3. Inspect, replace, and adjust drive belts and hoses
AM GG1. Diagnose and performance test A/C systems for problems and determine needed repairs
AM GG2. Clean, inspect, and repair A/C system components
AM GG3. Evacuate and charge A/C system and performance test
AM Other Read Micrometers

Diesel Mechanics
Cross-Cluster Common Competencies, Draft One

DM	A8.	Identify and select common fasteners
DM	D2.	Replace and adjust fan and auxiliary belts
DM	D3.	Replace water filter
DM	D7.	Replace hoses and clamps
DM	F2.	Evaluate problem
DM	I5.	Repair and rethread tapped holes
DM	K1.	Demonstrate safety procedures and precautions
DM	K4.	Evaluate test results
DM	K5.	Interpret schematic
DM	K7.	Remove and replace battery
DM	K8.	Remove and replace associated wiring and/or switches (solenoids/relays/contacts)
DM	K10.	Use trouble-shooting charts
DM	L2.	Use cutting torch
DM	L3.	Weld with arc welder in flat position
DM	L4.	Braze fittings
DM	L5.	Braze light gauge flat
DM	L6.	Weld oxyacetylene flat
DM	N3.	Remove and replace major components
DM	N4.	Evacuate and charge system

SE A5. Perform tasks within assigned time limits
SE C1. Identify and select related fasteners
SE Q1. Adjust tension and alignment of pulleys and belts

Commercial Art
Cross-Cluster Common Competencies, Draft One

CA	A1.	Demonstrate proper uses of T-square
CA	A2.	Demonstrate proper uses of triangles
CA	A3.	Demonstrate proper uses of drafting knives
CA	A4.	Demonstrate proper uses of scissors
CA	A5.	Demonstrate proper uses of tech pens
CA	A6.	Demonstrate proper uses of sharpeners
CA	A7.	Demonstrate proper uses of pencils
CA	A8.	Demonstrate proper uses of erasers
CA	A9.	Demonstrate proper uses of tapes
CA	A10.	Demonstrate proper uses of paper
CA	A11.	Demonstrate proper uses of fixatives
CA	A13.	Demonstrate proper uses of markers
CA	A14.	Demonstrate proper uses of ink
CA	A15.	Demonstrate proper uses of paint
CA	A16.	Demonstrate proper use of individually selected materials
CA	A17.	Demonstrate proper use of individually selected equipment
CA	A18.	Demonstrate proper use of individually selected camera
CA	D5.	Produce line drawings
CA	F1.	Prepare rough layouts
CA	H1.	Identify/illustrate one-point perspective
CA	H2.	Identify/illustrate two-point perspective
CA	H3.	Identify/illustrate multi-point perspective
CA	N4.	Identify methods of growing/improving
CA	Q1.	Demonstrate handlettering
CA	Q3.	Produce ruled forms
CA	Q4.	Produce spot illustration
CA	S1.	Identify hardware and basic functions/operations
CA	S2.	Identify software programs and uses

Cosmetology
Cross-Cluster Common Competencies, Draft One

COS	B2.	Identify essentials of personal grooming
COS	C1.	Identify types of equipment and implements
COS	C2.	Demonstrate the ability to operate equipment correctly
COS	D1.	Identify definitions pertaining to sanitation
COS	D9.	Identify safety precautions
COS	e1.	Give the definition for Chemistry
COS	e2.	Give the definition for matter
COS	e5.	Explain the forms of matter
COS	g2.	Read and interpret State Law requirements and regulations

Food Service
Cross-Cluster Common Competencies, Draft One

FS	A5.	Practice people skills
FS	A6.	Practice personal grooming
FS	B1.	Recognize overhead costs
FS	C1.	Practice personal hygiene
FS	C3.	Maintain clean facilities
FS	D1.	Identify hazards
FS	D3.	Use cutting utensils and equipment safely
FS	D5.	Use, clean, and maintain vents and exhaust equipment
FS	D7.	Respond to emergencies
FS	E1.	Use and clean coffee equipment
FS	E4.	Use and calibrate thermometers

Offset Lithography
Cross-Cluster Common Competencies, Draft One

OL A1. Check specifications and planning
OL B1. Prepare a rough layout
OL O5. Preventive maintenance

Group Three Competency Lists, Draft One

Color Codes:

Blue - CONSTRUCTION Cluster
Peach - MANUFACTURING Cluster
Green - TRANSPORTATION Cluster

Construction Cluster
Common Cluster Competencies, Draft One

BM	D3.	Bend and connect conduit
BM	E4.	Repair or install interior door operating hardware
BM	E5.	Identify procedures for repairing, replacing and/or installing floor coverings
BM	E6.	Repair, replace and/or install a ceiling system
BM	E7.	Install wall and/or ceiling insulation
BM	E8.	Install or replace interior trim
BM	F5.	Apply finish with brush
BM	F6.	Apply finish with roller
BM	H2.	Set forms
BM	H5.	Pour and finish concrete
BM	J4.	Prepare soil for seeding/sow seed
BM	J6.	Mix, apply, and store fertilizer
BM	Other	Painting in new construction
BM	Other	Interior finishes
BM	Other	Exterior finishes
BM	Other	Staining interior woodwork
BM	Other	Sealing (varnishing) interior woodwork
CM	A12.	Identify wood species and grades
CM	B6.	Set up and operate planer safely and accurately
CM	C3.	Lay out, cut, and construct a dado joint
CM	C6.	Lay out, cut, and construct a miter joint
CM	D1.	Identify various types of wood glues, their uses, and precautions

Manufacturing Cluster
Common Cluster Competencies, Draft One

DR	A6.	Identify drafting terminology
DR	C6.	Demonstrate techniques in line construction
DR	D2.	Construct regular polygons and ellipses
DR	D3.	Draw tangents to arcs, lines, and circles
DR	D5.	Divide a line in equal and proportional parts
DR	E1.	Interpret an orthographic projection (3rd angle)
DR	E2.	Prepare a multiview freehand (3rd angle)
DR	E3.	Prepare orthographic drawings (3rd angle)
DR	E4.	Identify use and application of orthographic drawings (3rd angle)
DR	E5.	Identify 1st and 3rd angle projection drawings
DR	F1.	Construct primary auxiliary views
DR	F3.	Construct secondary auxiliary views
DR	F4.	Identify use and application of auxiliary views
DR	G1.	Identify and draw standard sectional views
DR	G2.	Identify the symbols used to present different materials
DR	G3.	Identify and use cutting planes
DR	G4.	Identify and use conventional breaks
DR	G5.	Identify use and application of sectional views
DR	H1.	Apply dimensioning practices and techniques to drawings
DR	H2.	Construct the lines used to dimension drawings
DR	J1.	Construct isometric drawings
DR	J2.	Identify diametric, oblique, perspective and trimetric drawings
DR	J3.	Identify use and application of pictorial drawings
DR	M1.	Identify piping symbols, fittings, and valves
DR	M2.	Produce orthographic and isometric drawings
MS	B11.	Perform angular and simple indexing calculations
MS	D9.	Plan sequence of machining operations
MS	F3.	Correlate types of materials to their properties
MS	F4.	List major cutting tool variables
MS	F6.	Test workpiece for hardness without hardness tester
MS	G4.	Cut and weld band saw blades
MS	G5.	Select and set speeds and feeds on power saw
MS	G6.	Cut material to length with power hack saw
MS	G7.	Cut material to length with band saw
MS	K11.	Grind angular surfaces
MS	L3.	Calculate coordinates and dimensions of CNC drawing
W	L4.	Describe and apply principles of metallurgy in annealing, hardening and tempering
W	L5.	Describe methods of testing metals
W	L6.	Identify types of ferrous metal by spark test

AB	K2.	Replace energy absorbers
AB	Q10.	Remove and reinstall heating and air conditioning assembly
AB	Q11.	Remove and reinstall carpeting
AB	Q12.	Remove and reinstall seat belts and shoulder harness
AB	Q13.	Identify supplemental inflatable restraint systems
AB	Q14.	Diagnose supplemental inflatable restraint systems
AB	Q15.	Service and repair supplemental inflatable restraint systems
AB	R9.	Remove and replace a lock cylinder
AB	T1.	Service a taillight assembly
AB	T2.	Service a headlight assembly
AB	T3.	Service mechanical headlights and covers
AB	T4.	Aim headlights mechanical aiming equipment
AB	U1.	Remove and replace a radiator
AB	U2.	Remove, inspect and replace V-Belts
AB	U3.	Test antifreeze solution
AB	U4.	Service fan blades and clutches
AB	U5.	Check and service radiator and heater hoses
AB	U6.	Inspect, repair, and replace auxiliary oil cooler
AB	U7.	Inspect, repair, and replace fuel, exhaust, and emissions systems
AB	W1.	Identify front suspension systems
AB	W2.	Identify rear suspension systems
AB	W3.	Remove and reinstall front suspension systems
AB	W4.	Remove and reinstall rear suspension systems
AB	W5.	Remove and reinstall front drive train
AB	W6.	Service suspension systems
AB	W7.	Identify steering systems
AB	W8.	Perform four-wheel alignment
AB	W9.	Perform suspension quick checks
AB	W10.	Service power steering system
AB	W11.	Service brake system
AB	W12.	Identify causes of uneven tire wear
AB	W13.	Inspect, repair, and replace steering system components
AB	X1.	Identify vehicle frame construction, conventional and unibody
AB	X2.	Identify frame and unibody terminology
AM	C1.	Identify basic function and operation of vehicle mechanical components
AM	E3.	Jump start a vehicle
AM	F1.	Diagnose starting system and determine needed repair
AM	F3.	Repair or replace starter motor components
AM	G1.	Diagnose starting system and determine needed repair
AM	H1.	Diagnose lighting system problems and determine needed repairs

