BRIDGERLAND TROUBLESHOOTING METHODOLOGY

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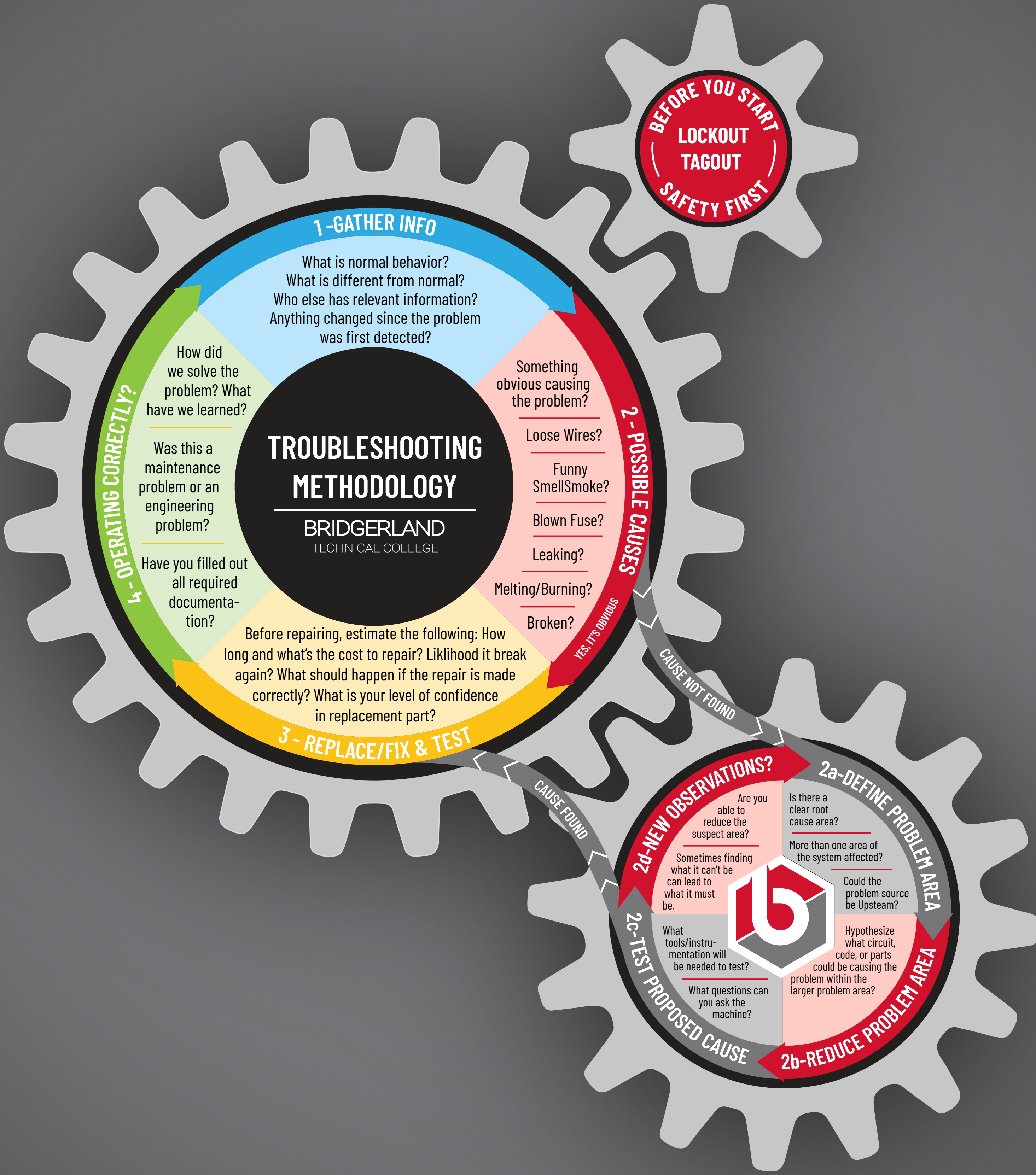

BEFORE YOU START
LOCKOUT
TAGOUT
SAFETY FIRST
TROUBLESHOOTING METHODOLOGY
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1 -GATHER INFO
What is normal behavior?
What is different from normal?
Who else has relevant information?
Anything changed since the problem was first detected?
2 - POSSIBLE CAUSES
Something obvious causing the problem?
Loose Wires?
Funny SmellSmoke?
Blown Fuse?
Leaking?
Melting/Burning?
Broken?
YES, IT'S OBVIOUS
CAUSE NOT FOUND
3 - REPLACE/FIX & TEST
Before repairing, estimate the following: How long and what's the cost to repair? Liklihood it break again? What should happen if the repair is made correctly? What is your level of confidence in replacement part?
4 - OPERATING CORRECTLY?
How did we solve the problem? What have we learned?
Was this a maintenance problem or an engineering problem?
Have you filled out all required documenta-tion?
CAUSE FOUND
2a-DEFINE PROBLEM AREA
Is there a clear root cause area?
More than one area of the system affected?
Could the problem source be Upsteam?
2b-REDUCE PROBLEM AREA
Hypothesize what circuit, code, or parts could be causing the problem within the larger problem area?
2c-TEST PROPOSED CAUSE
What tools/instru-mentation will be needed to test?
What questions can you ask the machine?
2d-NEW OBSERVATIONS?
Are you able to reduce the suspect area?
Sometimes finding what it can't be can lead to what it must be.

