

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

**COMMUNICATIONS SKILLS
DRAWING CONCLUSIONS**

**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
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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 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: DRAWING CONCLUSIONS

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

INTRODUCTION

Drawing conclusions means making a decision through a process of reasoning. It involves finding facts, examining opinions, and determining causes and effects. From this background, the relevant information is selected and used to reason through to the best conclusion.

For example, your cutting shears won't get through a piece of metal that you need to cut. What conclusion can you draw that might lead to a solution to the problem?

First you look for the relevant information. You check the manual to find out what kind of shears should be used for this type of metal. You observe the strength of the shears and their condition, and the thickness of the metal. You reason that the dull edge on the blade is the cause of the problem. You come to the conclusion that you need to sharpen your shears. You have identified the problem and decided on a solution.

As you can see, this is a useful process when you need to make a decision on the job, such as making recommendations for design and fabrication process modifications. When you think about the connection between what you observe and what you already know, you can come to a valid conclusion. You can use this conclusion to guide you in making workplace decisions.

You draw conclusions by comparing information obtained from different sources. Your information might come from texts and manuals, from listening to knowledgeable workers and teachers and from experience gained working on projects. Here is an example from an everyday situation.

Example: The ice on Lake Simcoe is thin, so you decide it won't be safe to snowmobile. Knowing the condition of the ice and the weight of a machine, you conclude there's a risk of an accident. The next day, when the newspaper reports a snowmobiler went through the ice, you realize you made the right conclusion.

In this skills manual, we examine the process of drawing conclusions by looking at the following:

- ◆ Selecting information for valid conclusions
- ◆ Drawing valid conclusions
- ◆ Recognizing conclusions

PART I
SELECTING INFORMATION FOR VALID CONCLUSIONS

A **valid conclusion** is one that is reasonable and that is based on fact as much as possible. The facts you use to draw a conclusion will come from instructors, textbooks, knowledgeable workers and your careful observations. Use this information and your experience to think through to a reasonable answer or solution – in other words, to a valid conclusion.

Example: An *insulator*, or non-conductor, does **not** allow electric current to flow through it whereas current flows easily through a *conductor*. You discover current is flowing in a wire where it shouldn't be; you need to know why because this is a fire safety issue.

If there is no knowledgeable person available to ask, you will have to look at the wiring system for clues. Check any information you have on conductors and insulators. The information you read and your observations should help you draw a reasonable conclusion as to the cause of the problem.

If you can't find a simple cause and solution, shut off the power or the switch and wait for an electrician to come. Turning an electrical problem over to a trained technician is a reasonable conclusion in this situation.

Read Passage 1 below as an example of information that might explain the reason for the problem.

Passage 1
Conductors

A material that allows an electric current to pass through it easily is called a *conductor*. Although there is no perfect conductor of electricity, conductors can be divided into three classes: good, medium and poor.

Insulators (Non-Conductors)

If a material does not allow enough electric current to pass through it to be calculated, it is called an *insulator* or *non-conductor*. Although there is no such thing as a perfect insulator, insulators are used to prevent electricity from flowing where it is not desired.

Note: Moisture has the ability to change an insulator into a poor conductor; it has the ability to change a poor conductor into a medium conductor.

When you start reading this passage you might think that the problem is with an insulating material – maybe a wire has been nicked.

Then you see the reminder about moisture and recall the dampness in the basement. You conclude that moisture is a more likely source of the problem. Looking for moisture somewhere near the electrical system is the first thing you should do. If you don't find a source of moisture, you need to keep looking for other reasons for the problem, so you can reach a valid conclusion.

Understanding Relationships

Drawing a valid conclusion often depends on understanding the relationship between two things. To discover the connection between the cause of a problem and its effect, such as the situation above, you might follow these steps:

- You look for information and read that moisture has an effect on an insulator.
- You conclude that this effect could be a possible reason for the problem.
- You go back and look for moisture at the site
- If there is moisture, you can conclude that this is a possible cause.
- If there is no moisture, you need to keep looking.
- In either case, you reasonably conclude that this is a situation for an experienced electrician.

