EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
ACCESS TO APPRENTICESHIP

COMMUNICATIONS SKILLS
SYNTHESIS OF INFORMATION

AN ACADEMIC SKILLS MANUAL
for
The Precision Machining And Tooling Trades

This trade group includes the following trades:
General Machinist, Tool & Die Maker,
Mould Maker, Pattern Maker, and
Machine-Tool Builder Integrator

Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities

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In preparing these Academic Skills Manuals, we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

COMMUNICATIONS SKILLS
SYNTHESIS OF INFORMATION

An academic skill required for the study of the Precision Machining and Tooling Trades

INTRODUCTION

An *alloy* is a substance *produced* when you combine two or more metals, along with other elements such as carbon. This combination, or *synthesis,* produces a new metal. The new metal has different qualities such as corrosion resistance, toughness and hardness. Stainless steel and brass are examples of alloys. Using a synthesized alloy enables you to avoid unwanted weaknesses in the original metals, such as softness or brittleness.

Synthesis *of information means combining pieces of information to arrive at an integrated whole*. If you manage to synthesize all the complex parts of an assignment, the result is a successfully completed project. In your training and in your work, you read texts, manuals, guides and handbooks to find out how and why you do things in specific ways. You learn skills and techniques working on the job. You synthesize all this information to see how it fits into the bigger picture – that is, how it fits into precision machining trades work. Synthesizing information achieves results you could not get from only one source.

Practical applications of *synthesis of information* range from writing clear and concise contract proposals, work orders and accident reports to selecting and applying information from mechanical, structural and architectural blueprints. You have to synthesize different types of information to create working drawings or to outline the steps for a fabrication job. When you are in charge of a project, you have to bring together information, people and materials. You have to be able interact and integrate tasks with a wide range of co-workers, supervisors and customers. It is your job to synthesize all the different aspects of the task.

In this skill sheet, we look at the following aspects of synthesizing information:

- Order of Synthesis
- Combining Information
- Using Synthesis

PART I
ORDER OF SYNTHESIS

Where do I Start?
Often a good place to is to ask questions.

Example: When you learn about metal, you might want to know how the different alloys of steel are made. Or, you might ask what material goes into each alloy, how it is formed, or about the strengths and weaknesses of the different alloys. Once you have figured out what questions should be asked, the next step is to begin answering those questions.

To answer the questions, you will find and collect information from sources such as texts, tables, manuals, codebooks, teachers, and supervisors. You learn details about the physical properties of different metals and how they are used. You might find a definition of stress load that leads you to a, understanding of how stress loads impact a metal framework.

Then, you have to organize all this material so it is available and useful. You synthesize it and you have a new understanding of which materials to choose in which circumstances.

1. Gathering Knowledge

When you begin to study your trade, you will probably learn information in the pattern set by instructors and your texts and manuals. Information is usually presented in a logical order. Texts and manuals start with general ideas and go on to more specific details and procedures. You proceed through the classes and texts systematically to cover all the relevant material.

Example: You are learning about metals in the order that is set up in your textbook. You read about various types of sheet metal in chapter 3. In chapter 4 you find a table about gauges and measurement. Chapter 5 has information about characteristics along with drawings and photos that show you how to recognize different types of metals. The text tells you when to go to the different sections, chapters, tables or figures. Your instructor may add handouts or recommend a certain book for more information about a topic.

You learn this material by:

- reading,
- making notes,
- listening to your teachers and other students,
- discussing ideas
- answering questions.

You will use a number of strategies to help you learn and to organize the information so that you remember it and can use what you already know when you come across a new idea. You will gather pieces of knowledge about all the aspects of your trade. You will learn:

- facts
- theories, and
- practice.

2. Combining Knowledge

You will combine this information in several ways. In some instances, you add to information in the same order as it is presented in a textbook or other resource. In the same way you that you reassemble a piece of equipment you are repairing, you combine the pieces systematically, to get the complete picture.

Your job will be to put all of that information together, you will start to synthesize it. You will:

- compare ideas,
- classify products and procedures according to how similar and different they are
- evaluate the relevance and usefulness of a material
- summarize the information, and,
- draw conclusions from what you have found.

These strategies will help you organize and remember what you are learning. Each thing you learn will fit into the whole body of knowledge about your trade.

> **Example:** You are learning about metals and metal alloys.
>
> When you understand the grade and classification of one type of material, you can relate it to a system of grading a different material.
>
> - You can compare the way each material is used and understand why it is used that way.
> - You can learn what you found out about grading systems to more easily learn about a third and then a fourth kind of grading system.