AM	J2.	Inspect, repair, or replace primary ignition components
AM	J5.	Perform on-board computer system diagnosis
AM	J6.	Repair or replace computer system components
AM	K1.	Diagnose fuel system problems and determine needed repairs
AM	K2.	Inspect, repair, or replace fuel supply component
AM	K6.	Repair or replace fuel injection components
AM	K8.	Diagnose and repair exhaust system problems
AM	L6.	Clean, inspect/replace air management system
AM	L7.	Clean, inspect/replace inlet air temperature control
AM	L9.	Clean, inspect/replace fuel vapor controls
AM	M2.	Remove and replace engine (front- and rear-wheel drive)
AM	Q1.	Inspect and repair oil system and components
AM	Q2.	Perform cooling system tests; determine needed repairs
AM	Q4.	Replace cooling system components (thermostat, radiator, controllers)
AM	Q5.	Inspect coolant, drain, flush, and refill cooling system with recommended coolant
AM	Q6.	Perform oil and lube service on normally aspirated and turbo-charged engines
AM	R1.	Diagnose and determine needed repairs on steering systems
AM	R2.	Clean and inspect power and manual steering gear boxes
AM	R3.	Reassemble,. adjust, and install power and manual steering gear boxes
AM	R4.	Clean and inspect power and manual rack-and-pinion steering rack
AM	R5.	Reassemble, adjust, and install power and manual rack-and-pinion steering rack
AM	R6.	Inspect and repair steering columns
AM	R7.	Inspect and replace steering linkage components
AM	R8.	Inspect, repair, and replace power steering pumps
AM	S1.	Diagnose and determine needed repairs on conventional and electric front suspension systems
AM	S2.	Inspect and repair control arm and spring assemblies on conventional systems
AM	S3.	Inspect and repair wheel spindles and bearings
AM	S4.	Inspect and replace shock absorbers and stabiiizer bars
AM	S5.	Diagnose and determine needed repairs on MacPherson Strut assemblies
AM	S6.	Clean, inspect, and assemble MacPherson strut assemblies
AM	T1.	Diagnose and determine needed repairs on conventional and electronic rear suspension systems
AM	T2.	Inspect and replace shock and spring assemblies
AM	T3.	Inspect and replace MacPherson strut assemblies
AM	T4.	Inspect and repair suspension linkages and bushings
AM	U1.	Diagnose and determine needed repairs on conventional and electronic rear suspension systems
AM	U2.	Set correct alignment angles on front wheels

AM	U3.	Set correct camber and toe on rear wheels
AM	U4.	Rotate and balance tire and wheel suspension
AM	V1.	Diagnose hydraulic brake systems and determine needed repairs
AM	V2.	Inspect and repair or replace master cylinders and lines of the hydraulic system
AM	V3.	Inspect and replace switches and valving devices
AM	W1.	Diagnose and determine needed repairs on drum brake systems
AM	W2.	Remove, clean, and inspect drum brake assemblies
AM	W3.	Repair, replace, and adjust drum brake components
AM	X1.	Diagnose and determine needed repairs on disc brake systems
AM	X2.	Remove, clean, and inspect disc brake components
AM	X3.	Repair, replace, and adjust disc brake components
AM	Y1.	Diagnose and determine needed repairs on power-assist brakes
AM	Y2.	Repair or replace power brake components
AM	Y3.	Repair or replace hydra-boost components
AM	Y4.	Check operation of anti-skid braking systems; adjust or repair according to manufacturer's recommendations
AM	BB1.	Diagnose and determine needed repairs
AM	BB2.	Inspect, service, and replace front axle shafts
AM	BB3.	Inspect, service, and replace drive shafts
AM	DD4.	Diagnose and determine needed repairs on hub assemblies
AM	DD5.	Disassemble, clean, and inspect hub assemblies
AM	DD6.	Reassemble and adjust hub assemblies
AM	EE4.	Inspect and replace external bushings, seals, and gaskets
AM	EE5.	Inspect, replace, and align power train mounts
AM	GG4.	Diagnose and repair automatic and electrical temperature control units.
AM	HH1.	Diagnose and repair heating system problems and determine needed repairs
AM	HH2.	Inspect and replace heating system components
DM	A9.	Identify and select common seals and gaskets
DM	B2.	Test cooling system
DM	B3.	Test engine lubrication system
DM	B4.	Check air intake and/or exhaust system
DM	B5.	Draw lubrication and/or oil sample
DM	B6.	Check linkage adjustments
DM	B7.	Perform visual inspection
DM	B8.	Replace fuel filters
DM	B10.	Inspect steering linkage for wear
DM	B11.	Inspect and adjust brakes
DM	C2.	Adjust supplementary governing and/or control devices
DM	C3.	Adjust intake and exhaust valves according to specifications
DM	C4.	Adjust injectors according to specifications
DM	C5.	Adjust governor (as applicable)
DM	D4.	Replace and/or test radiators

DM	D5.	Flush cooling system
DM	D6.	Replace and test thermostat and seals
DM	D8.	Inspect fan drive assembly and related hardware
DM	D9.	Replace water pump
DM	D10.	Test and replace oil cooler
DM	D11.	Test radiator coolant
DM	D12.	Recognize proper routing and sizing of cooling lines
DM	D13.	Pressure test cooling system
DM	E2.	Test injection nozzles and injectors
DM	E3.	Time fuel injection pump
DM	E4.	Bleed fuel system
DM	E5.	Replace injection nozzles and injectors
DM	E6.	Test fuel system
DM	E7.	Identify and install fuel line hoses and connections
DM	E8.	Inspect turbo charger condition
DM	F3.	Trouble-shoot overheating and overcooling
DM	F4.	Trouble-shoot engine vibration
DM	F5.	Trouble-shoot electrical system
DM	F6.	Trouble-shoot low and/or high oil pressure
DM	F7.	Trouble-shoot smoke
DM	F8.	Trouble-shoot leaks and/or contamination
DM	F9.	Trouble-shoot hard starting
DM	F10.	Trouble-shoot high oil consumption
DM	F11.	Trouble-shoot fuel system
DM	F12.	Trouble-shoot internal noises
DM	F13.	Trouble-shoot low power and/or performance
DM	F14.	Trouble-shoot air system
DM	F15.	Trouble-shoot low fuel mileage
DM	G2.	Evaluate oil conditions
DM	G3.	Replace and inspect oil filter
DM	G4.	Change engine oil
DM	G5.	Change transmission and/or differential oils
DM	G6.	Change power steering fluid
DM	G7.	Lubricate chassis components
DM	G8.	Replace transmission and/or differential filters
DM	H2.	Remove engine
DM	H3.	Remove injection pump
DM	H4.	Remove camshaft and bushings
DM	H5.	Remove cylinder ridge, pistons and liner
DM	H6.	Remove crankshaft
DM	H7.	Remove oil pump
DM	H8.	Remove cylinder head
DM	H9.	Remove exterior components
DM	I2.	Clean components

DM	I3.	Inspect flywheel
DM	I4.	Rebuild oil pump
DM	I6.	Rebuild cylinder heads
DM	I7.	Rebuild or replace accessories
DM	J2.	Install camshaft and bushings
DM	J3.	Install crankshaft
DM	J4.	Install cylinder liners
DM	J5.	Install piston on rod
DM	J6.	Install piston on cylinder
DM	J7.	Install oil pump
DM	J8.	Install timing gears
DM	J9.	Install cylinder heads
DM	J10.	Install injection pump
DM	J11.	Install exterior components
DM	J14.	Tune engine
DM	J15.	Test run engine
DM	J16.	Install engine
DM	K9.	Remove and reinstall generator and/or alternator
DM	M1.	Identify basic principles of hydraulics
DM	M2.	Identify basic hydraulic components
DM	O3.	Remove and replace springs and pins
DM	O4.	Rebuild steering sector and hydraulic pump
DM	O5.	Remove and replace king pin
DM	O6.	Remove and replace steering components
DM	O7.	Inspect, remove and replace mounted tires
DM	P2.	Repair cam, wedge and disc brakes
DM	P3.	Service hydraulic brake system
DM	P4.	Inspect brake drum and/or rotors using safety specifications
DM	P5.	Replace spring brake chambers and diaphragms
DM	Q2.	Remove and replace clutch assembly
DM	Q3.	Adjust clutch free play
DM	Q4.	Install throw-out bearing
DM	Q5.	Remove, adjust and replace drive line
DM	Q6.	Remove and replace transmission (manual and automatic)
DM	Q7.	Remove and replace axle shaft
DM	Q8.	Replace and adjust wheel bearing
DM	Q9.	Service hubs
DM	Q10.	Check drive line alignment
DM	Q11.	Remove and replace differential
SE	D1.	Test, repair, or replace fuel pump
SE	D2.	Test, repair, or replace fuel filters and strainers
SE	D3.	Remove, clean and replace fuel tank shut-off valves, fuel lines, fuel hoses, and connections
SE	D6.	Adjust fuel mixture and check for air leaks

SE	D7.	Service oil-bath air cleaner
SE	D9.	Service dry-element air cleaner
SE	G1.	Remove and service spark plug
SE	G2.	Check ignition timing
SE	G3.	Test and repair breaker ignition system
SE	G4.	Test and repair breakerless ignition system
SE	G5.	Troubleshoot ignition systems
SE	H1.	Change engine oil and filter
SE	H2.	Service crankcase breather
SE	H3.	Inspect, repair, and/or replace pressure lubrication system
SE	H5.	Locate and repair leaking gasket and seals
SE	H7.	Select proper oil
SE	I1.	Service air-cooled system
SE	I2.	Service liquid-cooling system
SE	I3.	Remove, inspect, repair, and/or replace water pump
SE	I4.	Remove, check, and replace thermostat
SE	I5.	Perform a pressure test on cooling system
SE	I6.	Remove, check, and replace radiator
SE	J1.	Service and/or replace a 2-stroke-cycle exhaust system
SE	J2.	Service and/or replace a 4-stroke exhaust system
SE	M1.	Troubleshoot the ignition system
SE	M2.	Troubleshoot the fuel system
SE	M3.	Troubleshoot compression problems
SE	N1.	Identify the characteristics of the 4-stroke-cycle engine
SE	N2.	Describe the operating cycle of the 4-stroke-cycle engine
SE	N3.	Disassemble a 4-stroke-cycle engine
SE	N4.	Inspect and service a cylinder
SE	N5.	Inspect and service the pistons, rings, and connecting rod
SE	N6.	Inspect and service a crankshaft assembly
SE	N7.	Inspect and service a valve train assembly
SE	N8.	Reassemble 4-stroke-cycle engine
SE	P1.	Identify the component parts of a manual transmission
SE	P2.	Identify the component parts of a transaxle
SE	P3.	Identify the component parts of clutch systems
SE	P5.	Identify the component parts of brake systems
SE	Q3.	Adjust and replace control cables
SE	Q5.	Lubricate chassis components
SE	Q6.	Inspect and adjust brakes
SE	Q7.	Inspect and adjust clutch

