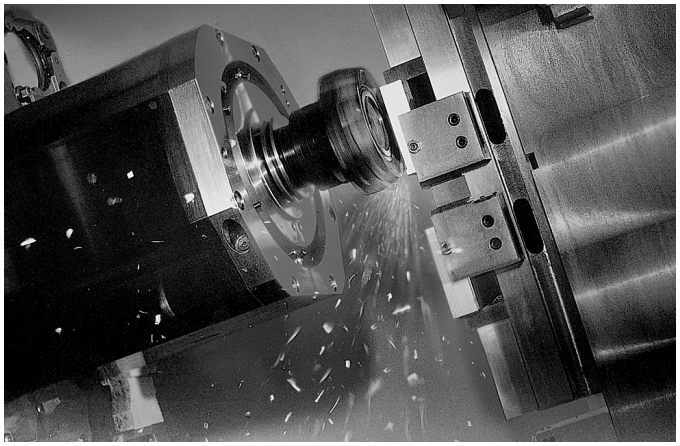

Introduction

1.0 OVERVIEW

Machinists are highly skilled men and women. They use drawings, hand tools, and various machine tools to shape and finish metal and nonmetal parts. Machinists must have a sound understanding of basic and advanced machining technology, including:

- The ability to properly use precision measuring tools.
- A proficiency in safe machine tool operation (manual, automatic, and computer-controlled).
- A knowledge of the working properties of metals and nonmetals.
- Basic academic skills (math, science, English, print reading, metallurgy).

A well-planned machining program integrates and balances hands-on experience with the comprehensive coverage of the technical aspects of machining technology.

Machining Fundamentals provides an introduction to this important segment of manufacturing technology. It furnishes basic information on the tools, materials, and procedures employed in machining technology. Remember—*before* you can go high tech, you must first understand the fundamentals.

1.1 INSTRUCTIONAL MATERIALS

The following materials have been developed to aid in presenting a dynamic machining program.

1.1.1 Textbook

The textbook is a very important part of an instructional program. ***Machining Fundamentals*** provides an introduction to machining technology. The text explains the *how, why,* and *when* of the various machining operations, setups, and procedures. Through it, your students/trainees will learn about the various related areas of machining technology, how machine tools operate, and when to use one particular machine instead of another. The advantages and disadvantages of the various machining techniques are also discussed.

Machining Fundamentals details the many common methods of machining and shaping parts to given specifications. It also covers newer processes such as laser machining and welding, water-jet cutting, high energy rate forming (HERF), cryogenics, chipless machining, electrical discharge machining (EDM), electrical discharge wire cutting (EDWC), electrochemical machining (ECM), numerical control (NC and CNC), robotics, rapid prototype forming, and the importance of computers in the operation of most of these machining techniques.

Machining Fundamentals is written in an easy-to-understand language. There are many color photographs and line drawings to help students/trainees clearly visualize machining operations and procedures.

Colors are used throughout ***Machining Fundamentals*** to indicate various materials or equipment features. The color key is on page 4 of the text. The following list identifies colors and materials by name.

Metals (surfaces)	Dark Gray
Direction or force arrows, dimensional information	Red
Machines/machine parts	Blue

Fasteners	Yellow
Tools	Dark Green
Abrasives	Brown
Work-holding and tool-holding devices	Purple
Fluids	Lime Green
Rulers and measuring devices	Tan
Miscellaneous	Orange

Learning Objectives

Every chapter opens with a list of objectives. They make the student/trainee aware of what he/she will be able to accomplish after studying the chapter.

Because of many factors, it may not be possible to achieve every objective with each class. However, it is better to thoroughly cover less material than to cover all of the material poorly.

Test Your Knowledge Questions

Each chapter ends with a set of questions. The questions can be used to check student comprehension of the text material. The questions can be used as either a quiz, homework, or extra credit.

Glossary

The glossary provides a quick reference to the definitions of technical terms used in machining technology.

Reference Section

A reference section of tables and other useful information is provided on pages 557–592. This section contains information on a variety of topics including the physical properties of many metals, cutting speeds and feeds, drill and screw thread sizes, and metric tables.

1.1.2 Instructor's Resources

The resources have been devised to assist the instructor in improving their machining technology program. For each chapter, it includes *Learning Objectives,* a list of *Technical Terms,* the text's *Test Your Knowledge Questions, Research and Development Ideas, Answer Keys, Reproducible Masters,* and *color transparencies.* It also includes a correlation chart for Level I of the *Duties and Standards for Machining Skills.*

Learning Objectives

For ease in referencing, text objectives are listed for each chapter. The goals presented involve basic concepts, skills, and understandings that should be stressed while teaching the chapter. The objectives can also be used as an outline when preparing lesson plans.

Technical Terms

It is important that machinists use the correct technical terms of the trade. Students should be encouraged to review and study any new and unfamiliar terms.

Test Your Knowledge Questions

The questions from the end of the chapters are included as reproducible masters. Save time by copying and distributing the reproducible master rather than having students use the questions at the end of the chapter and writing their answers on a separate sheet of paper.

Research and Development Ideas

These ideas offer an opportunity to bring many of the latest machining techniques into the shop/lab. They can be used by both the instructor and the student.

They can be used for open discussion, homework assignments, extra credit, or individual or group projects. They provide the opportunity for developing student/trainee originality and ingenuity.

Answer Keys

Answers to the *Test Your Knowledge* questions and workbook are provided within each chapter.