These steps are useful when you have a problem to solve.

In many cases, looking at the relationship between different parts of a system will lead you to a reason for the problem. If one thing is not working the way it is supposed to, it can lead to difficulties in many areas. Using the following steps to observe cause and effect relationships can often lead to a solution or even prevent a problem in the first place.

1. You observe the situation
2. You find information about what might cause this situation.
3. You compare your information to what you see.
4. You reach a conclusion about a likely cause.
5. You check to see if the conclusion seems reasonable.
6. You decide on an action based on your conclusion.
7. After carrying out this course of action, you recheck to see if it solved the problem.

Passage 2 describes factors that affect the performance of bearings. **Read Passage 2 and answer the questions that follow. Answers are at the end of this skill manual.**

Passage 2

Surface Finish of Journal and Bearing

The surface finish of both the journal (the part of the shaft, axle or spindle that turns in a bearing) and the bearing affects the amount of contact between the metal surfaces. Metals can be kept separated from each other with very thin oil if surface finishes are also very fine. This ensures satisfactory bearing performance.

A surface may feel smooth to the touch, but it will show peaks and valleys when magnified. These saw-toothed projections are smoothed out or worn down by a *run-in* (wear-in or break-in) period. After the run-in period, the surfaces will have a high degree of smoothness. The peaks will be reduced and flattened, sharp edges will be rounded, and surface variations between peaks and valleys will be reduced. With smoothed surfaces, a very thin oil film keeps the journal and bearing separated and the bearing can thus support heavy loads.

Questions:

1. You can conclude that satisfactory bearing performance will result from:
 - a) smoothness of surface finishes and proper run-in period.
 - b) very fine surface finish and very thin oil.
 - c) a surface smooth to the touch and a reduction of heavy loads.

2. You can conclude that a change in the thickness of oil could affect:
 - a) the amount of contact between metal parts.
 - b) the weight of the loads.
 - c) the saw-toothed projections.
 - d) all of the above.

3. A smoother finish and a thicker grade of oil should result in best operating efficiency.

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4. The proper run-in period will wear down the peaks and valleys of the journal and bearing surface.

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Passage 2 describes the importance of a proper run-in period on bearing performance. Having this information will ensure that you take the time to do a proper run-in. You can conclude from the passage that if you changed or omitted the run-in period, the result will not be satisfactory.

Each step in the process is important. You need to pay attention to details because a small change can make a big difference. Machine operation, the life of the parts, their ability to support weight, and the costs of down time depend on making sound decisions.

Note important details before you start a job. Read, ask questions, and use the information available to arrive at a practical conclusion as to how to carry out a job. Find out what factors will have an effect on the result. You may need to experiment and do some tests to check that you have drawn a logical conclusion.

PART II

DRAWING VALID CONCLUSIONS

Sometimes you know the result, but not the exact cause.

Example: When you read the newspaper report about the snowmobiler going through the ice on Lake Simcoe, you concluded that the ice was too thin for snowmobiling. This is probably true, but there could also be other factors involved.

You might have a good idea of what happened but you might be missing some of the reasons for the accident. Bad visibility, being unfamiliar with the lake and travelling over an area of strong currents could be factors in the snowmobile accident. Thin ice was the cause of the accident but you don't know why the snowmobiler drove over unsafe ice in the first place.

Getting all the Pieces

The same principle applies to paying attention to all the information concerning procedures you use at your workplace. If you make quick observations or if you skim through your manual, you might go ahead, assuming that you have all the pieces. But there is also the possibility that you have missed something. You can't draw a valid conclusion or find a solution to a problem if you overlook important, available information.

A valid conclusion relies on having, and examining, all of the information important to that situation.

Read Passage 3 below. Consider the conclusions you could draw with the information given.

Answer the questions that follow. The answers are at the end of this skills manual.