APPENDIX C:

Results from Instructors' Review of Initial Analysis

Competencies by Group, Revised

Groups of Competencies:
After Instructors' Analysis

Group One:

Competencies common to all 19 T & I Areas

One list of competencies that combines competencies from all 19 profiles, divided into 10 duty bands

Group Two:

Competencies common to two cluster areas:

Transportation and Service

One Division

Group Three:

Competencies common only to one cluster area

Three Divisions (corresponding to three clusters that had cluster-related skills):

Construction
Manufacturing
Transportation

Group One Competency Lists, Revised

Competencies Common to all 19 T & I Occupational Areas

A. Orientation to Trade Occupations

1. Identify job classifications, prerequisites for employment, and career opportunities (AB A1, AM C2, BM A1, CM A15, DR A4, ET D5, FS A1, FS A4, MA A1, P B1)

2. Practice job seeking/job keeping skills (CA N1, CA N2, CA N3, CA O3, CA O4, COS B2, FS A6, FS A7, FS C1)

3. Identify entrepreneurial skills

4. Identify skills necessary for advancement within the industry

B. Health and Safety

1. Identify and apply general occupational safety rules and practices (AB D2, AC A3, AC C2, BM A2, BM C1, BM D1, BM E1, BM F1, BM H1, BM J1, BT A1, CM A1, COS A1, DR A1, DM A1, DM A2, DM K1, EL A3, ET A2, FS D4, MA B1, MA B2, MA B5, MS A1, MS A2, MS L1, P A1, P A2, P A3, SE A1, W C1)

2. Understand environmental protection agency (EPA) and Occupational Safety and Health Act (OSHA) regulations (AM A7, ET A1, P A5, W A5)

3. Complete safety test (COS A6)

4. Identify and demonstrate the safe use of protective clothing and equipment (AB D3, AB F13, AM A4, ET A3, P A9)

5. Identify and correct or report safety hazards (AC A2, DM A3, EL A2, EL A6, FS D1, MS A4, P A6, W A1, W A4)

6. Identify techniques and practices of fire prevention (AB D4, AM A5, BM A4, ET A4, P A13, W A2)

7. Identify and demonstrate correct use of fire extinguishers (AC A1, COS A3, EL A1, FS D9, MA B4, P A12, W A3)

8. Identify appropriate first aid procedures (BM A3, COS A4, COS A5, ET A5, FS D7, FS D10, FS D11, FS D12)

9. Demonstrate the ability to keep a clean, orderly, and safe work area (AM B4, CM A2, COS A2, FS C3, MA B3, P A4)

10. Safely operate oxy-fuel gas torches (AB F10, AB F11, AB F12, DM L2, P A8, W C3, W C4, W C5)

11. Demonstrate safe use and maintenance of hand, electric, pneumatic, and hydraulic equipment (AB C1, AB C3, AB C4, AC C8, AM A2, AM A3, AM A6, BT A6, EL A5, ET A6, P A10, P A11, W A6, W A11)

12. Identify use, disposal, storage, and documentation of chemical materials (AB D5, AB D6, AB D7, AB D8, AB D9, AC A5, AM A1, FS D6)

C. Tools

1. Identify common hand tools, their basic use and maintenance (drill bits and sharpening, AC C7, BM A5, BT A4, CM A9, CM A14, CM D2, DM A4, ET other, ET C3, ET C4, ET C6, MA C1, MA C3, MS E1, MS E2, MS E3, MS L2, P C1, SE A2, SE B1, SE B2, SE B7, SE B8, W A9, W A10)

2. Identify common power tools, their basic use and maintenance (use pedestal grinders for drill bits, BM A6, BT A4, CM A10, CM B1, CM B2, CM B3, CM B4, CM B7, CM B10, CM B11, DM A4, ET C7, ET C8, MA C2, MA C4, MS E9, MS E10, MS E12, MS G3. MS H1, MS H3, MS H4, MS L2, P C2, P C12, P C13, SE A2, SE B5, SE B6, SE B7, SE B8)

D. Fasteners

1. Identify common types of fasteners and their basic uses (AB N1, AB N2, AB N3, AB N4, BT A5, CM A11, DR O3, DM A8, ET F5, MS H16, SE C1)

2. Identify and use tools to restore threads on fasteners (DM I5, MS E6, MS E7, MS E13, MS E14, MS E15, MS E16, SE B9)

3. Measure bolts and threads, SAE grade and metric (SE C2)

E. Trade-Related Documents

1. Obtain and use reference books, charts, manuals, catalogs, and price lists (AB E2, AM B3, DM A5, DM K10, ET F13, MS D7, P B7, P B8, SE A4, W A7)

2. Communicate with customers and write service orders (AC other, AC other, AC K1, AM B1, COS f5, FS A5)

3. Estimate cost of job (materials, labor) (AM B2, BT B4, CM A8, CM E8, DR O2, ET E5, FS B1, FS B2, FS B4, MA F10, MS B5, OL A2, OL A3, P B9, SE A5)

4. Identify federal/state/county/industry regulating bodies (AC other, BT A13, COS g2, DR A3, P B10)

F. Trade Print Reading and Symbology

1. Interpret trade symbols (BT B2, DR L1, DR M1, ET other, ET E1, ET E3, ET E4, MS D1, W B2)

2. Read and interpret basic prints and diagrams (AC other, AC D4, AC F15, AC H21, BM A8, BT B1, BT B3, CM E6, DR N1, DM K5, EL B17, ET other, ET E2, MA F3, MA F5, MA F6, MA F7, MA F8, MA F9, MS D2, P B5, W B1)

3. Plan job sequence based on prints and/or specifications (MA F4, MS D8)

4. Demonstrate techniques of pictorial and orthographic sketching and diagramming (CM E7, DR B2, DR C1, DR C2, DR C3, DR C5, DR D1, DR E1, DR E2, DR E4, DR E5, DR J1, DR J3, DR L2, DR M2, DR O1, DR Q2, ET D7, MA E6, MS D3, P B6, W B3, W B4)

5. Read and transfer measurement from sketch to product and from product to sketch (DR C4)

6. Read and interpret scale (MA F1, MA F2)

7. Calculate tolerances, dimensions, and allowances (DR H3, DR H4, MS D4, MS D5)

G. Basic Electricity/Electronics

1. Demonstrate knowledge of the basic fundamentals of electricity (AC D2, COS e3, COS e4, COS e7, DM K2, EL B1, ET other)

2. Read and interpret electrical meters (AM D4, AM D5, EL E8, EL H2, ET H1, ET H2, ET H3, SE F1)

H. Precision Measurement

1. Use basic math skills (AB B2, AM other, BM other, BT A7, BT A8, BT A9, CM A5, CM A6, CM A7, DR H5, DR S1, DR S2, DR S3, DM A6, MA E1, MA E2, MS B1, MS B2, MS B3, MS B12, MS B13, P B4, W A8)

2. Read a rule, fractional inch and metric (AB B1, BT A3, CM A4, MA E3, MS C2, MS C3, MS C4, P B3)

3. Select and use appropriate tools for required accuracy (MS C5, MS C6, MS C7, MS C8, MS C9, MS C10, MS C11, MS C12, MS C13, MS C14, MS C15, MS C16, MS C17, MS C18, MS C19, SE B3)

4. Demonstrate ability to work accurately with precision tools and instruments (BM A7, BT A2, CM A3, DM A10, SE A3)

5. Demonstrate the proper use and care of precision measuring tools and equipment (MS C1, SE B4)

I. Material Science

Metals
Plastics
Woods
(CM A13, CM H1)

J. Computer Literacy

Group Two Competency Lists, Revised

Color Codes:

Pink - TRANSPORTATION and SERVICE Clusters

AC	B1.	Identify principles of refrigeration
AC	B2.	Use high and low manifold gauge
AC	B3.	Leak-test and evacuate system
AC	B4.	Identify sealed system components
AC	B5.	Identify sealed system accessories
AC	B7.	Test temperatures
AC	C1.	Identify different types of tubing and fittings
AC	D3.	Identify and use test equipment
AC	D5.	Trouble shoot complete electrical circuit
AC	D6.	Test capacitors
AC	D8.	Describe the major concepts of electric motor theory
AC	D9.	Test electrical components
AC	E2.	Describe concept of control theory and application
AC	E5.	Adjust temperature pressure control
AC	E6.	Install and replace solid-state control
AC	E7.	Replace, calibrate and adjust temperature control
AC	E8.	Install, repair, replace and adjust time control
AC	E9.	Install and replace water regulating valve
AC	E10.	Adjust water regulating valve
AC	E11.	Install and replace oil pressure safety control
AC	E12.	Install and replace pneumatic controls
AC	E13.	Install, replace, and repair magnetic starter and components
AC	E14.	Install and replace current relay
AC	E15.	Install and replace potential relay
AC	E16.	Install and replace control relay
AC	E17.	Install and replace transformer
AC	E18.	Describe concept of programmable thermostats
AC	F2.	Test compressor efficiency
AC	F3.	Install and replace compressor
AC	F4.	Install and replace access valve
AC	F5.	Repair and replace condensor
AC	F6.	Repair and replace evaporator
AC	F7.	Repair and replace metering devices
AC	F8.	Replace components of defrost system
AC	F9.	Replace temperature controls
AC	F10.	Replace motor control devices
AC	F11.	Replace heaters
AC	F12.	Perform cleanup of a contaminated system
AC	F13.	Charge refrigeration system
AC	F14.	Perform preventative maintenance