Reproducible Masters

Full-page illustrations and *Test Your Knowledge* questions that can be copied and distributed to students and/or used as overhead transparencies. Each is correlated to the text with a chapter identification number. Color can be added to the transparencies with felt tip pens.

Color Transparencies

A set of full-color transparencies has been produced to help the instructor reinforce concepts presented in the textbook. The 56 transparencies are available in printed form with the Instructor's Resource Binder and in electronic form with the Instructor's Resource CD.

Duties and Standards for Machining Skills Level I *Correlation Chart*

A chart correlating the *Duties and Standards for Machining Skills* to the ***Machining Fundamentals*** text has been included on pages 25–26

of this resource. The categories are correlated to the text by chapter and section numbers.

The standards were developed by the metalworking industry to provide a certification and training method through which individual workers can receive recognition and reward for their abilities. The standards will also help employers identify training needs and evaluate job applicants fairly.

Although elements of all three standards often appear in training programs of varying levels, ***Machining Fundamentals*** is an introductory text so only Level I of the standards will be covered in this manual.

For additional information on the standards and testing programs, contact the National Tooling and Machining Association (NTMA), 9300 Livingston Road, Fort Washington, MD 20744.

G-W Test Creation Software

The G-W Test Creation Software is included with the Instructor's Resource CD. The database for the software package includes over 1400 questions. The versatility of the software allows the instructor to create customized tests.

Tests can be generated with randomly selected questions, the selection of specific questions from the database, and the addition of personalized questions. Different versions of the same test can be created for use during different class periods. The software also allows the modification and importing of graphics. Answer keys are automatically generated to simplify grading.

1.1.3 Workbook

The workbook is an aid for measuring student/trainee achievement and comprehension. It uses a variety of questions, problems, and assignments. The workbook materials within each chapter are presented in the same order as corresponding material in the textbook.

For use as a study guide, students/trainees should first read and study the material assigned in the textbook, giving careful consideration to the illustrations. Then, without the aid of the textbook, fill in the workbook answers. As recommended for several chapters of the text, the assignments in the workbook can also be divided into parts as seen fit by the instructor.

Answers to the questions and problems consist of words, letters, numbers, and simple drawings. Instruct students that words should be spelled correctly and letters and numbers should be carefully formed. It is highly recommended that the letters and words be printed. Stress to students that most tradespeople follow this same practice since the information will be easier to read and the possibility of errors greatly reduced. Sketches should be carefully drawn in the space provided. When required, mathematical calculations should be made in a neat, organized manner. This makes it easier to check the procedure used in solving the problem.

1.2 TO THE INSTRUCTOR

It is not possible for an author or publisher to provide a detailed machining technology program that will be suitable for every teaching situation. Some training programs require a specific outline to be followed. Also, the type, number, age, and condition of the machine tools available will vary.

As the instructor, only you can determine the material that will best serve your students/trainees. Only you know their abilities, the facilities, materials, and equipment at your disposal, and the time available.

Before the first class meeting, familiarize yourself with the text and its related teaching material. Outline the chapters you plan to teach. Prepare detailed lesson plans and gather and/or make the teaching aids that will be needed. Check equipment that will be used. Be sure it is in good condition with all safety features in place. Have ample supplies on hand.

This will probably be the first machining technology class to which your students/trainees have been exposed. What is so obvious to you, may be completely foreign to them. Make your lesson plans with this in mind.

1.3 SHOP/LAB MANAGEMENT

There are several areas in shop/lab management that must be considered. If properly developed, they can save time that can better be devoted to one-on-one teaching.

1.3.1 Control of Tools and Consumable Supplies

Many expensive tools are required in machining technology. A method for controlling

their disbursement and return to inventory must be devised and continually monitored to reduce the number of damaged tools and to prevent pilferage. The same care must be exercised for issuing stock and other consumable supplies.

You can examine the systems local industries have established for control of tools and supplies, and implement one of them, or you can devise your own.

1.3.2 Scheduling

Because of equipment limitations, you will not be able to have all students/trainees working on the same assignment at the same time. Assignments must be organized and scheduled so equipment will be used as much as practical.

1.3.3 Shop/Lab Management System

Good housekeeping and cleanliness is important in machining technology. Insist that students/trainees clean workstations after use. To aid in overall shop/lab cleanliness, each person should be assigned, on a rotating basis, a specific cleanup task each week. Praise them when the job is well done.

Once a week, a more thorough cleanup should be done. This includes cleaning lockers and getting shop coats and aprons washed.

Since the best teaching is on a one-to-one basis, a well organized student/trainee management system will give you more time for individual aid.

Assignments should be given on a rotating basis so all of them will be able to experience each position at least once during the term.

In the interest of maintaining a safe and orderly shop, a student/trainee management system should include the following positions and responsibilities:

Superintendent
Responsibilities should include:
- Directing the student/trainee management system.
- Bringing the class to order.
- Inspecting the shop/lab for cleanliness and apparent or potential safety problems.
- Checking with other systems managers to be sure they are working at their assigned duties.
- Assigning students to fill in system vacancies caused by absences.
- Initiating cleanup.
- Inspecting the shop/lab at the end of the period for cleanliness, securing reports from other systems managers.
- Reporting the condition of the machines, tools, and supplies.

Records Clerk
Responsibilities should include:
- Recording attendance and tardiness.
- Keeping progress charts up-to-date.
- Serving as bookkeeper for stock requisition.
- Delivering messages.
- Greeting visitors.