Passage 3 Butt Welds

A butt weld is made in the joint between two pieces of metal which are in approximately the same plane. Weld sequence is important: Weld in a sequence which allows one area to cool before welding in the area next to it. To do this, weld in a 1, 3, 5, 7 sequence; then go back to weld in a 2, 4, 6, 8 sequence. When welding sequence is done by skipping every other section (or intermittently), each weld can cool before the welder goes back to weld the spaces in between. This intermittent, or *stitch welding*, results in less strain.

Before filling the spaces between intermittently placed beads, grind the beads along the surface on the panel. Then fill the space with metal. If you place weld metal and do not grind the surface of the beads, blowholes can be produced. When welding thin panels (0.79mm or less), stitch welding is essential to prevent burn-through.

Questions:

1. What might you conclude if you discover blowholes in a weld?
 - a) An area did not cool before welding in an area next to it.
 - b) A section cooled too quickly.
 - c) The beads along the surface of the panel were not ground.
 - d) All of the above.
2. Thin panels require intermittent welding when they are in approximately the same plane.

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3. Which of the following will result from using the correct sequence for a butt weld?
 - a) prevention of burn-through in thin panels
 - b) less strain
 - c) avoidance of the problems of blowholes
 - d) all of the above
4. A weld made in a 1, 2, 3, 4, 5 sequence would not affect the strength of the completed weld provided that each weld was allowed to cool before the next weld was made.

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Getting the whole picture

Factors which are not stated may also affect the results of a job. For example, suppose you followed the sequence outlined in Passage 3, and still produced a weak or poor weld. Is something else different? Is your equipment up to standard? Is the angle of weld or your technique not what it should be? Is there something you didn't understand?

When looking for the cause of a problem, you usually start with the obvious reasons. But sometimes you need to check out everything. Make sure you don't reach a conclusion based on only part of the information. You want all the available information before drawing a conclusion. Always get the whole picture first.

Example: Suppose you work in an area with gas engines and motors. After a few months you come down with flu symptoms - headaches, dizziness and nausea. The symptoms hang on and you see your doctor. Your doctor asks if there are any factors at work that might cause the symptoms but you say everything seems fine. You and the doctor decide this is just a nasty bug. You carry on at work but the flu symptoms don't go away.

A few weeks later you notice the following warning on a piece of machinery where you are working:

NOTE: Use only in a well-ventilated area. Fumes from this machine can accumulate in the body and cause flu-like symptoms.

You wonder if your flu-like symptoms are caused by lack of ventilation. You make sure the window is open and the fan is running from now on when you are working on that machine. You look for changes in your health over the next weeks. Soon your illness is gone.

Can you conclude that lack of ventilation caused the problem? From your observations, it seems likely. You can now act on this conclusion by making sure your work area is properly ventilated.

In this example, your first conclusion was that you had the flu. You based this on your past experiences. It felt like other flu that you have had. However, when the flu didn't get better, you realized that there may be another reason for your symptoms.

From the information about fumes, you learned about another factor that might be causing the problem. You acted on that information by providing better ventilation and your symptoms disappeared. You drew a new conclusion based on further information and observation.

Is it a valid conclusion?

If a first conclusion doesn't provide a practical solution, you have to keep looking. When you add new information, you should then be able to draw a different, and more valid, conclusion. In other words, new information can lead to a new conclusion when the first conclusion is not valid.

Making an estimate about a job is one form of drawing a conclusion. To come up with a reasonable estimate requires several steps:

- ◆ You have to know what options are available.
- ◆ You have to find out the cost of each option.
- ◆ You have to compare the advantages and disadvantages of each option.
- ◆ Then you have to weigh the cost against the advantages and disadvantages. You will have to decide what the most important factors are in making this decision.
- ◆ Reaching a final estimate involves coming to a conclusion as to what the best option is for the cost.
- ◆ You can now present this estimate to the customer along with reasons for your choices.

To make sound decisions in the machining and tooling trade, you study information in texts, manuals and diagrams so that you learn the material and can apply it. You observe different factors in the workplace for the same reason - so you can understand and evaluate what you see. What you read (theory) and what you do (practice) are essential to making good decisions. You read and learn when working with written material; you observe and learn when gaining hands-on experience.