Each new piece of information adds to your knowledge. Just as importantly, it may change your understanding of a situation.

> **Example:** You learn about different metals and alloys used for making parts. You start with descriptions of each metal or alloy, their physical properties, chemical composition and terms to describe them, and how to identify each. As you develop an understanding of the uses and characteristics of various metals, you move to an understanding of their reactions to climatic conditions to their uses in fabricating commercial products.
>
> When you understand a characteristic of one metal, you can relate it to the characteristic of another. Then you can compare the way these metals are used. You compare new or unfamiliar products to older, familiar ones. You to read up on installation procedures of a new material so you can adjust your tools, practices and time estimates, and so you understand its advantages or disadvantages.

3. Using Knowledge

Once you have foundational knowledge, you will be asked to complete assignments or projects in the shop that require you to use a synthesis of that information. You will have to figure out what procedures or tools to use to complete a task. You will have to plan the order. To do these things you will:

- think through what you already know about the subject,
- perhaps get more information to find solutions to problems
- talk to people who can help you clarify anything you are unsure about,
- set priorities and,
- finally, combine all this information to suit the situation.

Example: You use synthesis of information to help organize an assignment. Some steps you might take include:

1. Decide on what the job involves. It could be to select a drill bit, solve a power tool problem, develop a pattern, or understand a computer process.
2. Make a list of materials required and estimated costs.
3. Find and collect information from various sources: texts, manuals, charts, experts, sales people at the local store and your own experience.
4. Organize and compare this information to bring all the steps together.

Synthesizing information so that it is useful is a lifelong task. It requires relevant background information, and an ability to observe and learn from your experience. As you try out new ideas and procedures, you rate how they work in different situations. Gradually you build up a storehouse of ideas you know are good. You can pick which technique to use in which situation. You get to know who is a good resource to talk to for answers. Now you can ***synthesize***, that is combine, all your sources of information until you have a complete picture.

After you have gathered and then combined the pieces of information, you should be ready to answer some questions about the topic. You will be tested on how well you have synthesized all this material through answering chapter questions, handing in assignments and writing tests.

Example: You have been learning about metals and metal alloys and have been given some questions to answer:

What is stainless steel?
How would I recognize it?
What is the difference between stainless and galvanized steel?
Where is each used?
What do I need to know if I am joining the two types?

The first two questions are "What is it?" questions that ask you to identify, recognize or describe something.

The third question asks you to understand how the two materials differ and how they are similar.

Then you are asked to recognize applications.

The last question asks about the concerns of a specific situation.

Note: *You could answer questions like these on any subject.*

4. *Applying Knowledge*

At some point you will take all of this information and apply it to a project, or a job. You will have to collect and organize information, not as it is set out in a text or in your training program, but *as you need it for that project*.

Example: You have been given a special welding project. Before you start the project, you need information from several sources, and you need to do a little experimenting t o be sure you meet the goal. The following might be required:

- Understand the design of the item to be built.
- Find the gauge of metal recommended and the measurements of the pattern to be followed.
- Understand what happens when joining (welding) the selected metal.
- Find and consult the right table with amperage figures for welding.
- Note whether the table gives adequate information or whether you need specifics from a supplier.
- Fine-tune amperage settings;
- Experiment with a scrap of the same thickness.
- Compare your results on the scrap with the expected results before proceeding .

The information you gather will relate to your purpose and the specific application. What will the finished product be used for? What stresses and conditions must it meet? What codes apply so that the final product meets industry standards? You need to ask all the questions that are relevant to the situation.

Each new piece of information adds to your knowledge. Synthesizing the information allows you to plan for factors such as shrinkage in metal and understand how designs serve their purpose.

As your experience grows, you are able to deal with more difficult situations as you meet them. You accumulate knowledge and you use it to acquire the *skills* of the trade. This process does not stop. You will update and upgrade both knowledge and skills throughout your career.

Tables

Table 1 is a synthesis of information. Someone has gathered and details organized about the topic so you find information quickly. It is usually easy to find details in the table format.

TABLE 1 Fine Tuning MIG Set Up

Problem	Solution
Spatter	1. Reduce voltage 2. Increase electrode extensions (ESO) 3. Reduce wire speed and voltage 4. Check shielding gas (Is it correct for this process?)
Too hot (too much penetration or burn through)	1. Reduce voltage 2. Reduce wire speed 3. Increase electrode extension (ESO) 4. Increase travel speed

Note: Use this table to adjust settings, travel speed and electrode extension. Check each weld for shape size and defects against Charts 1 and 4 and get advice and comments from an experienced welder.