Tool Crib Manager
Responsibilities should include:
- Issuing and returning tools to proper storage.
- Keeping accurate records of tools issued and returned.
- Reporting missing tools and tools in poor or unsafe condition.

Stock and Supply Supervisor
Responsibilities should include:
- Recording student/trainee requisitions for metal stock and supplies.
- Cutting stock to requisitioned size.
- Sorting metal scrap to salvage usable material.
- Reporting pending shortages of supplies.
- Keeping stock organized in storage racks.

The above are only suggested management positions. They can be added to, and the duties modified and/or changed.

1.4 IMPROVING INSTRUCTION

Whether teaching machining technology, or any other subject, you make use of certain universal instructional tools. All good teachers apply these concepts, either consciously or unconsciously. When making your lesson plans, try to implement the ideas listed below.

- ***Reinforce.*** The more ways a student/trainee is exposed to a given concept, the greater the understanding and retention of the material. A variety of learning experiences are designed to meet the reinforcement needs of the learner.
- ***Extend.*** The teaching suggestions in this manual are directed at students/trainees with a variety of ability levels. Some assignments may be chosen to encourage highly motivated students/trainees to extend their learning experience outside the shop/lab. These types of activities allow them to relate text information to other experiences.

- ***Reteach.*** Students/trainees respond differently to diverse teaching methods and techniques. This allows you to choose a different plan of action to reteach those who responded poorly to a previous strategy.

1.5 PLANNING AN INSTRUCTIONAL PROGRAM

No matter what approach you take in teaching a basic machining technology program, the importance of careful planning and organizing *cannot* be overemphasized. Planning to achieve program goals will be easier if you know *why, when,* and *how* to plan.

Knowing *Why* to Plan

Planning is the process of carefully selecting and developing the best course of action to achieve program goals and objectives. This action cannot be a hit-or-miss situation. How well you meet your teaching responsibility depends, to a great extent, upon your consistency. Every class should be planned and prepared carefully.

We plan so action will take place at the right time. Planning helps anticipate problem areas of learning, and makes adapting to and handling emergencies easier. Planning saves time, money, and ensures a higher quality product—your students/trainees.

Planning helps assure quality results, saves valuable class time, helps reduce discipline problems and makes it easier to adapt to changes. Planning is also good teaching—knowing what has to be taught, what has been taught, and what needs to be taught to reach program goals and objectives.

Knowing When to Plan

In lesson planning, it is best to be flexible. That is, planning must be continuous. You must be able to adjust your lessons for differences in classes or classes missed because of bad weather and other unplanned interruptions.

Rigid planning means that a specific lesson will be taught on a specific day. If a class is missed that day, there is no way to make it up. Although preferable to not planning at all, rigid planning is less effective than flexible planning.

When developing plans, you must consider the time available. Once you know this, you can classify the demands on this time by what must be done, what should be done, and what need not be done.

After a course of action has been determined, specific planning can begin by:

- Establishing goals for each class. Some classes may require more time to master the same skills and information than other classes.
- Taking inventory of supplies and equipment. Be sure the supplies are adequate.
- Considering different teaching techniques. What other methods are available that will be equally effective?
- Providing specific learning experiences in an interesting manner.
- Setting plans into action. Once a plan of action has been developed, it should be followed.

Knowing How to Plan

A lesson plan is an outline for teaching. It keeps the essential points of the lesson in front of you and ensures an orderly presentation of material. Such a plan does much to prevent important aspects of a lesson from being omitted. It will also prevent you from straying too far from the lesson and introducing irrelevant material.

Your lesson plan should include the material to be taught, the methods and techniques best suited to teach this material, any supplies or equipment needed, and teaching aids to be used.

Review your material before class time. Be familiar with all of the material related to the subject. You should be prepared to teach more material than you may have time to cover. Check all of the supplies and equipment to be sure they are ready to use, in safe working condition, and arranged so they will be handy during the lesson. Seating and viewing arrangements should be such that every student/trainee can see and hear the lesson.

Finally, keep your plans up-to-date. This can be done by observing student/trainee progress and achievement. Make changes when you think they are necessary for curriculum improvement.

In general, *always* prepare a lesson plan and *follow it.*

Modify it as necessary. Start with something that is familiar to the student/trainee. Then move into new material in short easily understood steps. Avoid long boring lessons and lessons that do not allow student participation.

The First Class Session

After becoming familiar with ***Machining Fundamentals*** you will have to determine which chapters can be used in your machining technology program and to the extent to which they will be covered. This will require special planning so students/trainees will acquire sufficient skills development through "hands on" activities.

Whatever your selection, Chapters 2, 3, and 4 should *not* be omitted. They are basic to any machining technology program.

During the first class session, after all the administrative paperwork is completed, have your students/trainees complete a personal information sheet designed like a job application. In addition to giving them experience in filling out a job application, it will help you get to know them better.

1.6 TEACHING METHODS FOR MACHINING TECHNOLOGY

No learning takes place until a student/trainee wants to learn. Getting them interested is the *most* difficult part of teaching. Motivation, therefore, is the first step in good teaching. You want to stimulate students/trainees so they want to learn.

One of the quickest way to lose student interest is to be unprepared and present a meandering lesson. For effective teaching, you must carefully prepare the material, the situation in which it will be taught, and the student/trainee who will receive the new information.

Start by learning and mastering the material yourself. Be sure all necessary materials and teaching aids are readily available and in good working condition.

Determine what equipment will be needed and position it so all students can see and hear the lesson and/or demonstration.