Example: You experience a mild shock while drilling. You take a good look at your drill and notice that the cord is frayed. You know from your reading that frayed cords can cause shocks. After concluding that the frayed cord is the cause of the electrical shock, you unplug the drill carefully and set it aside until the cord is replaced.

Here is another situation which calls for reaching a conclusion. **Read Passage 4 and answer the questions which follow. Answers are at the end of this skills manual.**

Passage 4 **Cutting Speed and Feeds**

The speed of the work revolving in a lathe is an important factor which affects the production rate and life of the cutting tool. If lathe speed is too slow, it will result in loss of time; if it is too fast, it will cause the cutting tool to break down quickly. This will require time to sharpen it again. The correct speed and feed should be used for the work material and the type of cutting tool. The correct lathe speed results in longer tool life and the shortest amount of time to machine the work.

Cutting speed is the rate at which a point on the circumference of the work passes the cutting tool per minute. It may be expressed in metres per minute (m/min) or feet per minute (ft/min). Recommended cutting speeds (CS) for various materials are determined by the metal and cutting tool manufacturer and listed in a table.

Follow these speeds for best cutting life and production rates. To calculate revolutions per minute (r/min) to set a lathe, the diameter of the work and cutting speed of the material must be known. Choose the formula for metres or inches per minute. If the machine does not have the variable-speed drives to set for the exact calculated speed, use the simplified formula.

Questions:

1. What conclusion can you come to if the life of a cutting tool is shorter than expected?
 - a) The lathe speed is too fast.
 - b) The lathe speed is too slow.
 - c) The diameter of the work was unknown.
 - d) All of the above.

2. If you are cutting a piece but have not determined the metal, what result might you expect?
 - a) The production rate may be low.
 - b) The cutting tool may break down.
 - c) The revolutions per minute may be calculated incorrectly.
 - d) All of the above.

3. You can conclude that the simplified formula for calculating revolutions per minute to set the lathe is close enough for most lathe operations.

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In this passage you learn about the how cutting speed of a lathe is a factor in two important results in the shop – production rate and the life of the tool. If you understand why the correct cutting speed is necessary, you will set it correctly for each piece that you machine. When you understand the relationships between these factors, you can draw valid conclusions that will get you sound results.

Look ahead

When you read technical information, like butt welds or cutting feeds, you obtain facts that you can use to make *predictions*. To make a prediction, you must read the instructions and then think ahead to what the outcome of following those steps might be.

You can predict that your outcome will be successful if you follow the instructions, use the right equipment and give yourself enough time for the job. You can also predict you will not get the right result if you do not follow the directions exactly or if you work without the required skill or knowledge.

Note: Because of other factors – unknown to you or overlooked – this may not result in a valid conclusion. If you do not arrive at the correct conclusion, you will have to continue researching until you discover it.

Look behind

You can turn the process of drawing conclusions around by looking backwards. If you discover a problem, you'll need to go back to find a cause. You may have to go through the instructions sentence-by-sentence. After reading the information again, check your technique and tools, and then observe what is actually happening on the job. This will help you to identify the cause of the problem. Then you can draw a conclusion that will let you figure out how to avoid the problem next time.

Process of elimination

The examples in this unit ask you to use a process of reasoning for several reasons. You might want to:

- decide what is the best way to proceed,
- choose a material,
- find an answer to a question, or
- find a solution to problem.

To come to a reasonable conclusion in these cases, you might use a process of eliminating possibilities. You make a preliminary selection between possible choices as a way of getting started.

- First, you try to eliminate the least likely or the weakest possibilities first.
- Next you look carefully at the more likely possibilities, based on your reading and experience.
- Then you pick what looks like the best choice.
- If you get more information or if your choice doesn't seem to be working out, you start the process over.
- You might have to look for more options to consider.

As you begin to see the relationship between various factors, you can begin to draw conclusions that work for your situation.

Example: You know that a change in altitude means a change in atmospheric pressure. If you are working at a different altitude than sea level, you conclude that a pressure gauge will not give you an accurate reading unless it is adjusted. Drawing this conclusion will lead you to check your equipment before you use it and to make the proper adjustments.