The headings in a table clearly and briefly direct you to the information. The heading at the top of Table 1 tells you what it covers. The headings in each column tells you exactly what information you will find in that column.

Footnotes offer more information. Did you read the note at the bottom of the table? If not, go back and read it now. It tells you to find charts 1 and 4 so you can check for defects. It also directs you to show your welds to an experienced welder or instructor.

The table is a summary, so it does have limitations.

> **Example:** A table is an adequate source to select the right classification and grade of metals used for fabrications or for avoiding weld splatter but be careful. *But,* it does not give you enough information to understand the relationship between voltage and burn through.
>
> Unless you have already read about the process in detail, you may not know what to expect if you "*reduce wire speed"*.

Because information in tables is usually brief, a table may refer you to other sources for further details. If you don't know how to do something or don't understand it, you will have to consult another manual or guide, or talk to an expert.

Use Table 2 that compares the activity of metals and Passage 1 that explains how the activity of metals is related to corrosion. **Answer the questions that follow. The answers are at the end of this skills manual.**

TABLE 2: Relative Activity of Metal

Magnesium	**Most Active**
Aluminum	▲
Zinc	
Chromium	
Iron	
Nickel	
Lead	▼
Copper	**Least Active**

Note: *Nonferrous metals contain little or no iron. They are resistant to corrosion and are nonmagnetic. In machine shop work, nonferrous metals are used where ferrous metals would be unsuitable. The most commonly used nonferrous metals are aluminum, copper, lead, nickel, tin and zinc.*

Passage 1
Galvanic Corrosion

When two dissimilar metals are in contact with each other, *galvanic corrosion* occurs. The metal that is more chemically active (See Table 1) will corrode. For example, zinc will corrode, cover, and thus protect, steel.

With other metals, galvanic corrosion can cause problems. For some situations only the products which combine the needed strength and rust resistance are recommended.

Questions:

1. According to Passage 1 and Table 1, aluminum is more chemically active than nickel.

   T F

2. If iron and nickel are in contact with each other, the nickel will corrode.

   T F

3. Galvanic corrosion may cause problems even when dissimilar metals are in the *least chemically active* range.

   T F

4. Why would nickel and zinc be used in machine shops?

   a) They are less active than copper or lead.
   b) They could be used when ferrous metals are unsuitable.
   c) They are resistant to corrosion and contain little or no iron.

Taking your own notes

Just as you would gather all of the tools necessary to do a particular job, you also need to gather all of the information required to do the job, then apply it correctly. It is a challenge to your note-taking and organization skills to gather information and then find it when you need it.

Some information will be essential for *every job* you do, but, *it may not be repeated*.

> **Example:** You find these instructions about safety procedures.
>
> Find updated health and safety procedures in Section IV. Refer to these procedures when using hand and power tools, when welding, soldering or cutting.

You would have to find out what is in Section IV. More importantly, you have to *apply the safety procedures.*

Trades people use different methods to organize and file information under a topic. You might photocopy or write out the details and keep them in a notebook that is always with you on a job. You might use a sticky note (with words like *soldering/ safety*) to mark the pages. You might examine this section before each job to prepare yourself. Whatever method you use, make sure you keep your information close at hand.

Problems?

Do not be discouraged by problems. When you have problems with a tool or an uneven weld, use it as an opportunity to learn more about your trade. Search for more information to find the reasons for the problem and the solutions to it.

Synthesized information contributes to your overall knowledge and skills. You will know *why* it is essential to follow correct maintenance for tools or to use the right grade of metal when you understand *how* one thing relates to another. When you understand how your knowledge and

skills relate to a finished product, you will understand why it is essential to use the right measuring tools. You will understand why the correct guides and tables are essential to getting you the right result.

In developing this knowledge, you will often search for answers from several sources sifting through one piece of information after another to compare and evaluate it. Synthesizing this information will help you do your job.

PART II
COMBINING INFORMATION

In this section, we'll ask you to combine details from **Passages 2, 3,** and 4 with the related diagrams to understand and to compare details about *deformation.*

Read Passages 2 and 3 and answer the questions that follow. Be sure to read all the available information in the passages and figures. Answers are at the end of this skills manual.