AC	F16.	Check and adjust air flow
AC	G1.	Test compressor efficiency
AC	G2.	Install, replace and repair compressor
AC	G3.	Install and replace condensing unit
AC	G4.	Install, repair and replace stem-type valve
AC	G5.	Install, replace and test control valves
AC	G6.	Repair and replace condensor
AC	G7.	Repair and replace evaporator
AC	G8.	Replace and repair metering device
AC	G9.	Adjust metering device
AC	G12.	Perform cleanup of a contaminated system
AC	G13.	Charge refrigeration system
AC	G14.	Check and adjust air flow
AC	G15.	Identify and use related tools and instruments
AC	G16.	Pump down unit
AC	G17.	Perform preventative maintenance
AC	G18.	Interpret wiring diagram
AC	H2.	Test compressor efficiency
AC	H3.	Install and replace compressor
AC	H4.	Install and replace condensing unit
AC	H5.	Repair and replace condensor
AC	H6.	Repair and replace evaporator
AC	H7.	Install, replace and test control valves
AC	H8.	Replace and repair metering devices
AC	H10.	Perform cleanup of a contaminated system
AC	H11.	Charge air conditioning system
AC	H12.	Check capacity of cooling system
AC	H13.	Interpret wiring diagram - cooling system
AC	H14.	Describe operation of a heat pump
AC	H15.	Interpret wiring diagram - heat pump
AC	H16.	Check capacity of heat pump
AC	H17.	Replace defrost system components - heat pump
AC	H20.	Identify and describe operation of heating system components
AC	H23.	Check and adjust air flow
AC	H24.	Install and replace electric motor
AC	H25.	Repair, replace and service electronic air cleaner
AC	H26.	Perform preventative maintenance
AC	H27.	Pump down unit
AC	H28.	Remove and replace drier cartridge
AC	H29.	Clean, repair and maintain cooling tower
AC	I1.	Perform systematic problem solving of an air system
AC	I2.	Perform systematic problem solving of an electrical system

AC	I3.	Perform systematic problem solving of a fuel system
AC	I4.	Perform systematic problem solving of a refrigerant system
AC	J1.	Interpret psychrometric chart
AC	J2.	Solve psychrometric problems
AC	J4.	Describe concept of air treatment
AC	J5.	Describe concept of heat loss and heat gain factors
AC	Other	Control Circuits
AC	Other	Servomechanisms
AC	Other	Rheostats
AC	Other	Magnetic-Electromagnetic Devices
AC	Other	Calibration Meters
AC	Other	Motor Controllers (Servos)
AC	Other	Condensor-Capacitor
AC	Other	Basic Electronic
AC	Other	Troubleshooting or Problem Solving Skills
AB	S1.	Identify electrical system components
AB	S2.	Service a battery
AB	S3.	Splice a wire
AB	S4.	Diagnose and repair electrical accessories
AM	D1.	Check continuity in electrical circuits using test light and voltmeter, oscilloscope, and wiring diagram
AM	D2.	Check for shorts, opens, and grounds
AM	D3.	Measure resistance in electrical circuits using an ohmmeter
AM	E1.	Clean and inspect battery clamps, cables, and connectors
AM	E2.	Perform battery condition tests
AM	E4.	Charge and install a battery
AM	F2.	Remove, clean, and inspect starter motor and components
AM	G4.	Repair or replace charging system components
AM	H2.	Repair or replace lights, sockets, wires, and switches
AM	I1.	Diagnose and repair gauge and warning circuits
AM	I2.	Diagnose and repair electrical accessories (horn, wiper, motor)
AM	Q3.	Inspect, replace, and adjust drive belts and hoses
AM	Ee3.	Inspect, adjust, and replace sensors, cables, and actuators
DM	D2.	Replace and adjust fan and auxiliary belts
DM	D3.	Replace water filter
DM	D7.	Replace hoses and clamps
DM	F2.	Evaluate problem
DM	K3.	Perform common diagnostic tests
DM	K4.	Evaluate test results
DM	K6.	Repair and/or replace starter
DM	K7.	Remove and replace battery

DM	K8.	Remove and replace associated wiring and/or switches (solenoids/relays/contacts)
DM	N2.	Demonstrate an understanding of basic AC theory and operation
DM	N3.	Remove and replace major components
DM	N4.	Evacuate and charge system
EL	A4.	Identify and practice safe soldering methods
EL	B2.	Describe the basic physics of semiconductor materials
EL	B3.	Describe the relationship between electrical and magnetic properties
EL	B4.	Describe the electrical and magnetic properties of a magnet
EL	B5.	Describe the photoelectric effect
EL	B6.	Describe the thermocouple effect
EL	B7.	Describe the electrical effect of friction
EL	B8.	Describe the concept of resistance, voltage and current and how they relate to each other
EL	B9.	Describe the concept of capacitance, voltage and current and how they relate to each other
EL	B10.	Describe the concept of inductance, voltage and current and how they relate to each other
EL	B12.	Identify and test resistors
EL	B13.	Identify and test capacitors
EL	B14.	Identify and test inductors
EL	B15.	Calculate series and parallel; resistive, capacitive and inductive networks
EL	B18.	Calculate RC time constant circuits
EL	C1.	Describe types of transformers
EL	C2.	Determine transformer requirements
EL	C3.	Determine rectifier (diode) specifications for specific installations
EL	D1.	Identify schematic design symbols for ser...conductor devices
EL	D13.	Test diodes
EL	D14.	Test transistors
EL	H1.	Describe the operation and demonstrate the use of an oscilloscope
EL	I2.	Identify the levels of computer languages
EL	M3.	Solder/desolder circuits
SE	F2.	Read electrical schematics
SE	F3.	Test, service, and/or replace battery
SE	L3.	Repair or replace related electrical components including safety devices
SE	Q1.	Adjust tension and alignment of pulleys and belts

Group Three Competency Lists, Revised

Color Codes:

Blue - CONSTRUCTION Cluster
Peach - MANUFACTURING Cluster
Green -TRANSPORTATION Cluster

Construction Cluster
Common Cluster Competencies, Revised

BM	B2.	Identify safety rules for carrying and erecting a ladder
BM	B3.	Identify safety rules for erecting scaffolding
BM	B7.	Clean windows
BM	C3.	Cut and solder copper pipe
BM	D3.	Bend and connect conduit
BM	E4.	Repair or install interior door operating hardware
BM	E5.	Identify procedures for repairing, replacing and/or installing floor coverings
BM	E6.	Repair, replace and/or install a ceiling system
BM	E7.	Install wall and/or ceiling insulation
BM	E8.	Install or replace interior trim
BM	F5.	Apply finish with brush
BM	F6.	Apply finish with roller
BM	H2.	Set forms
BM	H5.	Pour and finish concrete
BT	C1.	Use builder's level
CM	A12.	Identify wood species and grades
CM	B6.	Set up and operate planer safely and accurately
CM	C3.	Lay out, cut, and construct a dado joint
CM	C6.	Lay out, cut, and construct a miter joint
CM	D1.	Identify various types of wood glues, their uses, and precautions
ET	A7.	Apply techniques of lifting and climbing with ladders
ET	C5.	Use pouch tools
MA	B6.	Demonstrate proper installation and use of scaffolding
P	A7.	Practice ladder and scaffold safety

Manufacturing Cluster
Common Cluster Competencies, Revised

DR	F1.	Construct primary auxiliary views
DR	F3.	Construct secondary auxiliary views
DR	F4.	Identify use and application of auxiliary views
DR	G1.	Identify and draw standard sectional views
DR	G2.	Identify the symbols used to present different materials
DR	G3.	Identify and use cutting planes
DR	G4.	Identify and use conventional breaks
DR	G5.	Identify use and application of sectional views
DR	H1.	Apply dimensioning practices and techniques to drawings
DR	H2.	Construct the lines used to dimension drawings
DR	H6.	Identify geometric dimensioning and tolerancing techniques
DR	H7.	Apply geometric dimensioning and tolerancing techniques
MS	D9.	Plan sequence of machining operations
MS	F3.	Correlate types of materials to their properties
MS	F4.	List major cutting tool variables
MS	F6.	Test workpiece for hardness without hardness tester
MS	G4.	Cut and weld band saw blades
MS	G5.	Select and set speeds and feeds on power saw
MS	G6.	Cut material to length with power hack saw
MS	G7.	Cut material to length with band saw
MS	M3.	Calculate coordinates and dimensions of CNC drawing
W	B5.	Interpret structural shapes, sizes and weights
W	C2.	Identify types of fuels and their application
W	L4.	Describe and apply principles of metallurgy in annealing, hardening and tempering
W	L5.	Describe methods of testing metals
W	L6.	Identify types of ferrous metal by spark test