Is this valid?

When you observe what happens in the workplace, you use what you see to draw conclusions about what works and what doesn't. At some point, you have to decide if your conclusions are valid.

Often when you draw a conclusion, you need more testing or examples to be sure it is valid. If an outcome happens once during project, you can't be sure it will always happen that way. More examples are required before you can use that outcome to make predictions. You will know the conclusion is valid if the same thing happens every time you follow that procedure.

Example: You may produce a defective joint because you used the wrong welding sequence. However, in another situation, a defective joint may be the result of temperature that is too low. Noticing causes and results while you are learning and while you are working adds to your awareness of what a valid conclusion is.

Noticing causes and results, while you are learning and while you are working, adds to your awareness of what is a valid conclusion for a given situation. With experience, you will come to instinctively figure out what is the best way to proceed.

You may have overlooked other factors which affect the outcome of the finished work. If you notice that you have missed something on a project, make sure to take it into account the next time. Each factor will have an effect on the finished product. As you learn how each factor affects the process, you will work hard to develop the skills needed to reach a satisfactory conclusion.

Sometimes you need to reach a conclusion quickly, perhaps about what product to choose. You don't have time to check all the possible results of using the different products. You can ask other workers what they would choose. You can turn to an expert. You can also rely on manufacturers' literature. The information will often tell you what to expect. If the company is reliable, you can count on them to test their product and to guarantee them.

A conclusion may be valid in one situation given the information you have available. It may *not* apply in another situation. Learn to judge each new situation before you draw a conclusion. Look at the relationship between cause and effect. Keep track of what happens in different situations so you have a range of possibilities from which to choose. Consider all the possibilities and keep your mind open when making conclusions.

There are skills you can develop to help in making valid conclusions:

1. Observe and keep records of what happens in different situations on the job.
2. Talk to skilled workers to add to your store of knowledge.
3. Watch and listen as you work.
4. Test your ability to judge a situation.
5. Start to see patterns that can help you make reliable prediction.

As you become more experienced, you will find it easier to reach valid conclusions and make logical decisions.

PART III ***RECOGNIZING CONCLUSIONS***

You might be reading a text or manual and you want to decide if the information presented is a series of facts or if there is a conclusion made based on those facts. Experienced workers might talk about different situations and you aren't sure what conclusion to draw from the conversation. There are guides that help you recognize when a conclusion is being made.

The language of conclusion

Some words provide clues that a conclusion is being drawn. When you examine information to find solutions, notice when any of these words are used. The words, *therefore*, *must have* (*must be*) and *would have to be*, indicate that a conclusion is being drawn in the information:

Example: You look at a porous weld with little holes in it. You can see rust on the base metal. You tell someone, "If the base metal is rusted, it causes a poor weld. I can see rust on the base metal, so that *must be* the cause of the poor weld."

The words, *if, so that, due to, because of, or since*, indicate the steps in a logical reasoning process that lead to a correct conclusion. They point out the causes that lead to a result. The conclusion follows.

Examples:

If wear on the lips or margin of a drilling tool is not removed, the result is loss of size and negative back taper on the tool.

Due to clean air regulations, some solvents are no longer used.

Because of the wide variety of tools available, procedures for misfires differ.

Since so much work is measured with a micrometer, it is essential to read and use this instrument accurately to achieve accurate results.

Words and phrases such as *will then, consequently, therefore, must, as a result* or *thus* often indicate the results of something happening. Once you know cause and effect, you can then draw a conclusion.

Examples:

If a tool uses more air pressure, *it will then cause* the air compressor to wear out faster.

Bends are often made to the corner of notches; *as a result* the metal may break at the corners when the bend is made.

Loosening the locking handle and rotating the holder until the tool bit is in the cutting position reduces setup time, and, *thus*, increases production.

Some metals are very brittle; *therefore*, they may break when bent to make sharp corners.