Passage 2
Elastic Deformation

Elastic deformation or *elasticity* is the ability of metal to stretch and then return to its original shape. Sheet metal that is gently bent to form an arc will *spring back* to its original shape when the force acting on it is removed. See Figure 1. When metal experiences pressure, it bends. When the force is released, the metal returns to its original shape, provided it has not bent beyond the elastic point. Some special steels used in timing devices have this elastic quality.

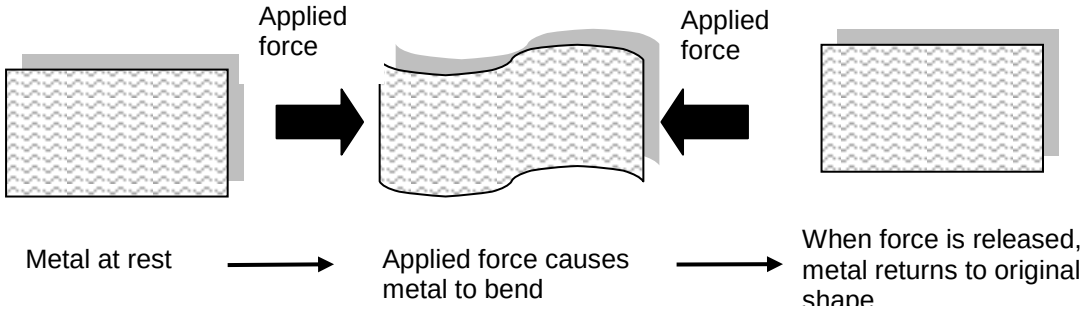

Figure 1: Elastic Deformation
Elastic deformation is the ability to bend under pressure and then return to the original shape

Questions:

1. Define (briefly) elastic deformation.

2. What does spring-back mean?

3. What could you predict if a force bends a metal beyond its elastic point?

Passage 3
Plastic Deformation

Plastic deformation is the ability of metal to be bent or formed into different shapes. The material will retain its shape even after the deforming force has been removed. When a metal is bent *beyond* its elastic limit, it will have a tendency to spring back, *but* not all the way back to its original shape. This is because the grain structure has taken on a new set. See Figure 2.

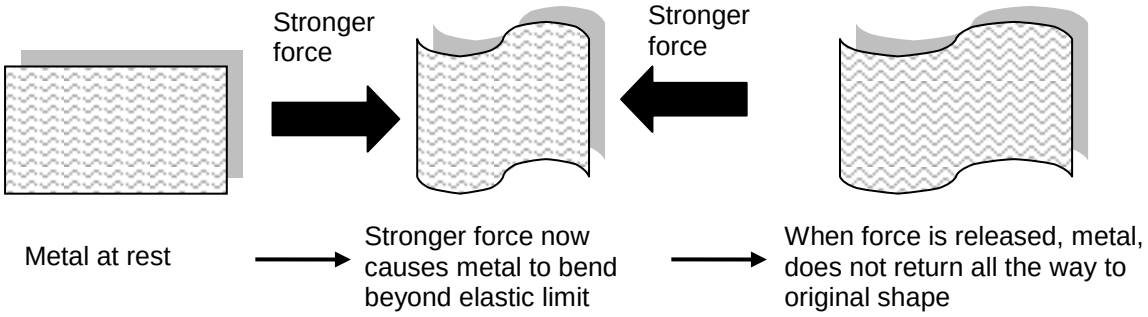

Figure 2: Plastic Deformation
Plastic deformation causes metal to retain some bend after force is released

Questions:

1. How is plastic deformation different from elastic deformation?

2. If a metal is bent beyond its elastic limit, what is this called? What happens to its grain structure?

3. What can you conclude about the meaning of the words - taken on a new set - as applied to a metal you are working with?

Add information

Passage 2 and 3 provide definitions and diagrams that show the effects of force on metals. Use the diagrams to add to your understanding. Could you clearly explain these ideas to a customer? Can you see the applications to your trade? Passage 4 below continues the synthesis of information about elastic and plastic deformation. **Answer the questions that follow. Answers are at the end of this skills manual.**

Passage 4
Elasticity and Plasticity

If load is increased little by little, *elongation* increases proportionally. But, if the load exceeds a certain limit, internal slipping of the grain pattern occurs. Even if the rate of load increase is constant, elongation will suddenly increase and the maximum load will be reached. After that, partial elongation will occur in one portion of the material and it will break. See Figure 3, Point D.

