

**EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING**
Revised for
ACCESS TO APPRENTICESHIP

**COMMUNICATIONS SKILLS
SYNTHESIS OF INFORMATION**

**AN ACADEMIC SKILLS MANUAL
for
The Metal Work Trades**

This trade group includes the following trades:
Heat & Frost Insulator, Iron Worker,
Precision Metal Fabricator, Sheet Metal Worker, and
Welder & Fitter

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

Revised 2011

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
Metal Work Trades*

INTRODUCTION

An *alloy* is a substance you get 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, you end up with 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 – how it applies to your trade. By synthesizing your information, you get results you wouldn't get from one source alone.

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 bring different types of information together 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. It is your job to synthesize all the different parts 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 start 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 these questions, you have to 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 also find a definition of stress load that leads you to a new 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 precision fabricating. 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 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:

1. What is stainless steel?
2. How would I recognize it?
3. What is the difference between stainless and galvanized steel?
4. Where is each used?
5. 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 purpose*.

Example: You have been given a special fabricating project that involves welding. Before you start the project, you need information from several sources, and you need to do a little experimenting to 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 this information allows you to plan for factors such as shrinkage in metal and understand how designs for fittings 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 that knowledge 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

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

Example:

TABLE 1 Fine Tuning MIG Set Up

Problem	Solution
Spatter	<ol style="list-style-type: none">1. Reduce voltage2. Increase electrode extensions (ESO)3. Reduce wire speed and voltage4. Check shielding gas (Is it correct for this process?)
Too hot (too much penetration or burn through)	<ol style="list-style-type: none">1. Reduce voltage2. Reduce wire speed3. 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 heading 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 send 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.

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, and 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 this instruction 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 1, 2, and 3** with the related diagrams to understand and to compare details about *deformation*.

Read Passage 1 and answer the questions that follow. Be sure to read all the available information in the passage and use the figures. Answers are at the end of this skills manual.

Passage 1 **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.

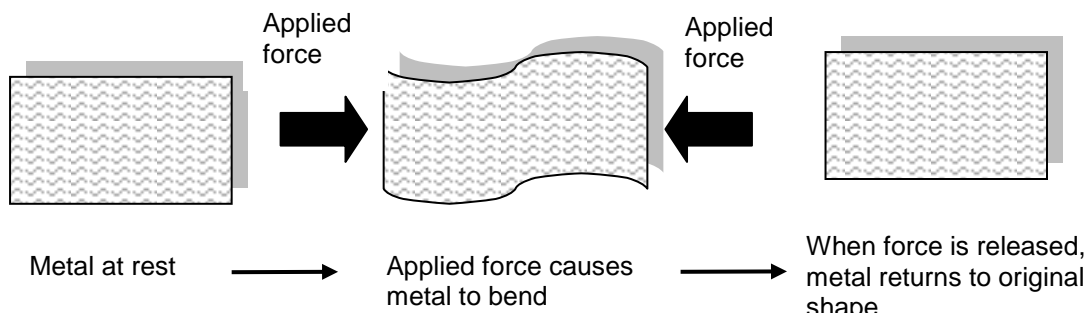


Figure 1: Elastic Deformation

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?

Add information

Understanding one concept can make understanding the next one easier. **Read Passage 2 and answer the questions. Answers are found at the end of this manual.**

**Passage 2
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.

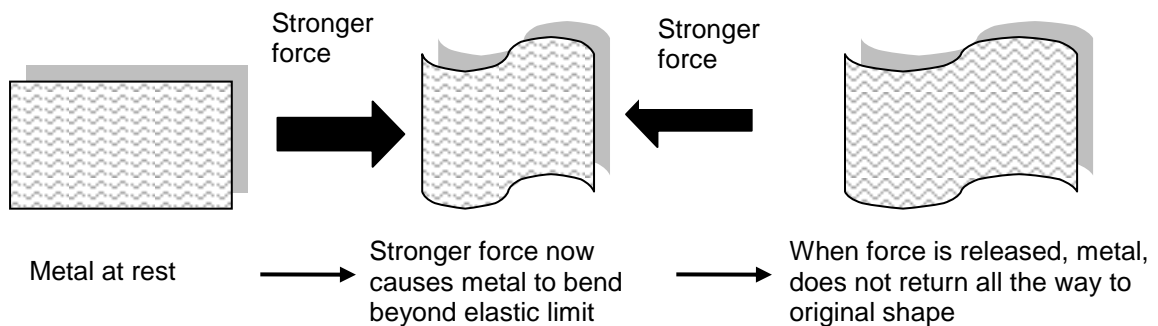


Figure 2: Plastic Deformation

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 more information

Passage 1 and 2 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 3 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 3 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.

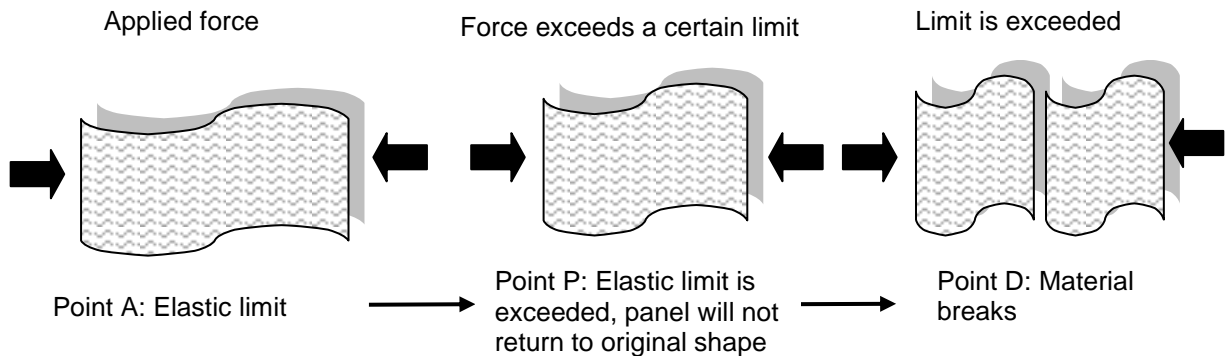


Figure 3: Effect of Load Size on Panel

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

The information in each passage will combine to give an explanation of how metal reacts to pressure. The diagrams illustrate the concepts, show what is happening and add information.