Transportation Cluster
Common Cluster Competencies, Revised

AB C5. Describe proper fitting and jacking techniques
AB K2. Replace energy absorbers
AB Q10. Remove and reinstall heating and air conditioning assembly
AB Q11. Remove and reinstall carpeting
AB Q12. Remove and reinstall seat belts and shoulder harness
AB Q13. Identify supplemental inflatable restraint systems
AB Q14. Diagnose supplemental inflatable restraint systems
AB Q15. Service and repair supplemental inflatable restraint systems
AB R9. Remove and replace a lock cylinder
AB T1. Service a taillight assembly
AB T2. Service a headlight assembly
AB T3. Service mechanical headlights and covers
AB T4. Aim headlights mechanical aiming equipment
AB U1. Remove and replace a radiator
AB U2. Remove, inspect and replace V-Belts
AB U3. Test antifreeze solution
AB U4. Service fan blades and clutches
AB U5. Check and service radiator and heater hoses
AB U6. Inspect, repair, and replace auxiliary oil cooler
AB U7. Inspect, repair, and replace fuel, exhaust, and emissions systems
AB V8. Inspect, flush, and replace heater core
AB W1. Identify front suspension systems
AB W2. Identify rear suspension systems
AB W3. Remove and reinstall front suspension systems
AB W4. Remove and reinstall rear suspension systems
AB W5. Remove and reinstall front drive train
AB W6. Service suspension systems
AB W7. Identify steering systems
AB W8. Perform four-wheel alignment
AB W9. Perform suspension quick checks
AB W10. Service power steering system
AB W11. Service brake system
AB W12. Identify causes of uneven tire wear
AB W13. Inspect, repair, and replace steering system components

AB	X1.	Identify vehicle frame construction, conventional and unibody
AB	X2.	Identify frame and unibody terminology
AM	C1.	Identify basic function and operation of vehicle mechanical components
AM	E3.	Jump start a vehicle
AM	F1.	Diagnose starting system and determine needed repair
AM	F3.	Repair or replace starter motor components
AM	G1.	Diagnose charging system and determine needed repairs
AM	H1.	Diagnose lighting system problems and determine needed repairs
AM	J2.	Inspect, repair, or replace primary ignition components
AM	J5.	Perform on-board computer system diagnosis
AM	J6.	Repair or replace computer system components
AM	K1.	Diagnose fuel system problems and determine needed repairs
AM	K2.	Inspect, repair, or replace fuel supply component
AM	K6.	Repair or replace fuel injection components
AM	K8.	Diagnose and repair exhaust system problems
AM	L6.	Clean, inspect/replace air management system
AM	L7.	Clean, inspect/replace inlet air temperature control
AM	L9.	Clean, inspect/replace fuel vapor controls
AM	M2.	Remove and replace engine (front- and rear-wheel drive)
AM	Q1.	Inspect and repair oil system and components
AM	Q2.	Perform cooling system tests; determine needed repairs
AM	Q4.	Replace cooling system components (thermostat, radiator, controllers)
AM	Q5.	Inspect coolant, drain, flush, and refill cooling system with recommended coolant
AM	Q6.	Perform oil and lube service on normally aspirated and turbo-charged engines
AM	R1.	Diagnose and determine needed repairs on steering systems
AM	R2.	Clean and inspect power and manual steering gear boxes
AM	R3.	Reassemble, adjust, and install power and manual steering gear boxes
AM	R4.	Clean and inspect power and manual rack-and-pinion steering rack
AM	R5.	Reassemble, adjust, and install power and manual rack-and-pinion steering rack
AM	R6.	Inspect and repair steering columns

AM R7. Inspect and replace steering linkage components
AM R8. Inspect, repair, and replace power steering pumps
AM S1. Diagnose and determine needed repairs on conventional and electric front suspension systems
AM S2. Inspect and repair control arm and spring assemblies on conventional systems
AM S3. Inspect and repair wheel spindles and bearings
AM S4. Inspect and replace shock absorbers and stabilizer bars
AM S5. Diagnose and determine needed repairs on MacPherson Strut assemblies
AM S6. Clean, inspect, and assemble MacPherson strut assemblies
AM T1. Diagnose and determine needed repairs on conventional and electronic rear suspension systems
AM T2. Inspect and replace shock and spring assemblies
AM T3. Inspect and replace MacPherson strut assemblies
AM T4. Inspect and repair suspension linkages and bushings
AM U1. Diagnose and determine needed repairs on conventional and electronic rear suspension systems
AM U2. Set correct alignment angles on front wheels
AM U3. Set correct camber and toe on rear wheels
AM U4. Rotate and balance tire and wheel suspension
AM V1. Diagnose hydraulic brake systems and determine needed repairs
AM V2. Inspect and repair or replace master cylinders and lines of the hydraulic system
AM V3. Inspect and replace switches and valving devices
AM W1. Diagnose and determine needed repairs on drum brake systems
AM W2. Remove, clean, and inspect drum brake assemblies
AM W3. Remove, replace, and adjust drum brake components
AM X1. Diagnose and determine needed repairs on disc brake systems
AM X2. Remove, clean, and inspect disc brake components
AM X3. Repair, replace, and adjust disc brake components
AM Y1. Diagnose and determine needed repairs on power-assist brakes
AM Y2. Repair or replace power brake components
AM Y3. Repair or replace hydra-boost components
AM Y4. Check operation of anti-skid braking systems; adjust or repair according to manufacturer's recommendations
AM Bb1. Diagnose and determine needed repairs

AM Bb2. Inspect, service, and replace front axle shafts
AM Bb3. Inspect, service, and replace drive shafts
AM Dd4. Diagnose and determine needed repairs on hub assemblies
AM Dd5. Disassemble, clean, and inspect hub assemblies
AM Dd6. Reassemble and adjust hub assemblies
AM Ee4. Inspect and replace external bushings, seals, and gaskets
AM Ee5. Inspect, replace, and align power train mounts
AM Gg4. Diagnose and repair automatic and electrical temperature control units
AM Hh1. Diagnose and repair heating system problems and determine needed repairs
AM Hh2. Inspect and replace heating system components
DM A9. Identify and select common seals and gaskets
DM B2. Test cooling system
DM B3. Test engine lubrication system
DM B4. Check air intake and/or exhaust system
DM B5. Draw lubrication and/or oil sample
DM B6. Check linkage adjustments
DM B7. Perform visual inspection
DM B8. Replace fuel filters
DM B10. Inspect steering linkage for wear
DM B11. Inspect and adjust brakes
DM C2. Adjust supplementary governing and/or control devices
DM C3. Adjust intake and exhaust valves according to specifications
DM C4. Adjust injectors according to specifications
DM C5. Adjust governor (as applicable)
DM D4. Replace and/or test radiators
DM D5. Flush cooling system
DM D6. Replace and test thermostat and seals
DM D8. Inspect fan drive assembly and related hardware
DM D9. Replace water pump
DM D10. Test and replace oil cooler
DM D11. Test radiator coolant
DM D12. Recognize proper routing and sizing of cooling lines
DM D13. Pressure test cooling system
DM E2. Test injection nozzles and injectors
DM E3. Time fuel injection pump
DM E4. Bleed fuel system
DM E5. Replace injection nozzles and injectors

DM E6. Test fuel system
DM E7. Identify and install fuel line hoses and connections
DM E8. Inspect turbo charger condition
DM F3. Trouble-shoot overheating and overcooling
DM F4. Trouble-shoot engine vibration
DM F5. Trouble-shoot electrical system
DM F6. Trouble-shoot low and/or high oil pressure
DM F7. Trouble-shoot smoke
DM F8. Trouble-shoot leaks and/or contamination
DM F9. Trouble-shoot hard starting
DM F10. Trouble-shoot high oil consumption
DM F11. Trouble-shoot fuel system
DM F12. Trouble-shoot internal noises
DM F13. Trouble-shoot low power and/or performance
DM F14. Trouble-shoot air system
DM F15. Trouble-shoot low fuel mileage
DM G2. Evaluate oil conditions
DM G3. Replace and inspect oil filter
DM G4. Change engine oil
DM G5. Change transmission and/or differential oils
DM G6. Change power steering fluid
DM G7. Lubricate chassis components
DM G8. Replace transmission and/or differential filters
DM H2. Remove engine
DM H3. Remove injection pump
DM H4. Remove camshaft and bushings
DM H5. Remove cylinder ridge, pistons and liner
DM H6. Remove crankshaft
DM H7. Remove oil pump
DM H8. Remove cylinder head
DM H9. Remove exterior components
DM I2. Clean components
DM I3. Inspect flywheel
DM I4. Rebuild oil pump
DM I6. Rebuild cylinder heads
DM I7. Rebuild or replace accessories
DM J2. Install camshaft and bushings
DM J3. Install crankshaft
DM J4. Install cylinder liners
DM J5. Install piston on rod
DM J6. Install piston on cylinder

DM	J7.	Install oil pump
DM	J8.	Install timing gears
DM	J9.	Install cylinder heads
DM	J10.	Install injection pump
DM	J11.	Install exterior components
DM	J14.	Tune engine
DM	J15.	Test run engine
DM	J16.	Install engine
DM	K9.	Remove and reinstall generator and/or alternator
DM	M1.	Identify basic principles of hydraulics
DM	M2.	Identify basic hydraulic components
DM	O3.	Remove and replace springs and pins
DM	O4.	Rebuild steering sector and hydraulic pump
DM	O5.	Remove and replace king pin
DM	O6.	Remove and replace steering components
DM	O7.	Inspect, remove and replace mounted tires
DM	P2.	Repair cam, wedge and disc brakes
DM	P3.	Service hydraulic brake system
DM	P4.	Inspect brake drum and/or rotors using safety specifications
DM	P5.	Replace spring brake chambers and diaphragms
DM	Q2.	Remove and replace clutch assembly
DM	Q3.	Adjust clutch free play
DM	Q4.	Install throw-out bearing
DM	Q5.	Remove, adjust and replace drive line
DM	Q6.	Remove and replace transmission (manual and automatic)
DM	Q7.	Remove and replace axle shaft
DM	Q8.	Replace and adjust wheel bearing
DM	Q9.	Service hubs
DM	Q10.	Check drive line alignment
DM	Q11.	Remove and replace differential
SE	D1.	Test, repair, or replace fuel pump
SE	D2.	Test, repair, or replace fuel filters and strainers
SE	D3.	Remove, clean and replace fuel tank shut-off valves, fuel lines, fuel hoses, and connections
SE	D6.	Adjust fuel mixture and check for air leaks
SE	D7.	Service oil-bath air cleaner
SE	D9.	Service dry-element air cleaner
SE	G1.	Remove and service spark plug
SE	G2.	Check ignition timing
SE	G3.	Test and repair breaker ignition system