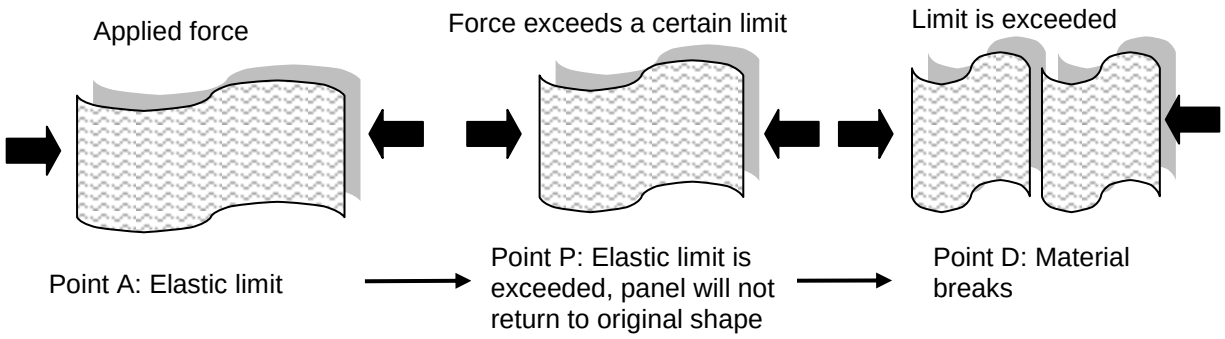

Figure 3: Effect Of Load Size On Panel

In Figure 3, Point **A** indicates the elastic limit. If the load is lower than **A**, deformation will disappear when the load is removed. The metal goes back to its original shape and this is called *elastic stress*. However, if the load exceeds Point **A**, the deformation remains even if the load (force) is removed. See Point **P**. This is called *permanent stress* as the panel will not return to its original shape.

Questions:

1. By increasing load gradually and at a constant rate, you can predict a sudden increase in elongation.

T F

2. Deformation will disappear and the metal will *spring back* at Point A when the load is removed if the load is less than the elastic limit (Point A*)*.

T F

3. If a load exceeds the elastic limit,

a) deformation will disappear when the load is removed
b) permanent stress occurs
c) elongation of the metal returns to Point P

Passages 2, 3, and 4 provide definitions and diagrams that show the effects of force on metals and explain the concept of elastic limit. Use the diagrams to add to your understanding. Could you clearly explain these ideas to a customer? Can you see the applications to your trade?

Add more information

If you understand a concept, such as that of elastic limit, you can understand how the ideas in the concept will affect a task you might have to do. When you combine all the details and guides at hand, you can get on with the job.

Observe how the concepts in Passages 2 and 3 have prepared you to understand something you will do in the shop.

Read Passage 5 then answer the questions that follow. Answers are at the end of this skills manual.

Passage 5
Torque Wrenches

All materials are elastic: that is, they will stretch, compress and twist. Even such materials as cast iron and hardened steel used in the construction of compressors are elastic – to a point. To avoid warpage or other damage to parts, the mechanic must measure the amount of tightness when tightening bolts, nuts and other attachments on compressor parts and assemblies. This measurement is done with a *torque wrench*.

A torque wrench is made up of the wrench handle with different sized sockets. A dial or pointer on the handle measures the pounds-feet of torque. Torque is calculated by multiplying the length of the handle (in feet) by the pull applied (in pounds)* to the handle. Recommended torque for the various parts of mechanisms is specified in the manufacturers' service manuals. Bolts should be torqued up in stages. Never tighten to the maximum value in one step.

✶ Use the conversion table for metric measurement.

Questions:

1. A mechanic over-tightens bolts and then corrects to the recommended torque. What is the most likely result?

   a) Warpage (deformation) will disappear and the metal will *spring back*.
   b) Warpage will ***not*** disappear and the metal will ***not*** spring back.
   c) Either of the above.

2. Warping of parts will occur if bolts (or nuts) are tightened too much or if they are tightened too little.

   T F

3. Tightening bolts in one step saves time and gives you recommended results.

   T F

You can see that the addition of information moves you from theory about elasticity to some practical applications. When you understand a scientific theory such as elastic limit, you can understand *how* it could cause problems when you are making repairs.

But the passage does not offer directions on how to solve the problems and you will need to find out. The addition of information about materials or conditions may change how you approach each job and what adjustments you make. You need the right information to get the right answers. You can't form an opinion or understand why one technique is better than another until you understand all the factors which affect performance. Therefore, look more information to understand any problem.