Decide how you want to motivate your class. You can use curiosity. Students/trainees want to see, hear, and know about new and different things. Competition is another way to create interest. Some learners may want to take on a challenge to surpass another person or group.

Above all, you must be interested in what you are doing. If you are not interested in the subject matter, it is unlikely your students/trainees will be interested.

Before placing responsibility for failure on a student, review and evaluate the lessons taught to determine whether the goals of the lessons were attained.

Some instructors assume that if they are quick to learn, the same holds true of others. This has the effect of retarding the learning process rather than enhancing it. Impatience can create student/trainee fear of the instructor. To do a good job, you must have the respect of the learner. You do not have to be liked by them, but you do not want to be feared. There is quite a difference.

Although careful preparation will greatly improve your teaching effectiveness, it does not guarantee success. The amount of effort to develop and hold student interest will vary from class to class. More or less instruction than was planned may be required. Student/trainee alertness may vary with physical condition including illness, fatigue, and lack of sleep. Their rate of learning may change for no apparent reason. There may be distractions that you did not expect.

In order to determine what may be distracting your students/trainees, or causing lack of interest, consider the following. Do you:

- Use and pronounce words correctly?
- Avoid the use of localisms, slang, and monotonous connectives?
- Look directly *at* and speak directly *to* the learner?
- Maintain good eye contact?
- Use the appropriate vocabulary level?
- Prepare yourself?
- Use variations in the pitch of your voice?
- Give credit where credit is due?
- Stimulate thinking when you ask a question by phrasing it to bring out the *why* and *how*?
- Know all students by name?
- Summarize frequently, as each major point in the lesson is made?
- Direct questions at inattentive students/trainees?
- Delay the entire class when one student is causing a problem?
- Continually check class reaction?
- Use teaching aids whenever possible?
- Display teaching aids where the entire class can see them?
- Check training aids like video equipment, projectors, screens, and tapes before class starts?
- Preview and select audio-visual material for specific instructional content?

- Prepare students/trainees for the video, film, or tape?

The list could go on and on but the key is being prepared. Know what you are going to teach and how you are going to do it. You can only develop student interest in what you are teaching if you are interested in what he/she is achieving.

Some other tips to teaching effectively include those listed below.

- Put the students at ease. Humor is an effective tool to help students/trainees to relax. Remember, a tense atmosphere will inhibit learning.
- Students have five senses. The more senses you can involve in the learning process, the more likely the student/trainee will remember what is taught.
- You should direct questions to individual student/trainees to attract and hold attention and interest, measure knowledge and understanding, and focus attention on the main concepts.
- Students/trainees are people with different personalities and attitudes. You will be more successful as a teacher if you get to know your students individually. This will allow you to see the areas in which each one needs help and encouragement.
- Do not allow the class to become a monologue in which you spend the entire period lecturing. You must encourage them to ask questions and discuss topics.
- When using a chalkboard, stand to one side of the board. Also, talk directly to the class *not* to the chalkboard.
- Remember, topics which are simple to you may be most complex for the students/trainees. Avoid covering a topic too quickly.
- You must speak clear enough, loud enough, and slow enough for your students/trainees to follow the lesson.
- Use a tape recorder to critique your verbal presentation.

1.6.1 Student/Trainee Evaluation

Discuss with the students/trainees how they will be evaluated. Emphasize the importance of attendance and its significance when they enter the workplace. Avoid allowing students/trainees with a number of unexcused absences to make up missed work at the end of the work term with a short meaningless assignment. Some programs require a predetermined number of hours in actual attendance before a certificate or degree is granted. More and more instructors are "docking" students/trainees for absences in the same manner their wages would be reduced for a similar problem in industry.

Since grading methods vary greatly, it is not possible to include detailed evaluation techniques in this manual.

The material in the following sections may be of more concern on the secondary school level than the post-secondary level.

1.7 MAINTAINING DISCIPLINE

Discipline is one of the primary responsibilities of the teacher/instructor. Good class discipline can make teaching a pleasure while poor discipline can make teaching agony.

It would be foolish to assume that there is a set of rules, magic formulas, or chants that will guarantee a teacher/instructor good discipline and respect. There are however, ideas that have been successfully used by many teachers/instructors. Remember, these are only recommendations. It is necessary to work at maintaining good discipline every minute you are in the classroom. There is no one correct way to do it. What works today may not work tomorrow.

- The purpose of discipline is correction. Discipline is *not* chastisement. Discipline is systematic training for improvement of a person's attitude and action.
- Make reprimands with justice and tact. When you are angry or not feeling well, it is wise to refrain from any drastic action until you have the opportunity to review the situation in a better state of mind.
- Be consistent in disciplinary actions.
- Consider the student's mental and physical condition.
- Seek the actual cause of their poor work or attitude.
- Never be influenced by a student's reputation.
- Control order through an interest in your work. Students/trainees sense when you do not like your job.
- Provide sufficient equipment and working materials.
- Keep machines and equipment in good working condition.
- Maintain a clean and attractive shop/lab.

- Be sure all student's can see and hear you when you present a lesson.
- Handle all disciplinary cases yourself whenever possible. A good teacher/instructor is one who seldom has to call on higher authority to maintain discipline in his/her class. Report only major infractions to higher authority. Be able to document problems with complete and up-to-date records.
- Stop problems at their origin.
- Make only necessary rules and *enforce them every day.*
- Avoid assigning schoolwork as punishment. The entire class should not be disciplined for the acts of an individual.
- Make disciplinary actions fit the deeds.
- *Never* use abusive language and/or profanity.
- Grade papers and tests so they can be returned the next class session.
- Have work prepared for the substitute when you must miss a class. Student/trainee time should not be wasted and you will know where to start when you return to class.