SE	G4.	Test and repair breakerless ignition system
SE	G5.	Troubleshoot ignition systems
SE	H1.	Change engine oil and filter
SE	H2.	Service crankcase breather
SE	H3.	Inspect, repair, and/or replace pressure lubrication system
SE	H5.	Locate and repair leaking gasket and seals
SE	H7.	Select proper oil
SE	I1.	Service air-cooled system
SE	I2.	Service liquid-cooling system
SE	I3.	Remove, inspect, repair, and/or replace water pump
SE	I4.	Remove, check, and replace thermostat
SE	I5.	Perform a pressure test on cooling system
SE	I6.	Remove, check, and replace radiator
SE	J1.	Service and/or replace a 2-stroke-cycle exhaust system
SE	J2.	Service and/or replace a 4-stroke exhaust system
SE	M1.	Troubleshoot the ignition system
SE	M2.	Troubleshoot the fuel system
SE	M3.	Troubleshoot compression problems
SE	N1.	Identify the characteristics of the 4-stroke-cycle engine
SE	N2.	Describe the operating cycle of the 4-stroke-cycle engine
SE	N3.	Disassemble a 4-stroke-cycle engine
SE	N4.	Inspect and service a cylinder
SE	N5.	Inspect and service the pistons, rings, and connecting rod
SE	N6.	Inspect and service a crankshaft assembly
SE	N7.	Inspect and service a valve train assembly
SE	N8.	Reassemble 4-stroke-cycle engine
SE	P1.	Identify the component parts of a manual transmission
SE	P2.	Identify the component parts of a transaxle
SE	P3.	Identify the component parts of clutch systems
SE	P5.	Identify the component parts of brake systems
SE	Q3.	Adjust and replace control cables
SE	Q5.	Lubricate chassis components
SE	Q6.	Inspect and adjust brakes
SE	Q7.	Inspect and adjust clutch

APPENDIX D:

Final Presentation and Committee Questions

Industrial Education
Common Competencies Project

Manufacturing Cluster

Drafting

Machine Shop

Welding

Service Cluster

Air Conditioning, Heating, Refrigeration

Electronics

Construction Cluster

Building Maintenance

Building Trades

Cabinetmaking

Electrical Trades

Masonry

Plumbing

19 Areas
5 Clusters

Transportation Cluster

Auto Collision Repair

Auto Mechanics

Diesel Mechanics

Small Engines

"Other" Cluster

Commercial Art

Cosmetology

Food Service

Offset Lithography

D-1

Project Goal:

Establish What These 19 Areas Have In Common

Process:

1. Initial meeting held to outline project

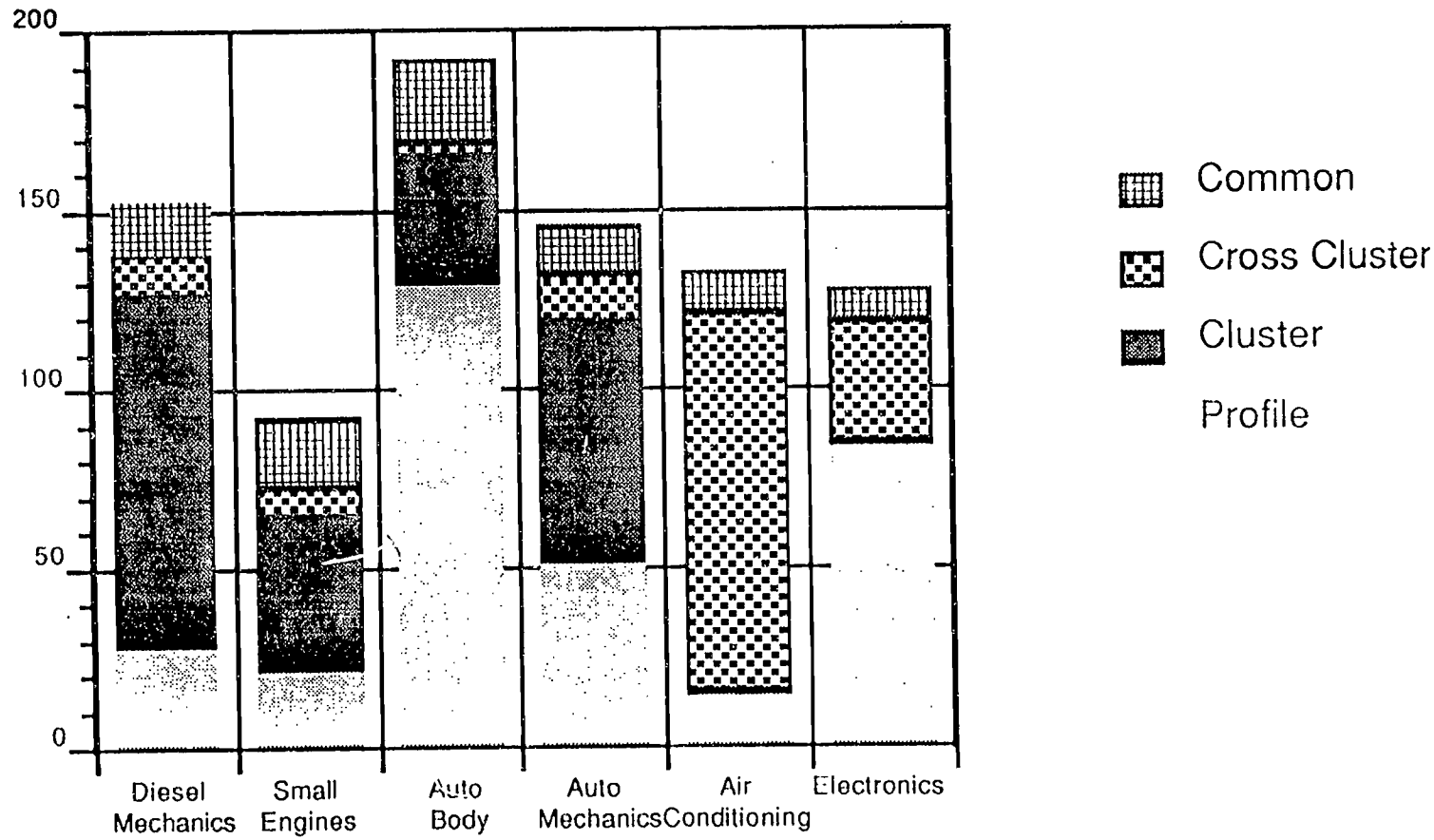
   Instructors examine competency profiles for all 19 areas to see what they have in common with each area

2. DESE and IML meet to determine what patterns instructors' work shows

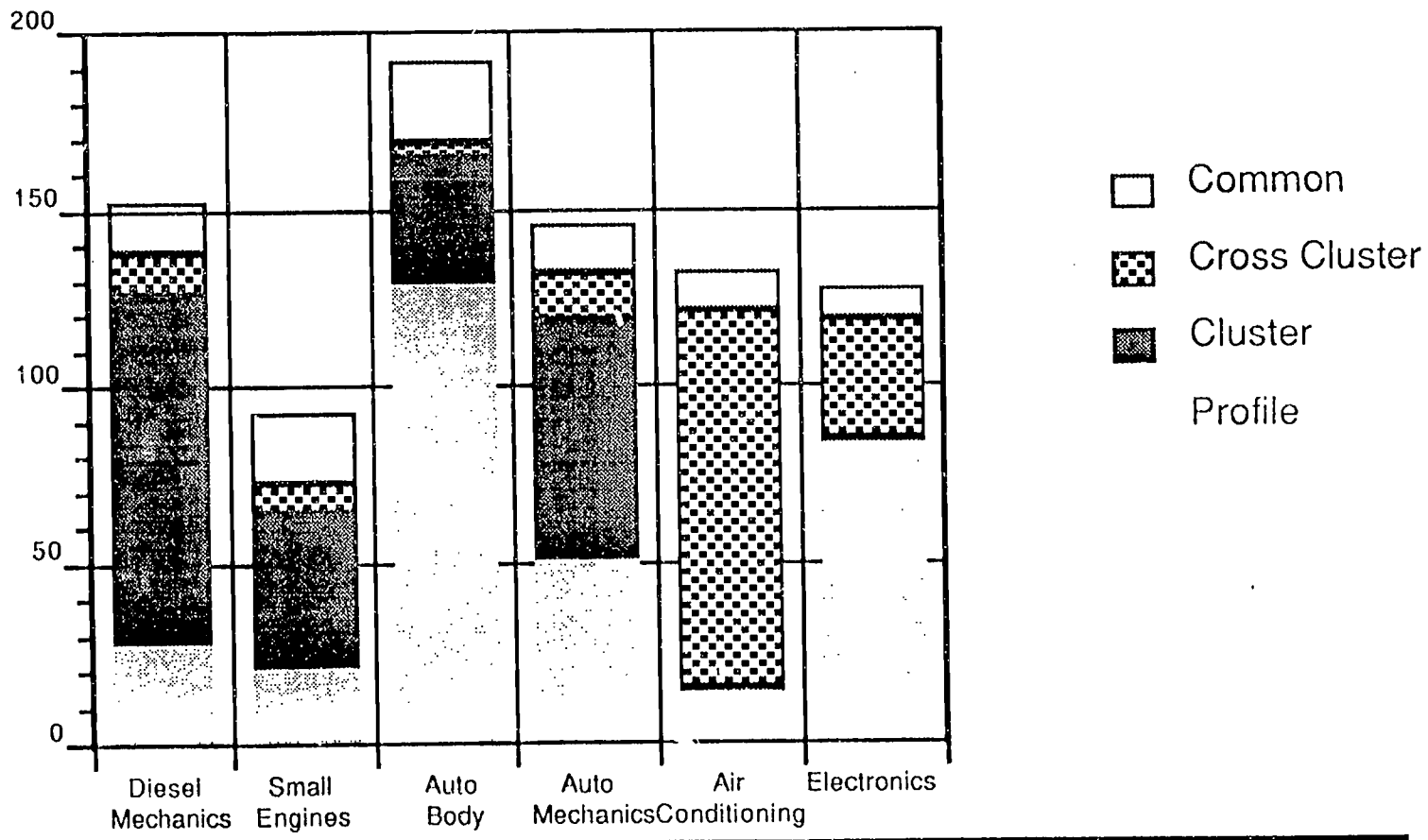
   Competencies are split up accordingly into lists