Note: *Use the index and table of contents when looking for information in your textbook and service manuals. It will save you time.*

Keep an open mind

When you read several sources or different passages, you may get reasons or explanations that differ from each other. Keep an open mind. Often new details force you to rethink what you know. If what you read conflicts with what you have already learned, look at it positively.

Maybe you are being offered information you hadn't considered before or that is more up to date.

Check other reliable sources and continue to learn. Use all sources available to find the right guides, to understand equipment, safety and principles of concepts such as load and stress, and to find causes of problems. As you add information from a variety of sources and combine this with your experience, your understanding of the whole picture will continue to grow.

You do have to decide eventually what information to use in order to get started. If you understand *how* something works, you can understand *how* it will affect a result. When you see the relationship between what you do and the result you get, you will understand how to proceed. When you combine all the details and guides at hand, you can get on with the job.

Fact or Opinion
Synthesis will help you deal with information that is not directly stated. Sometimes, you get a sense of a writer's attitude – whether he or she has a dislike for a certain method or a preference for a particular tool. You may pick up from a co-worker that a certain way of doing something is the best. Another worker might suggest that the same procedure is not so important.

In this situation, you need to synthesize all your information to make your own evaluation. It's a good habit to ask the question" *why"* a lot. First, you will find out why something is done a certain way. Second, you can give clear explanations to clients so they understand what you are doing and what they are paying for.

It's important to know the source of any information and be aware of the differences between trade tips that may not be backed up by reliable data and advice that is backed up by facts. An up to date, approved trade text, an expert in the field, a manufacturer's guide and a shop manual are examples of reliable sources. Check your sources routinely to see that they are dependable and current. Check with trade experts to ensure that your trade approves any Internet source.

You do all this information searching and source checking so that you have reliable material to gather into a synthesis. Before you combine details into a comprehensive picture, you need to be sure that you can count on their validity. Then you can use the synthesis as a base from which you make your decisions about the different aspects of your work.

PART III
USING SYNTHESIS

Setting priorities
*A **priority** is something that is first in importance*. When you *set a priority*, you decide on the importance of something by comparing it to something else. You also decide on the sequence in which different steps are ordered. Rating or setting priorities is important on the job. Synthesizing information helps you do this successfully. When you prioritize, you answer questions such as the following:

- In what order should I organize the steps of the job?
- What needs to be done first?

- What safety and code issues should I be aware of before I start?
- Which clients' needs are most pressing?
- What time commitments have I made to clients?

Safety first

A caution or warning indicates the information is essential to your safety on the job, so find out about it before you proceed. It sets the first priority in your planning for a project.

Example:

Warning: If suppliers or employers do not supply details on ingredients, health effects, handling or other aspects of this and other hazardous products call the Construction Safety Association of Ontario at 1-800- .

Example:

Caution! *Do not pour near open flame or combustible materials*.

You might need to know if a container which once held a flammable material is considered a *combustible material.*

You might need to know the general reactions of combustible materials and products, so you handle and use these products safely in all situations. You could ask:

- How do they behave in confined or poorly ventilated spaces?
- Near pilot lights or switches?

You need *all* the details and directions, and you need to get them from the correct source so you are safe on the job. It is important to completely understand them as they will apply in other situations.

Find out all you can, so you understand the caution fully and can apply it properly in all situations.

Example:

If *any* amount of cadmium (Cd) is present in the brazing alloy, consult the safety manual. Follow the procedures exactly as listed. Carefully check the specifications of the brazing alloy before starting.

In this situation:

- Check the specifications of the brazing alloy.
- If cadmium is present *in any amount*, find the safety manual.
- Follow all the directions *exactly*.

You will be referred to safety details.

Example:

> Electric drills should be grounded for safety.
> Grounding is covered in detail in Section 6.

- It is your job to find Section 6, read it and apply the information ***before*** you use this or any other tools of this type.

Pay attention to directions that send you somewhere else – to a different chapter or source. The information in a *warning* will be essential to the operation you are performing right now, so follow up before you proceed. Just as you gather all the correct materials and equipment to do a job, gather all the information required and apply it correctly.

Set priorities for the tasks

You set priorities when you plan your work. If you have four jobs to do, which one comes first? Maybe you always do jobs in the order they come in or as materials become available. Maybe you start with the easiest and work through to the hardest. Other factors also play a part. Before you draw a conclusion about a task, collect information. Examine the information detail-by-detail. Consider this the sorting stage.