Discipline requires more than the few suggestions listed above. Talk to your principal/director on what their ideas are for discipline and what support you can expect from them should a problem arise that you are not able to handle.

1.8 PREPARING FOR THE SUBSTITUTE TEACHER

Substitute teachers have one of the most difficult jobs in education. Some of us expect a substitute teacher to do things we cannot do ourselves. For example, they are to keep a class under control with a lesson plan as brief as, "Read Chapters 1, 2, and 3 and answer the questions at the end of the chapter."

The instructor who maintains a well organized machining technology shop/lab will provide carefully planned material for the substitute teacher. Advanced preparation for instructor absence will permit the program to continue with minimum interruption.

Materials and information that will be required by the substitute teacher include:

- A seating chart and attendance book for each class.
- The location of keys.
- Brief descriptions of the daily routine and the student/trainee organization.
- Procedure for distributing equipment and materials.
- The procedure for cleanup and dismissal.

The operation of equipment should not be allowed.

The best plans are of little value if the substitute cannot locate them. To avoid such a situation, assign a specific place for storing the plans. It is recommended that several instructors in the shop/lab area be informed where the plans are stored.

Request that the substitute teacher leave a report on accomplishments and/or problems for each class. The substitute's report should include the material covered, work completed, and class conduct. The substitute should include the strengths and weaknesses of materials prepared on his/her behalf as well as any suggestions for improvement.

1.9 VARYING STUDENT/TRAINEE ABILITIES

Students/trainees entering your classroom will undoubtedly possess a variety of skills. Some may possess basic metalworking skills while others may not. Students will also have a wide variety of career goals. Some students/trainees plan to attend college and become engineers in the field of metals technology while others will attend community college programs to become technicians. Still others may want to enter the trade or enlist in the Armed Forces as specialists in machining technology.

As with any field of study, the level of student/trainee comprehension and performance will vary within each class. Achievement in machining technology depends not only on a person's communication skills and dexterity, but their ability to visualize solutions to problems. You must recognize the degree to which your students/trainees possess these skills. Different teaching methods are required for students/trainees with different ability levels. Following are some suggestions that may be helpful in serving all students/trainees, especially those with special needs.

1.9.1 Identifying Students/Trainees with Special Needs

Ideally, special needs students/trainees will be identified by the school psychologist. The school nurse should also provide information

regarding students/trainees who, because of the medication they are taking, or because of other physical disabilities, should not be permitted to operate machinery. *Actions of some of these students/trainees may endanger themselves or other people in the class. Work out a plan with your principal, supervisor, or director in advance on how this type of a situation should be handled.*

Characteristics of special needs students/trainees are included in the following list. An infrequent occurrence does not denote that someone is a special needs student/trainee.

- Impaired speech, hearing, and/or vision.
- Inability to communicate effectively (reading, writing, oral expression, and questioning).
- Short attention span or lack of interest.
- Lack of motivation.
- Lack of self-confidence.
- Poor computational skills.
- High rate of absenteeism.
- Frequent disruptive behavior.

Mainstreaming

In the past, most special needs students were segregated into separate rooms for instruction. The rooms were generally staffed with instructors trained to work with special needs students. The instructors, however, were not well-trained in vocational-technical disciplines. Mainstreaming is a popular method of integrating special needs students into vocation-technical programs.

A variety of special needs students are commonly found in any classroom. Some may have limited mobility while others may have vision or hearing problems. Always remember that a special needs student needs to be challenged just like any other student. The type of challenge may be based on the student/trainee's potential. Of course, this may require modification in teaching methods.

When working with hearing-impaired students/trainees, talk in a normal voice. Face the class, speak distinctly, and pronounce words clearly. With this approach, a student/trainee with lip reading ability will find it easier to understand the lesson. At the same time, you will be heard more clearly by the rest of the class.

A vision-impaired student/trainee should be allowed to explore the shop/lab with a student companion. The exploration will allow the student to become familiar with locations of equipment and other items. Seat the student toward the front of the class. It is not necessary, however, to seat the student in the first row. When lecturing, be specific in your references. Pay close attention to the needs of the student/trainee.

There is also the possibility that there will be students/trainees for whom English is not a first language. Speak slowly and clearly and encourage them to communicate as best they can in English. Help them develop their speaking and writing skills so they will feel more comfortable and achieve a higher level of comprehension.

1.9.2 Identifying the Gifted Student/Trainee

The gifted student/trainee may be more difficult to recognize than the special needs student/trainee. In some cases, an instructor is informed of a gifted student by a counselor. In many cases, however, gifted students/trainees have not been identified. Vocational/technical instructors should be familiar with gifted students/trainee's characteristics and modify teaching methods accordingly. Common characteristics include:

- More inclined to question or comment on the subject.
- Consistently scores high on exams and performance activities.
- Consistently completes work ahead of others and requests additional assignments.
- May seem bored, restless or disinterested.
- Displays more interest or a longer attention span.
- Consistently pays close attention to detail on procedures or techniques that are generally taken for granted.

Gifted students can be motivated and challenged by being assigned work with greater complexity, asked to assist slower students/trainees, pressed into service as assistants in the classroom and shop/lab, given problem-solving activities that involve creative thinking, and given special topics to research and report to the class.