3. Instructors meet and make changes to competency lists
4. Competency lists are finalized and sent to instructors for one more review
5. Results are presented at a final project meeting

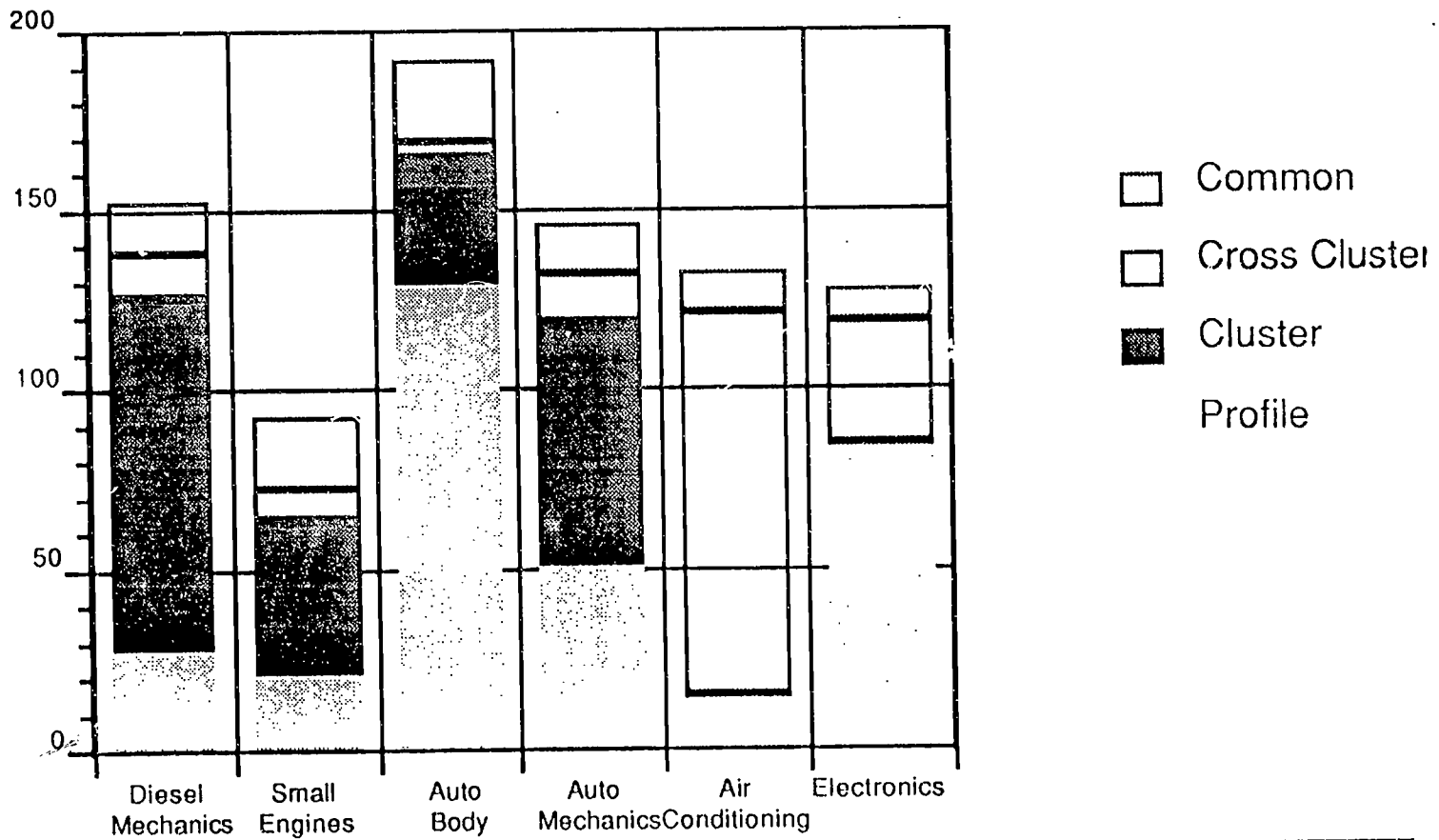
Transportation and Service Clusters: Common Cluster Level Competencies



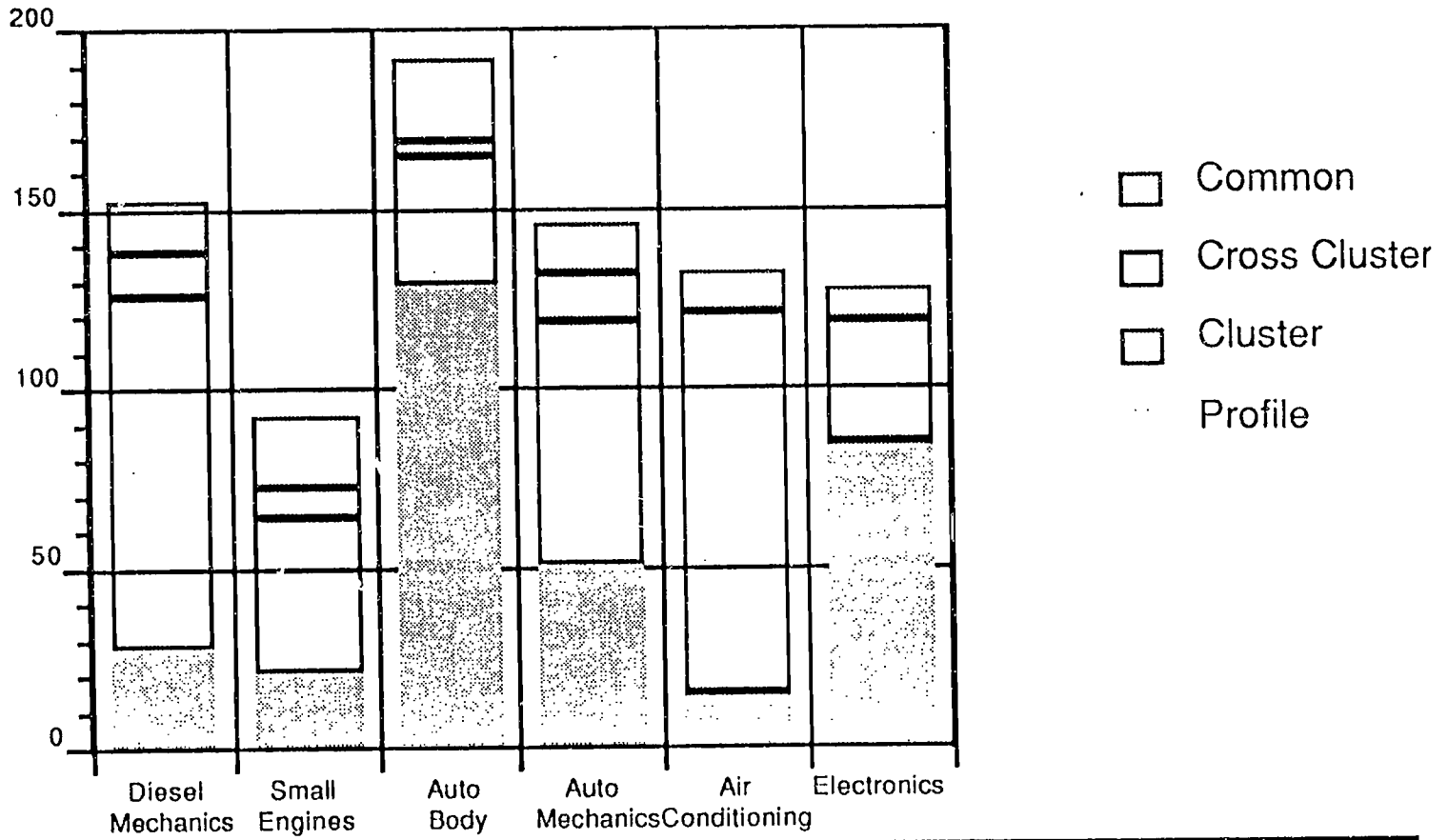
Transportation and Service Clusters: Cross Cluster Level Competencies