Example: You may read the direction below when centring a workpiece using a centre head:

Rotate the centre head one-quarter of a turn and scribe a second line. *Lightly* centre-punch where the lines cross.

In another section of the text, you may read the following:

The centre head is used effectively *only* if the stock being centred (whether round, square or octagonal) is true in shape *and* cut off at a 90˚ angle.

Set priorities for the details

As you assess and arrange these collected facts in priority, you may reach a new synthesis. This may lead to new predictions or conclusions about the difficulty or success of this job.

Example: Before you make decisions about centring a workpiece, asses your information. Two directions are essential to the right result – an accurately centred hole. The first gives steps in a "how to" sequence; but the second direction sets out an essential condition that must be met in order to achieve the right result.

Are all the details of the information equally important? Are some your responsibility, such as accurate settings, and others out of your control, such as the quality of the stock? What is most important to the success of this job? Does anything warn you of problems or unusual situations to watch for? These questions direct you to find details, compare them and rate their importance to the situation.

Problem areas
Suppose you need to understand the correct use of lubricants. Find information from your texts, manuals and your own experience. Add notes from more experienced workers and then organize what you've read. You can guide yourself with a series of questions:

- What types of lubricants are available to me?
- How are they the same?
- What are their differences?
- How should they be stored?
- What is the shelf life of lubricants?
- What are the special handling considerations?

Then go on:

1. Find details about the problem.
2. Put the details into groups or categories.
3. Compare the details to your needs.
4. Bring the information together find solutions to the problem.

You can usually determine the priority *before* starting your search. For example, codes, safety and industry standards are essential, but how important is cost? Is it also a priority? As new questions arise during your research, you may have to go to other sources to answer the questions or retrace your steps through the same material. Whichever you do, make sure you understand everything thoroughly so you can meet ***all*** the conditions of the job.

You can generally apply this approach when considering the consequences of your actions. This applies whether the job is complicated or straightforward. Ask questions and assess actions as you move ahead with each project.

Evaluating the information
Sometimes you have to carefully read and then decide whether the information is clear to you, or whether it is useful to you.

> **Example:**
> Either a drag (pulling) or leading (pushing) technique may be best for MIG welding. Probably the drag technique is best for short circuiting transfer and the leading technique is best for spray arc transfer.
>
> **Is it clear? Is it useful?** The word "probably" suggests there may not be a clear choice between drag or leading technique except for some types of welding. What does this mean for you? Does the choice depend on a welder's skill or experience? Should you decide on one technique, experiment with both, ask an experienced welder for more advice, or all of the above? You need to assess this information to decide how to proceed.

Sometimes information leaves is no room for questions.

Example:
Never use two die halves with different serial numbers.

This direction is simple. You may need more information to know the consequences of using dies with different serial numbers, but what you ***should do*** and ***should not do*** is clear.

Some information may make you want to review what you already know. You may also need to check a manual and get a professional's opinion.

Example:
Carelessness in applying flux ruins many soldering jobs. Care should be exercised to avoid dropping flux anywhere except where the soldering is to be done.

What does "carelessness" mean exactly? Are there types of "carelessness" that ruin work? Does it apply only to "dropping flux" where it is not wanted? What are the consequences of dropping flux? At what point is poor work different from ruined work?

It is clear in the example that a soldering that meets a standard is possible with the right care. However, you need to understand what the words mean. How do you know if you have the required skill and care? When you solder a fitting, will others in your trade rate this job as up to trade standards. If not, you need to develop the skill and care to meet or exceed the standard.

Be very sure you recognize when information does not offer you choices.

Examples:
Never, under any circumstances use a steel rule except as a precision measuring tool. It will nick, mar and become damaged.

Always turn off the machine power switch *before* making any adjustments (See note for adjustments) or installing any accessories. See Chapter 7.

Follow the safety practices outlined in Section 3 when operating this equipment.

Be sure you recognize ***warnings***, ***cautions***, health and safety directions that are matters of fact and governed by codes. These are areas and issues where you have no choice.

CONCLUSION

Synthesis of information involves combining different pieces of information to compare and evaluate information, to set priorities or to solve problems. Your ultimate purpose is to produce the best results on the job.

Summary

1. **Ask questions** directly related to the assignment or job.

2. **Research and collect information** from all sources. Note and follow any directions that tell you to look somewhere else for information.

3. **Organize, compare, prioritize, and evaluate information** in relation to the questions you need to answer.