1.10 ADDITIONAL RESOURCES

A variety of supplemental materials may be used to allow the students/trainees to further develop their interest in machining technology. Not all learning occurs in the classroom. Students/trainees should be encouraged to read supplemental material, participate in field trips, and join organizations in the field. When possible, outside activities should be followed up by some means of discussion and/or evaluation.

1.10.1 Field Trips

Field trips can be an excellent way to motivate students. Every community, large or small, offers opportunities in the metalworking fields. Field trips should be carefully planned and arrangements made ahead of the visit.

Students/trainees should receive a briefing prior to the trip. They will then know what to look for and can better understand what they observe. If possible, have a representative from the shop/company visit your classroom and give a presentation prior to the field trip.

A follow-up evaluation and discussion is a must after a field trip. Often having students write a short theme on what was observed can be helpful. Such a report will also improve a student/trainee's writing ability.

1.10.2 Vocational-Technical Fairs

Many schools, vocational-technical centers, and community colleges use fairs to motivate students. Students should also be involved when planning such an exhibition. The display may be in the shops/labs, local mall, or some other location.

Machining technology students/trainees may want to display completed assignments and give demonstrations.

1.10.3 Vocational-Technical Organizations

Encourage students/trainees to get involved in recognized organizations such as the Vocational Industrial Clubs of America (VICA). These organizations promote vocational-technical education and provide worthwhile experiences for the students/trainees.

These organizations also strive to develop character, as well as leadership abilities. Strong emphasis is placed on the respect for the dignity of work, high standards in ethics, workmanship, scholarship, and safety.

1.10.4 Awards Dinner

An annual awards dinner is an excellent way to reward student/trainee achievement. It also offers an opportunity to gain recognition of your program.

Invite parents, administrators, prominent citizens, future employers, and the press to the event.

1.11 SHOP/LAB MANAGEMENT

Good shop/lab management starts several days *before* the first class session. It should include conservation (time, effort, and energy), plus student/trainee safety, so the major endeavor can be directed toward improving instruction, which in turn, enhances learning.

Shop/lab management also requires some paperwork. The better you prepare for the first class session, the more time you will have to take care of the many minor problems that crop up when the students/trainees arrive. Get all of the forms you plan to use made up and reproduced in advance. Be sure they are readable, and prepare enough for all of your classes.

Accident Reports

In many learning situations, it is mandatory that each accident or injury be reported. Fill out a report immediately in those situations. Have the injured person report as soon as possible to the infirmary. Check with your principal, supervisor, or director for specific instructions on filling out the required forms.

1.12 TEACHER/INSTRUCTOR RESPONSIBILITY

Most states have laws relating to safety requirements in various areas of educational programs. Contact the necessary authorities to check your state's laws and local requirements.

In machining technology they usually relate to mandatory eye protection for special areas of the shop/lab. Such as when:

- Turning, shaping, cutting, or stamping solid materials with hand tools and/or power driven tools, machines, or other equipment.
- Casting, welding, and heat treating.
- Handling caustic materials.

While not usually mandated by state law, some systems have established policies on keeping certain problems under control or eliminating them as a possible source of student/trainee injury. They include:

- Appropriate footwear must be worn in metalworking areas.
- Long hair must be contained while operating power equipment.
- Use of drugs (medication and/or illegal) that impair muscular coordinating, spatial perception, etc.

You will find it to your advantage to know and understand the laws and requirements affecting your program.

Safety of students/trainees is paramount. Dangers from toxic gases, lack of oxygen, flying particles, sharp metal edges, hot metal, electrical shock, and falling objects are ever present. A strong, firm safety policy is mandatory for both students and technicians. Safety warning and cautions (*printed in red*), are located throughout the ***Machining Fundamentals*** textbook. These warnings are *not* exhaustive.

The office of Occupational Safety and Health Administration (OSHA) requires assurance that working conditions are kept healthy as far as vapors, fumes, temperature, dust, air contaminants, and noises are concerned.

Safety should be a top priority for everyone. It is the best and most efficient way to do any task. Common sense safety rules include the following:

- Keep work stations clean and orderly.
- Wear correct clothing for the job. Students should wear gloves when handling substances of a corrosive or sharp nature. Protect clothing by wearing an apron. Loose clothing can get caught, and a careless movement can mangle fingers. Advise students/trainees that they must wear safety shoes, hard hats, and hearing protection.
- Respect fire.
- Use proper lighting.
- Keep aisles and exits clear.
- Avoid electrical shocks. Be sure the electrical circuit is locked open before handling electrical equipment. Avoid standing or sitting in damp or wet places when doing electrical work. Never allow students to work with wet hands. The instructor should check all student-installed electrical service before allowing it to be "plugged-in" to the electrical circuit.
- Report all accidents and injuries.
- Wear safety glasses, goggles, and face shields when appropriate. Proper eye protection should be worn at all times in the shop. Goggles worn in the shop/lab should meet USASI Safety Code Z17.1-1968 (United States of America Standards Institute). When not being used, goggles should be stored in a cabinet and exposed to a germicidal lamp to destroy bacteria.
- Use adequate respiratory protection. Proper ventilation is vitally important in any shop or lab environment. Toxic vapors and fumes must be minimized. Exhaust blowers, along with makeup air units, should be used.
- Maintain and store equipment, tools, and supplies correctly. Never operate machinery without *all* safety guards in place.
- Use proper tools and procedures.
- Disconnect all power when tools or equipment are not in use.

The Occupational Safety and Health Act (OSHA) establishes standards affecting the safety of workers in any occupation.