Transportation and Service Clusters: Cluster Level Competencies

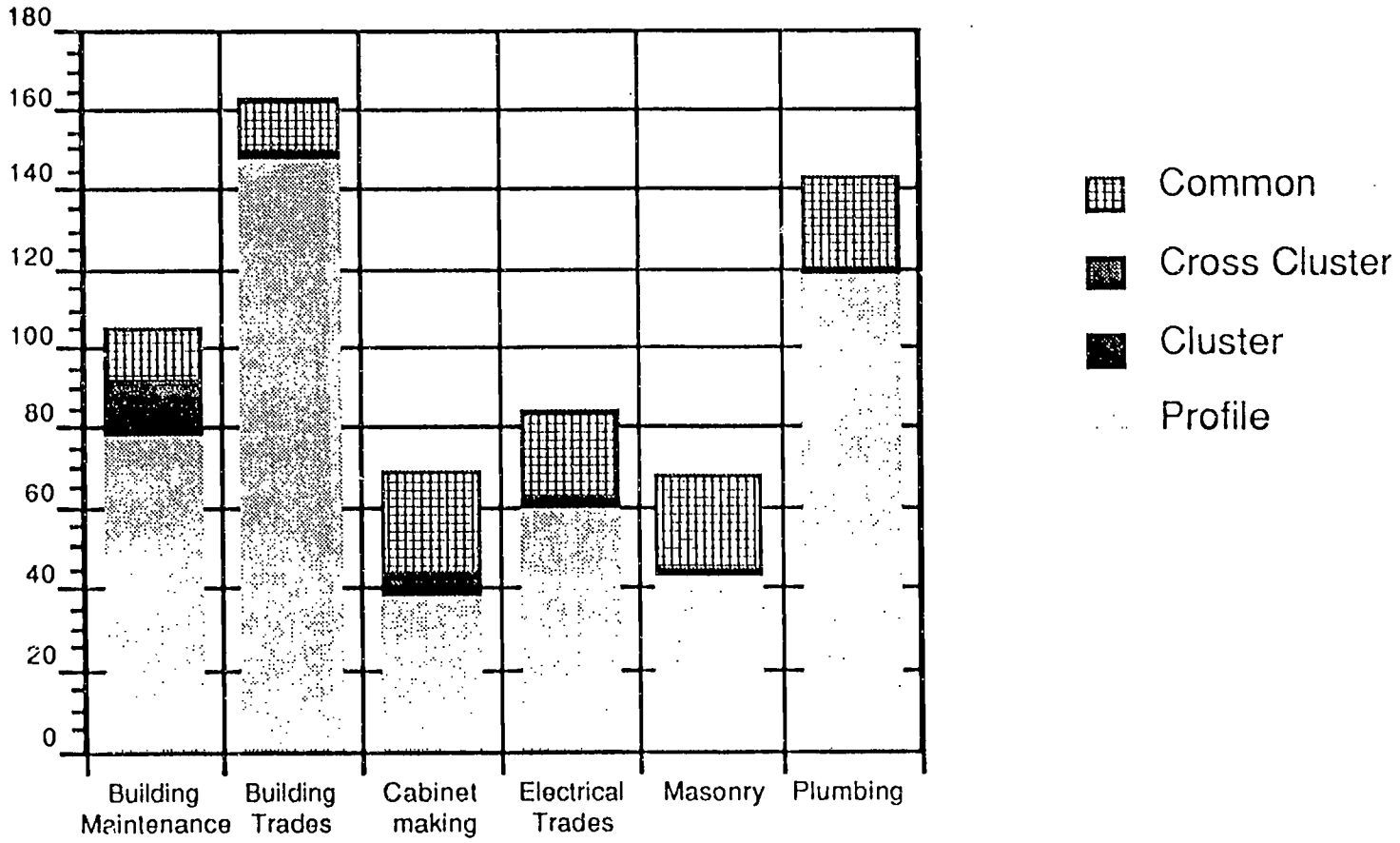


Transportation and Service Clusters: Profile Specific Competencies

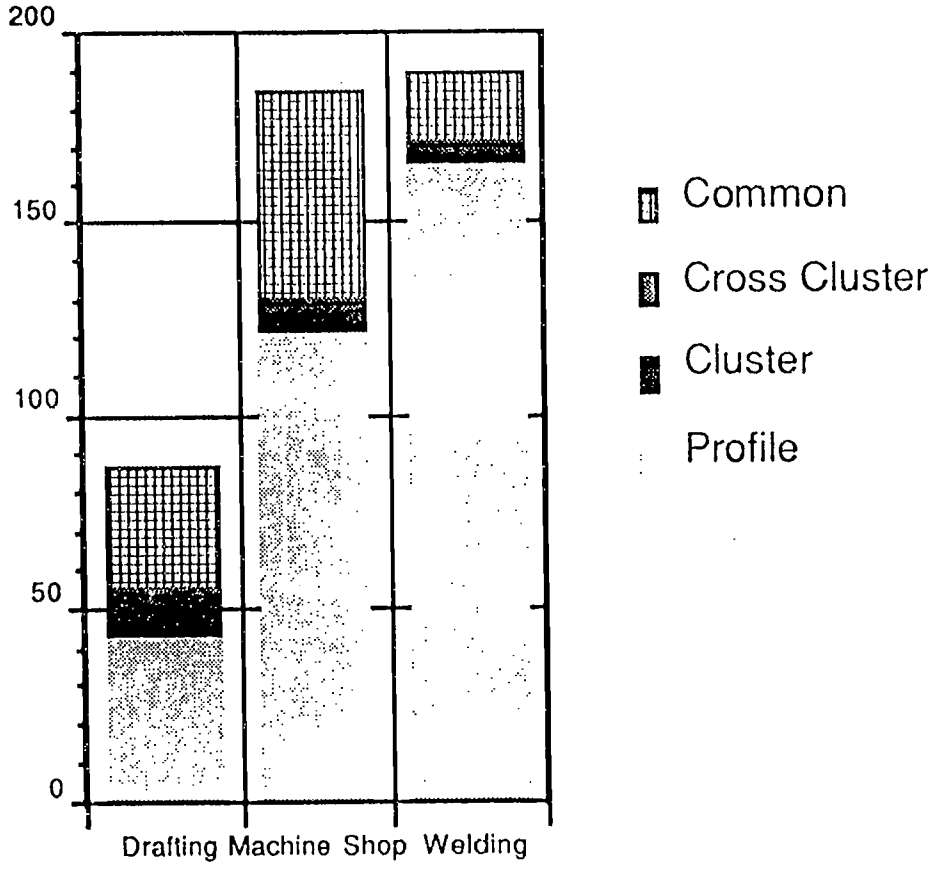


D-6

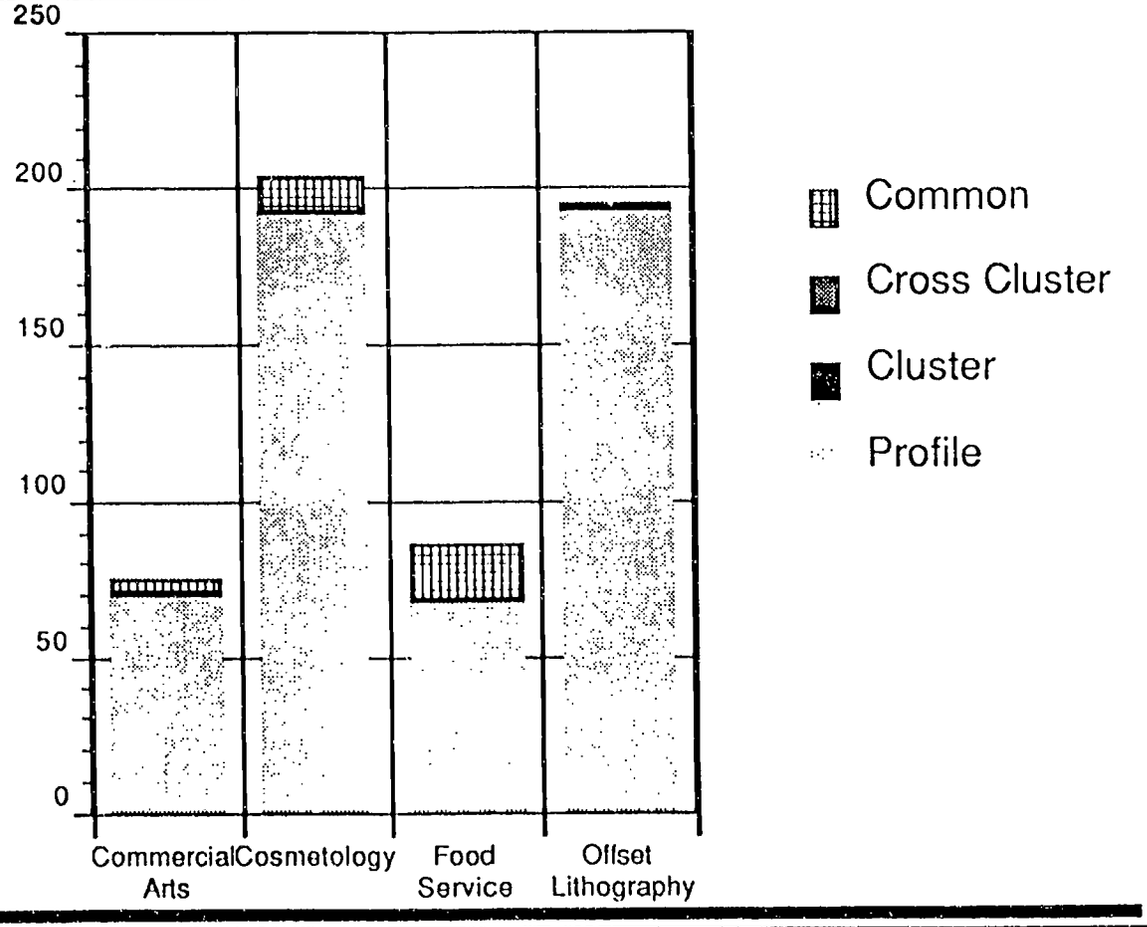
Construction Cluster



Manufacturing Cluster



"Other" Cluster



Questions to Advisory Committee, Final Meeting

1. In examining the list of common competencies that can be taught across a significant number of T & I areas, which of those merit more formal development?

2. In general, when looking at T & I, should there be a core set of tasks identified and organized to be taught within a specific time of instruction?

3. Can T & I education benefit by examining the full range of courses offered to students from their junior high through high school grade levels to determine a sequence of course studies that better or best prepare the student for a specific T & I area?

4. Now that those skills that students should possess prior to enrollment in T & I classes have been identified, should measurable, competency-based entrance tests be established to determine individual students' readiness to learn in those classes?

5. In examining the current delivery system, what must exist to allow a full range of student participation and enhance the Tech Prep philosophy?

6. Are there some steps that can be taken to improve program appeal, standards, and quality?