Another method of drawing conclusions is by turning information around:

Example:

Tools of high quality purchased from a reputable manufacturer have a number of advantages. Most

- offer lifetime guaranties against failure,
- are lightweight and easy to handle,
- hold up under use

If the above is true about high quality tools bought from a reputable manufacturer, you might conclude that the opposite is true of poor quality tools. In other words, that they do not offer lifetime guarantees against failure, are not lightweight and are not easy to handle.

Although you can turn some information around, be careful not to jump to conclusions based on too little information. There may be inexpensive tools available that are a good deal and that work well. Before you draw a conclusion about tools based only on price, you might want to do some research by talking to others and reading guides that compare tools.

Read the advice below about caring for measuring tools:

Measuring tools must be handled with the care.

1. Never drop a square as this can ruin accuracy.
2. Always keep it clean.

Precision tools require care. Does this mean you can toss around other instruments and tools? Think about the result of this action. Drawing valid conclusions always requires a certain amount of common sense.

CONCLUSION

To draw valid conclusions, you must first make accurate observations. Then you compare what you see to what the information you have from textbooks and manuals. You might ask a more experienced worker for their opinion of the situation. All this information is used to reason through to a logical conclusion.

After reaching a conclusion, you need to check if it seems valid in other situations. This process will gradually build up a wealth of experience that you can use to make future decisions. You will be able to quickly decide what course of action to take in various situations. This will also be useful in making a reasonable estimate.

Understanding the relationship between cause and effect is a necessary step in reaching a valid conclusion. Skill in drawing conclusions will give you the ability to judge a situation accurately. You will also develop the habit of making sound decisions as you learn. This will help you develop into an efficient and effective trades person.

Summary

1. **Use a variety of resources to draw conclusions.** These include experience, observations, advice from experts and all relevant technical reading information
2. **Read technical material carefully** to find information about causes, results and solutions; you can then use the information in the workplace.
3. **Carefully observe** what is happening in the workplace.
4. **Understand the relationship between things** to be able to judge cause and effect.
5. **Understand that a change in a procedure, material or tool often affect something else.** Notice how these changes affect the result.
6. **Consider whether you have all the information** needed to reach a valid conclusion. Are there factors affecting the outcome that you do not understand or don't know about?
7. **Eliminate weak possibilities** to focus on the strongest and the most likely.
8. **Observe language used in drawing conclusions** such as *therefore, thus, would have to be, must be* which set up the situation and then reach a conclusion.

Answer page

PART I Passage 2, Surface Finish of Journal and Bearing

1. You can conclude that satisfactory bearing performance will result from the following:
 - b) a very fine surface finish and very thin oil
2. Which of the following could you conclude would be affected by a change in the surface finish?
 - a) the amount of contact between metal parts.
3. A smoother finish and a thicker grade of oil should result in best operating efficiency.

F Would a thicker oil result in longer part life and smoother operation? Nothing in Passage 2 suggests a thicker oil would give the *best operating efficiency*. In fact, the passage states in two places that *a very thin oil* will provide sufficient separation between metals.

4. The proper run-in period will wear down the peaks and valleys of the journal and bearing surface.

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PART II Passage 3, Butt Welds

1. Which might you conclude if you discover blowholes in a weld?
 - c) The beads along the surface of the panel were not ground.

This question asks you to come to a conclusion about the cause of a problem.

2. Thin panels require intermittent welding when they are in approximately the same plane.

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3. Which of the following will result from the correct sequence for a butt weld?
 - d) All of the above.
4. Suppose you weld in a 1, 2, 3, 4, 5 sequence. You can conclude this sequence will not affect the strength of the completed weld if you allow each weld to cool before making the next weld.

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PART III Passage 4, Cutting Speed and Feeds

1. What conclusion can you come to if the life of a cutting tool is shorter than expected?
 - a) The lathe speed is too fast.

2. If you are cutting a piece but have not determined the metal, what result might you expect?
d) All of the above.

The right results depend on several factors. The correct cutting speed depends on the correct speed for the material.

3. You can conclude that the simplified formula for calculating revolutions per minute to set the lathe is close enough for most lathe operations.

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