There are still questions you might want answered as to how the concept applies to your work.

You might want to know:

- 1. What types of metal would have most or least elasticity?
- 2. How do you know the elastic limit of a material you are working with?

3. If a load exceeds the elastic limit, what shape will the metal take?
4. What is meant by “certain limit”?
5. How would elongation affect the life of a metal?

These questions will send you on an information search. You will need to find and combine new details about the behaviour of specific metals. The point is that you need good information before you can synthesize the details into a complete picture. You need the whole picture – a synthesis – before you can plan and then successfully complete a project.

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 isn't 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. A co-worker might say that a certain way of doing something is the best. Another worker might suggest that the same procedure is not so important.

Here you will need to bring together 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 plan out 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 client's 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.
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- 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 need to consider the role of the following factors when precision shearing:

- Accurate measuring
- Accurate setting stops
- Care, type and sharpness of blades

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 the shearing job you are doing, assess what you have. Are all the details of the information equally important? Are some your

responsibility, such as setting accurate stops on the shear, and others out of your control, such as the type of metal and the type of part? 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 solve a problem with welding defects. 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 welds cause me problems?
- What is the most likely cause?
- Did I check amperage and machine settings?
- Did I read directions,
- Do certain metals or thicknesses seem to be the problem?
- Do I need to test weld first?

Then go on:

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

Evaluating the information

Sometimes you have to read carefully 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 and 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 evaluate this information to decide how to proceed.

Sometimes information leaves is no room for questions.

Example:

Keep the nozzle close to square on the weld puddle. Don't lean or angle the gun too far in any direction, because a loss of shielding gas coverage could result. Keep the gun angle within 35 degrees of perpendicular with the puddle.

In this example, you are told how to hold the welding gun and why (to maintain shielding gas coverage). You may need to measure to get a 35 degree angle and practice holding the gun before you actually weld, but the reason for doing this and the directions are quite 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's 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.

Example:

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

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.

Passage 4 below offers guidelines about shearing metal. It describes a difficulty when cutting a particular size.

Passage 4 **Shearing Narrow Strips**

Whatever the gauge, narrow strips of sheet metal have a tendency to distort when sheared. This tendency is usually greater in softer and more ductile material and in narrower strips. The slope of the upper knife has an influence on the type of distortion. The precision metalworker must straighten the distortion before fabrication.

Three major types of distortion are *camber*, *curl* and *bow*.

Camber: This tendency is for a strip to curl so its edges are no longer straight but are bowed in a long curve.

Curl: This is the tendency for a strip to twist or curl around itself in a corkscrew.

Bow: This type of distortion is the tendency for a narrow strip to change from its flattened condition to a bowed shape.

This passage advises you to consider a problem *before* you start on a job. If you read through Passage 4 again, you will find the writer asks you to take time to straighten distortion before fabricating. You don't want to find yourself trying to work with a corkscrewed piece of sheet metal wondering what went wrong.

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 II **Passage 1, Elastic Deformation**

1. Define (briefly) elastic deformation.

Some metals can be stretched or bent. They will then return to their original shape when the force is removed. This quality is called elastic deformation or elasticity. Look for a table to give you elastic limits. A trade application (timing devices) is given at the end.

2. What does spring-back mean?

Spring-back describes the action of a material returning to its original shape before it was bent or stretched.

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

The note at the bottom of Figure 1 tells you that the metal returns to its original shape provided it has not been bent *beyond* its elastic point. If the metal is bent beyond this point, it will not return to its original shape. Could this cause damage to the metal? Could it interfere with the function of the metal? Passage 2 and further reading (synthesis) will help with this answer.

PART II **Passage 2 Plastic Deformation**

1. 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 a quality of some materials that allows them to be stretched to a certain point (elastic limit) and then return to their original shape when the force stretching them is released.

2. 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. The grain structure of the material (which is invisible to the eye) has changed.

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?

If the grain structure takes on “a new set”, it suggests a different shape that is permanent. In your work you need to know whether this is desirable or undesirable, whether this metal is “out of shape” or whether it is the shape you planned.

PART II Passage 3, Elasticity and Plasticity Page 10

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

F The passage states clearly that “even if” load increase is gradual and at a constant rate, elongation will *suddenly increase*. It says nothing about preparing for or predicting this. Maybe you can predict with more experience and knowledge about grain structures and about individual materials (metals), but it is not suggested here. Because of the statement, “*partial elongation will occur in one portion . . . and it will break*”, you need to know more about load on various materials.

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 Refer to Passage 1 for a definition of “*spring back*”. Refer to Figure 3 for Point A and to the second half of Passage 3 for the explanation.

3. If a load exceeds the elastic limit.

b) permanent stress occurs. Passage 2 states this while Passage 3 gives an explanation with details.