It is important to remember before starting the diagnosis of any system that all required safety procedures are followed. Failure to do so can result in injury, equipment damage, and immediate dismissal. Most companies have a zero-tolerance policy. **Lockout/ Tagout** before entering or interacting with the system. Double-check to make sure no additional hazardous energy remains in the system. If you are unsure of safety protocols or procedures check with your supervisor or instructor.
Remember, BEFORE YOU START - SAFETY FIRST!

BEFORE YOU START
LOCKOUT TAGOUT
SAFETY FIRST

Troubleshooting is a primary skill required for anyone working with automated systems. Troubleshooting is a logical, systematic search for the source of the problem to solve the problem. This does not necessarily mean solving the problem but also finding the problem's source. In the past, many relied on experience alone to fix known problems, but as automated systems become more complex it is important to be able to find a problem's source even if the troubleshooter has never experienced the problem before.

Bridgerland Technical College's Troubleshooting Methodology is more than just rote memorization of common problems in a system, although this does play a part. It also includes increasing a student's fundamental understanding of electrical, pneumatic, hydraulic, and mechanical systems, as well as individual components, control systems, and the logic required to make decisions. The most important aspect is learning and practicing a method for solving both simple and complex problems. As students gain greater experience using the methodology, over time, it will become second nature.

GATHER INFORMATION

What is normal behavior for the machine?

If you're not sure, ask experienced operators or other maintenance personnel.

Understand all information from the operator's perspective. Remember that an operator is not necessarily a technical person so their impression of the causes of the problem will likely need to be verified, but their impression of the symptoms can often be better than that of technician since they run the machine on a regular basis and are more familiar with the normal behavior. Be careful to not spend a lot of time on the operator's impression of what should be done without first verifying the problem.

Has anything has changed on the machine recently?

Was it recently PM'ed? Adjusted? Parts replaced? Be careful not to spend too much time on this question or the information it produces. Recent events could be nothing more than coincidental. Also, machines commonly begin to fail without any recent notable events. If the problem is a failure of the normal sequence of the machine, what was the last thing that the machine did successfully before stopping / malfunctioning?

Is it still in the state that it was in when it malfunctioned (in-state)?

Has the operator reset faults, attempted to home or restart the machine? Has anything else been done that may have changed the evidence that you have in front of you?

If the machine is in-state, preserve information that may be lost once troubleshooting begins. This could mean uploading the PLC program and preserving it, photographing critical items and connections, observing, and documenting the state the machine was in (what step in a sequence or program did it stop in?), and making any temperature, voltage, amperage readings as applicable.

Perform lockout/tagout and any other safety precautions!

Take special note to make sure no part of the safety system has been bypassed or disabled.

Make your own initial observations. Use all your senses.

- Do you see, smell, hear, feel (heat or vibration) anything that appears to be abnormal?
- Are there any noticeable loose wires, hoses or hose clamps? Anything hanging or out of place?
- Have you done a continuity test on any visible fuses?
- Have you found all of the fuses (schematic)?
- Is there anything leaking?
- Do you smell smoke or notice any burned/melted pieces?
- Is anything noticeably broken, cracked, or loose? Any missing bolts, fasteners, or metal filings on the floor or at the bottom of the machine?
- Have any parts of the safety system been bypassed?

POSSIBLE CAUSES

As much as possible, troubleshooting tools should be collected in advance of an event that requires them.

Is it something obvious?

If YES, then continue to **REPLACE/FIX & TEST.**

There is no point in spending a significant amount of time troubleshooting if something is clearly disconnected, or a machine runs just one cycle and then stops because the machine mode is set to “single cycle”.

If nothing seems obvious:

DEFINE THE PROBLEM AREA

On larger or more complex machines, try to identify which part of the machine is causing the problem. There may be more than one. Does the problem seem to be electrical, communication, pneumatic, parts failure, or some other problem? Consider whether or not a problem upstream may be creating problems further downstream. Will an upstream problem need to be fixed first?

REDUCE THE PROBLEM AREA

Once a general area has been identified, try to reduce the problem area to individual circuits, parts, programming area, etc. Theorize possible causes for the symptoms that have been identified. To do this, it is helpful to have an in-depth knowledge of the machine and associated technology. Put together a list of possible causes.

TEST THE PROPOSED CAUSE

Once a problem area has been reduced, think about what questions you can start asking the machine. Troubleshooting tools are used to ask questions of the system.