OSHA is a federal law that mandates most safety recommendations published by organizations. Graduates who find employment in industry should know and practice these regulations. The act is being enforced by the U.S. Department of Labor.

A copy of the act should be available to all instructors. Copies of the Federal Act are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402. Copies of the state act are also available from state Departments of Safety.

Job Safety and Health, published by the U.S. Department of Labor, Occupational Safety and Health Administration, may be used in a classroom or laboratory for discussing safe working conditions. It is available from the U.S. Government Printing Office.

The National Safety Council, 1121 Spring Lake Drive, Itasca, Illinois, 60143-3201, publishes safety education data sheets and posters that cover safety in the home, on the job, and in various other locations. A list of the available safety education data sheets can be obtained by writing the council at the above address.

Most cities have codes concerning the installation and operation of refrigeration and air conditioning equipment. Students should be acquainted with the code or codes for their city.

1.12.1 Other Areas of Responsibility

We live in a litigious society. Because of the nature of working in a machine shop/lab, industrial-technical instructors must be acquainted with situations that might cause legal actions to be brought against them and the institution where they teach.

Often times, an act of negligence is brought about by ignoring basic safety rules or not using common sense. The following list has been

provided to enlighten your sense of responsibility. It is not all-inclusive. If you have serious concerns in regards to legal matters and liabilities, contact the appropriate department(s) of your school system.

- *Perform all machining operations in a proper and safe manner.* Failure to employ the proper use of safety guards, safety goggles or glasses, protective clothing, and proper procedure can endanger both you and your students/trainees. If students/trainees are taught improper and unsafe practices, they will use improper and unsafe practices.
- *Keep all circumstances under your control.* Although you may perform a demonstration with the utmost care and precaution, if the area is disorganized or dirty (i.e., oil or cutting fluid on the floor), it is likely that someone may be injured.
- *Do not entrust tools or machine operation to a student/trainee that you know is likely to inflict intended harm upon others.* If someone has been unruly or has threatened to harm fellow classmates, report the incident to the appropriate authorities. If you believe someone is a threat to his/her classmates, take the appropriate steps for their removal.
- *Safety cannot be overemphasized.* Remind students on a daily basis to stay alert and pay attention to danger zones.
- *Give students/trainees adequate preparation before allowing them to perform any machining operation.* Repeat procedures and safety practices in lectures, during demonstrations, and while a student performs the operation.
- *Always keep tools and machines in good working condition.* Do *not* allow students to work on machines that are in disrepair. If you are unable to repair the problem yourself, change the lesson plans or assignment until the repairs can be made. Inspect tools and machines on a daily basis and encourage your students/trainees to do the same.

As stated earlier, this is not an all-inclusive list. Adequate preparation, emphasis on safety, proper maintenance, and the application of common sense will help maintain a safe and productive shop/lab.

1.13 KEEPING UP-TO-DATE

As with all technical areas, there are constant changes and improvements in machining technology. The following material may help keep your program in tune with advances and changes in the metalworking field.

1.13.1 Advisory Council

The establishment of an advisory council is usually required when program financial aid is received from the state and/or federal government. The council should be composed of people who are actively engaged in machining technology.

The function of an advisory council is to advise instructors on the needs and trends in the industry. They can also help keep programs current, and provide contacts for placement of students/trainees completing the program.

1.13.2 Additional Means for Keeping Up-to-Date

Since there is constant change and improvements in all technical areas of machining technology, there are, in addition to the advisory council, other ways to keep up-to-date with these changes.

To keep pace with change, instructors should subscribe to and read monthly trade magazines and journals; visit modern machine shops and talk with management and personnel; attend seminars sponsored by the various machining technology vendors and trade associations; and attend trade shows and conventions.

Some employers offer special sabbatical leaves to allow instructors to work in the field for a specified period of time, so as to gain experience in the latest techniques available.

Summer employment in a modern shop would also be helpful. Summer session at the college level can be beneficial in improving teaching techniques and in developing a better understanding of the overall educational picture.

Keeping abreast with modern developments in machining technology is mandatory if you want to offer a course that will equip your students with the skills, knowledge, and attitudes needed today.

1.14 RESOURCE MATERIALS

There is an immeasurable amount of resource material available on the metalworking industry. Maintain a library if possible or request that the library carry a selection of textbooks and publications on the field. The following books, catalogs, manuals, and periodicals are only a brief listing of available material.

1.14.1 Reference Books

Amman, Jost, *The Book of Trades* (Historical): Dover Publications, (Original publication date 1658).

Barsamian, Michael, and Gizelbach, Richard A., *Machine Trades Print Reading:* Goodheart-Willcox Publisher.

Biekert, Russell, *CIM Technology:* Goodheart-Willcox Publisher.

Brandt, Daniel A., *Metallurgy Fundamentals:* Goodheart-Willcox Publisher.

Brown, Walter C., *Basic Mathematics:* Goodheart-Willcox Publisher.

Brown, Walter C., *Print Reading for Industry:* Goodheart-Willcox Publisher.

Diderot, Denis, *A Dideroit Pictorial Encyclopedia of Trades and Industry,* Vol. 1 and 2 (Historical): Dover Publications, (Original publication date 1752).

Duenk, Lester G., Editor, *Improving Vocational Curriculum:* Goodheart-Willcox Publisher.

DuVall, J. Barry, *Contemporary Manufacturing Processes:* Goodheart-Willcox Publisher.