4. **Find answers to all questions** and be prepared to review your steps to answer new questions that arise.

5. **Notice the difference between fact and opinion** when searching for answers.

6. **Combine information from several sources** to provide answers or instructions that you would not find using one source only.

ANSWER PAGE

PART I Table 1, Relative Activity of Metal
Passage 1, Galvanic Corrosion

1. According to Table 1 and Passage 1, aluminum is more chemically active than nickel.

   T Find each metal on Table 1 and compare its position to the others. The metals at the top are in the most active range. Aluminum is higher on the table than nickel so the answer is true.

2. If iron and nickel are in contact with each other, the nickel will corrode.

   F "The metal which is more chemically active will corrode." The more active metal in the table is iron. The nickel, therefore, would ***not*** corrode.

3. Galvanic corrosion may cause problems even when dissimilar metals are in the *least chemically active* area.

   T Sentence one in paragraph one states that if *two dissimilar metals are in contact ... galvanic corrosion occurs*. Sentence one, paragraph two, states, "*...with other metals, galvanic corrosion can cause problems*" Although the passage does not explain the specific problems to expect, a cause (galvanic corrosion) and effect (problem) are clear.

4. Why would nickel and zinc be used in machine shops?
   b) They could be used when ferrous metals are unsuitable.

   This question reminds you to refer to all information even if you are not directed to it. The **Note:** below Table 1 says that nonferrous metals are used when ferrous metals are unsuitable (Answer b) and identifies both nickel and zinc as commonly used nonferrous metals. It does not describe situations when ferrous metals would be unsuitable. Both Answer a) and Answer c) may be reasons to use nickel and zinc, but because neither the passage nor the notes state this, you will have to find another source to find when they would be used.

PART II Passage 2, Elastic Deformation
Passage 3, Plastic Deformation

Answers for #1 and #2 are found in Passage 2.

1. Define (briefly) elastic deformation.

   Some materials can be stretched or bent. They will then return to their original shape when the force that is causing them to bend is removed. This quality is called elastic deformation or *elasticity*. Look for a table to give you elastic limits.

2. What does spring-back mean? Give an example where this principle is applied.

   Spring-back describes the action of a material returning to its original shape. Its original shape is its shape before it was bent or stretched. An application of this principle is found in timing devices. Some metals curl or bend when heated and then return to their original shape when the heat is removed.

Answers for #3 and #4 are found in Passage 3 and in Note below Figure 1.

3. If a metal is bent beyond its elastic limit, what is this called? What happens to its grain structure?

   If metal is bent beyond its elastic limit, it is called plastic deformation. Although there is some spring back, the material does not go all the way back to its original shape. In other words, it takes on a new shape. The grain structure of the material (which is invisible to the eye) has changed.

4. How is plastic deformation different from elastic deformation?

   Plastic deformation is the ability of a metal to take on a new shape. If the material has stretched beyond its elastic limit and cannot return to its original shape, it has a new shape. *Elastic deformation* is the ability in some materials to be stretched to a certain point (elastic limit) and then return to their original shape when the force stretching them is released.

5. What can you conclude about the meaning of the words "taken on a new set" as applied to a metal you are working with?

   "Taken on a new set" means the metal or material will hold a new shape. The object of bending some metals is to achieve a specified shape. When the metal does hold its new shape, it is important that it is the shape specified and that it holds without any weakening to any part.

Passage 4, Torque Wrenches

1. A mechanic over-tightens bolts and then corrects to the recommended torque. What is the most likely result?
   c) Neither of the above.

   This is not a trick question. Ask yourself if there is enough in these passages to answer this question. Passage 1 suggests that the metal probably would spring back if force were gently applied and then removed. However, we don't know if these conditions are met here. We don't know the reactions of different metals to over-tightening (force). In fact, we don't know a lot. With so many – or even one – unanswered questions, more research is needed.

2. Warping of parts will occur if bolts (or nuts) are tightened too much or if they are tightened too little.

   F You need to get specified, predictable results from your work. Too little tightening will not place a force on the metal; therefore, warping is unlikely. However, a loose bolt, nut or other part may cause damage in some other way that you do not anticipate.

3. Tightening bolts in one step saves time and gives you recommended results.

   F Passage 3 states, "Bolts should be torqued up in stages. Never tighten to the maximum value in one step." This is a clear direction. The passage doesn't tell you what would happen if you torqued to maximum values in one step. However, you could safely predict that it would ***not give*** a recommended result.