- Prioritize questions that you will "ask" the machine. Often we are are looking for the tool to tell us something, but the tool just answers the questions. For instance, do I have 24 volts across a certain point? The meter really just answers, "yes you have 24V," or "no you do not." The meter doesn't tell you if 24V is good or bad. Here are some additional questions:
    - How much time and money will the question take to ask?
    - What is the likelihood that the answer to the question will be relevant? (Does the question represent a likely failure mode or identified suspect portion of the machine?)
    - What questions can be combined to save time and money?
    - Will the answer help determine the problem area? For instance, is the problem indication (inputs) or control (outputs). Is the problem pneumatic or electrical?
- Ask the questions. Collect and record data.
- After initial data is collected, reprioritize questions for the next round, hopefully with a more focused set of questions. Be careful to not get distracted by information that is not relevant. Remember that you can also formulate and ask questions of a subsystem of the machine.

CAUSE FOUND move to **REPLACE/FIX & TEST**

CAUSE NOT FOUND, **are there any new observations?** Start back at **DEFINE THE PROBLEM AREA**.

TROUBLESHOOTING TOOLS

Like most tasks, troubleshooting requires tools. The tools required for troubleshooting can vary and are specific to the type of troubleshooting being done. Most of the tools required for troubleshooting can be collected in advance of the event that triggers their use. These could include:

- Documentation of the equipment – This could include user's manuals: maintenance, electrical, pneumatic, or hydraulic manuals.
- Manuals of subsystems
- Maintenance and repair history
- A clear understanding of the theory of operation of the machine
- A clear understanding of the technology that is used on the machine – That could be electrical, pneumatic, hydraulic, laser, etc.
- Tools to ask questions of the involved technologies:
    - In an electrical system, that could be a multimeter, oscilloscope, or spectrum analyzer.
    - For hydraulics or pneumatics, that could be pressure or flow gauges.
    - For controlled systems, that could be a computer, interface cables, and code diagnostics.
- A clear understanding of how to use the diagnostic tools.

REPLACE/FIX AND TEST

How has the machine been recovered and returned to an operational state when this happened previously?

This can be helpful not just as a tip to get the machine running again but as to what may be the cause.

Most small, simple systems can be repaired quickly and at little extra cost. As systems become bigger and more complex, estimating the following is recommended before proceeding with a repair:

- How long will it take to repair and what is the estimated cost? How long will it take to obtain parts? It may not be worth attempting to repair if the cost is too high or if it's going to take too much time to make the repair.

- What is the likelihood that it will break again? If the same problem is happening frequently, are you installing the new parts or making the repairs correctly? Are there ways to improve on previous repairs to make it last longer?

- What should happen within the system if the repair is made correctly? The system is currently exhibiting X behavior, what should that behavior look like if a proper repair is made? What voltages or pressure should you see?

- What is your level of confidence in the replacement part? It is always possible that the replacement part is also faulty. How could you test the part?

Try to simulate real-world conditions when testing the repair.

For example, try to feed product into the machine the way it would naturally and normally be fed rather than doing something that might be quicker, but not the natural way the machine would do it.

Caution should be taken when restarting the system

Should reset procedures be followed before starting back up at full speed?

Engaging the system at full speed immediately in its current state may cause new problems.

- Is there a way to ramp up the overall speed rather than going full speed immediately?
- Are there areas of the process that operate more optimally at certain temperatures or at certain speeds that will not do so if the machine has been sitting for a period of time?

OPERATING CORRECTLY?

There is a natural tendency, once the problem has been solved, to just move on without thought or reflection as to why the problem happened in the first place, or how improvement could be made when future problems occur. When you are new to a system or machine, your initial approach may be less efficient. It's important each time to evaluate what could be improved in your methods. You should always ask:

- How was the problem solved?
- What was learned from this process?
- If for example, it took an hour to get to the root of the problem, what could you do next time to do it faster?
- Could the process of troubleshooting take a matter of minutes next time, if you change where you start looking for the problem?
- Was this a maintenance problem or an engineering problem?
- Was the machine not properly maintained?

Anticipating part failure, if proper preventative maintenance is employed, is an important part of maintaining any system. Part failure tracking can be as simple as keeping track of how long various critical parts wear out on a spreadsheet and then replacing them before they fail. Were previous attempts to repair done incorrectly? For example, were belts not tensioned properly? Were bolts not torqued properly? Did someone just hit it with a hammer and hope it would keep working for a little while longer?

Engineering problems include things like incorrect part specification which makes the part not durable enough to last. It could also include a lack of access to repair common problems or perform common preventative maintenance. How could this be improved for better performance in the future?

Finally, It is good practice to **document what went wrong**, and what was done to properly repair or fix the problem. Documentation often includes:

- Who made the repair?
- When it was made?
- Why the repair was needed?
- What symptoms the machine was exhibiting?
- What tools and parts were required to make the repair?
- How long it took to perform the needed procedure?

You will encounter many technical and mechanical issues during your career. Over time, utilizing this methodology will become second nature as you gain more experience, and as you become more familiar with the steps to diagnose and troubleshoot. With continual improvement and practice, you will eventually become the “go-to” person at your company, who can solve most systematic problems.

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