Gradwell, John; Welch Malcom; and Martin, Eugene, *Technology Shaping Our World:* Goodheart-Willcox Publisher.

Green, Robert E., Editor, *Machinery's Handbook:* Industrial Press Inc.

Littrell, J. J., *From School to Work:* Goodheart-Willcox Publisher.

Madsen, David A., *Geometric Dimensioning and Tolerancing:* Goodheart-Willcox Publisher.

Masterson, James; Towers, Robert; and Fardo, Stephen, *Robotics Technology:* Goodheart-Willcox Publisher.

Phagan, R. Jesse, *Applied Mathematics:* Goodheart-Willcox Publisher.

Walker, John R., *Modern Metalworking:* Goodheart-Willcox Publisher.

Wanat, John H.; Pfeiffer, E. Weston; and Van Gulik, Richard, *Learning for Earning:* Goodheart-Willcox Publisher.

Wilson, Bruce A., *Design Dimensioning and Tolerancing:* Goodheart-Willcox Publisher.

1.14.2 Catalogs and Manuals

American National Standards Institute (ANSI)
1430 Broadway
New York, NY 10013
(Catalog of standards and price list)

The Association of Manufacturing Technology
7901 Westpark Drive
McLean, VA 22102-4206
(List of machine tool manufacturers)

Dover Publications, Inc.
31 East 2nd Street
Mineola, NY 11501
(Catalog on metalworking history, etc.)

Hanser Gardner Publications
6915 Valley Avenue
Cincinnati, OH 45244-3029
(Catalog of technical books and audio visual materials)

The Industrial Press
93 Worth Street
New York, NY 10013
(Machinery's Handbook)

The M.I.T Press
Massachusetts Institute of Technology
Cambridge, MA 02142

National Tool & Machining Association
9300 Livingston Road
Fort Washington, MD 20744
(Catalog of technical books and audio visual materials)

U.S. Bureau of Labor Statistics
Government Printing Office
200 Constitutional Ave., NW
Washington, DC 20210
(Occupational Handbook)

Catalogs of precision tools, machine tools, etc. Journals of various industrial and trade associations.

1.14.3 Periodicals

American Machinist
Penton Publishing
1100 Superior Avenue
Cleveland, OH 44114

Automation News
155 E. 23rd Street
New York, NY 10010

CAD/CAM & Robotics
Kerrwil Publications Ltd.
501 Oakdale Road
Downsview, ON, Canada M3N 1W7

Cutting Tool Engineering Magazine
400 Skokie Blvd., Suite 395
Northbrook, IL 60062

The Home Shop Machinist
The Village Press
2779 Aero Park Drive
Traverst City, MI 49686

Industrial Education
Cummins Publishing Company
26011 Evergreen Road
Southfield, MI 48076

Industrial Machinery Digest
One Chase Corporate Drive #300
Hoover, AL 35244

Machine Design
1100 Superior Avenue
Cleveland, OH 44144

Metalfax
29100 Aurora Road
Solon, OH 44139

Metalworking Digest
1350 East Touhy Avenue
Des Plaines, IL 60017

Modern Machine Shop
6600 Clough Pike
Cincinnati, OH 45244-4090

Tooling and Production
29100 Aurora Road, Suite 200
Solon, OH 44139

1.14.4 Agencies and Associations

American National Standards Institute (ANSI)
1430 Broadway
New York, NY 10018

American Vocational Association
1410 King Street
Alexandria, VA 22314

International Technology Education Association (ITEA)
1914 Association Drive
Reston, VA 22091

National Association of Industrial Technology (NAIT)
3300 Washenaw Avenue, Suite 220
Ann Arbor, MI 48104-4200

National Institute for Metalworking Skills
2209 Hunter Mill Road
Vienna, VA 22181

Vocational Industrial Clubs of America (VICA)
Box 30
Leesburg, VA 22075

1.14.5 Audiovisual Materials

A variety of audiovisual materials is available for use in machining technology. Contact the following companies and associations for listings of available materials.

DCA Educational Products, Inc.
1814 Kellers Church Road
Bedminster, PA 18910

Hanser Gardner Publications
6915 Valley Avenue
Cincinnati, OH 45244-3029

Minnesota Mining and Mfg. Co., 3M Center
Visual Systems Division
Austin, Texas, 78769

National Tooling & Machining Association
9300 Livingston Road
Fort Washington, MD 20744

L.S. Starrett Company
121 Crescent Drive
Athol, MA 01331

Sterling Educational Films
241 E. 34th Street
New York, NY 10016

1.14.6 On-Line Resources

Many resources for Machining Technology and education are available over the information superhighway. They are sponsored by corporations, private organizations, and individuals.

On-line addresses for information on all areas of machining technology can be found in trade magazines and journals. Using the Internet can keep you current on new machine tool developments, and machining and manufacturing techniques.

Most of the sites provide information free of charge or for a minimal fee. Since the information superhighway is constantly expanding, the addresses for some of the following sites may have changed since the publication of this manual. The following is only a sampling of companies with on-line sites:

Cincinnati Milacron (CNC machine tools)
www.milacron.com

Mastercam (software)
www.mastercam.com

Modern Machine Shop Magazine
www.gardnerweb.com/mms

Nikon
(optical comparators and CNC
Video measuring systems)
www.nikonusa.com

Sharnoa Corp. (CNC machine tools)
www.sharnoa.com

South Bend Lathe Corp. (machine tools)
www.southbendlathecorp.com

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If you have comments, corrections, or suggestions regarding the textbook or its supplements, please send them to:

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