Use and Maintain Systems: Diagnose and Troubleshoot

Foundations of Technology

Montgomery County Public Schools

Outcomes

In this presentation you will learn:

- Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. (ITEA 12-M)
- Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision (ITEA 12-N)
- Operate systems so that they function in the way they were designed (ITEA 12-O)

Diagnosing a Problem

The focus of this lesson is going to examine how to diagnose a system that is malfunctioning and the use of tools, materials, machines, and knowledge to repair it. By the time you leave high school, you should be able to use and maintain various types of products and systems — a key element to technological literacy.

You may be the type of student that has developed strong personal interests and ability in technology and will be ready to pursue further education in the field. You should also be able to articulate and communicate your thoughts to others using oral, written, and electronic communication techniques.

You should be capable of diagnosing, troubleshooting, analyzing, and maintaining systems. These abilities become central to keeping systems in good working order. It is important for you to know that establishing maintenance schedules help to prevent breakdowns.

Diagnosing a Problem

For example, you could establish regular schedules to change the air filters in your home or to change the oil in the car. If certain products or systems fail, it is important that you be able to diagnose, troubleshoot, and repair them. Much information about how to diagnose and repair a product or system is contained in the product's service manual.

Having a clear understanding of the severity of the problem is key to deciding if more experienced help is needed.

All systems should function the way they were designed. These systems may include two-way communication radios, transportation systems that move goods from one place to another, and power systems that convert solar energy to electrical energy.

Repair

Repairing a building may include replacing damaged ceiling tile, applying new wall coverings, or fixing a hole in the wall. Product repair can involve replacing workout or broken parts and adjusting mechanisms.

Repair is the process of putting a product back into good working order. This requires three steps:

- **Diagnosis:** The cause of the problem is determined
- **Replacement or adjustment:** Worn or broken parts are replaced. Misaligned parts are adjusted
- **Testing:** The repaired product must be tested to ensure that it works properly

A temporary repair

Maintenance

Buildings and other constructed structures need maintenance just like manufactured products. Building must be cleaned and painted. Windows are cleaned. Roofs are sealed to prevent leaks. Bridges and communication towers are painted to prevent rusting. Railroad tracks are leveled, and switches are lubricated. Streets and driveways receive periodic coatings to seal out water.

Most maintenance is done on a schedule. The schedule is designed to keep the product working properly. Therefore, maintenance is sometimes called preventative maintenance. Many products come with a maintenance manual. This document lists:

- The types of maintenance needed
- Methods of performing maintenance
- A time to schedule for each maintenance task

Worker diagnosing a problem on a house prior to painting

Upkeep

No product or structure will work all the time or last forever. Some products are used until they stop functioning and are then discarded. For example, few of us try to salvage bent paper clips or bolts with stripped threads.

Many products, however, are too costly to discard the first time they stop working. Throwing away a bicycle or a car every time a tire goes flat would be very expensive. It cost less money to repair the product.

Upkeep is a term that is often used in conjunction with or in place of the term maintenance. Upkeep refers to all the costs and actions required to keep products and systems operating properly.

Using products makes our lives better. However, we must use products wisely. Each product and structure should receive periodic maintenance and necessary repairs so they work at peak performance.

Some old rusting nuts and bolts

Man repairing a flat tire

Troubleshooting

The focus of this part of the lesson is about troubleshooting. **Troubleshooting is a form of problem solving**. It is the systematic search for the source of a problem so that it can be solved. Troubleshooting is often a process of elimination — eliminating potential causes of a problem.

Usually troubleshooting is applied to something that has suddenly stopped working, so the first focus, or concentration of attention, should be on what has changed. However, care must be used to not jump to false conclusions of causality — the logical relationship between one physical event (called cause) and another physical event (called effect) being the direct consequence (result) of the first event.

For example, you walk into a dark room and turn on the wall-mounted light switch and the light does not come on. Is the wall-mounted light switch the problem? Probably not. The bulb may have burned out, the power cord may be unplugged from the receptacle, or perhaps the switch on the light fixture has been turned off. Most people would repeatedly flip the light switch on/off a few times thinking that the cause was the switch.

A basic principle in troubleshooting is to start from the simplest and most probable possible problems first. "Is it plugged in and does that receptacle have power?“ Further steps in troubleshooting are to check each component in a system one by one, and to substitute known good components for any suspect ones. It also helps to start from a known good state, if your computer has a problem — try rebooting.

Describing the Symptoms

If you need to call in a specialist, a complete and accurate symptom description will ensure the quickest and most accurate solution. The symptom description must be complete and accurate. The more detailed the symptom description, the less work you'll need to do and you will save a lot of time.

A good symptom description minimizes the risk of "fixing the wrong problem", and helps determine the facts if there's a suspicion that you made the problem worse. Don’t take something apart if it is not necessary. If you do take something apart make sure you know how to put it back together. I know a guy who took his lawn mower apart because it would not start and all he needed to do was to replace the spark plug. He did not troubleshoot properly.

Example Troubleshooting

A teacher friend had a problem with the air-conditioning in his car. I was familiar with the car since I owned a similar model. He took the car to the dealership where he purchased the car and they wanted $700.00 to replace the compressor that makes the air-conditioner work. He explained to me that it was working perfectly and just shopped and he was going to pay to have it fixed because it was too hot to be without it.

automotive fuses

I am not a car technician but I know a few things about cars. I told him I thought I could fix the problem without costly repairs because he gave me clues as he described the problem. The best clue to me was that “it just stopped working” but was working fine the last time he was in the car.

Troubleshooting this problem seemed simple. I started with an obvious component — the fuse. If a fuse is burned out in a car the system it operates will not work.

I replaced a fuse that cost less that $1.00 and the air-conditioning system came on and worked perfectly. Sometimes people do not always look for the simple things, they always think it has to be complicated and expensive. Always start by looking at the simple obvious things when you troubleshoot.

Operate as Designed

This part of the presentation is about safety and technological systems. The intent of the lesson is not to give you pages of safety rules, rather, to discuss safety in general as it relates to systems and to give you a few examples.

Systems should operate so that they function in the way they were designed. All systems are designed with safety in mind for the user. Using safe procedures and following directions is absolutely essential to ensuring an accident-free environment.

Tools, machines, and systems make each of our lives more comfortable. They also injure or kill thousands of people each year. Every day local newspapers report injuries and deaths caused by careless use of such tools and machines as home appliances, factory machinery, and automobiles.

Safety Systems

- Many people ignore a railroad crossing signal and arm when a train is coming and purposely go around the arm to beat the train because they don't want to wait. They would rather jeopardize their lives to beat the system.
- Many drivers will ignore the traffic system by running red lights, speeding, talking and sending text messages on cell phones while driving.
- Systems are designed for safe operation. By altering the system or changing the steps negates the precision and safety.

Safety system for railroad track crossing

The school bus incorporates a stop sign and flashing red light as part of the safety system for students.

Safety Training

Factory worker with proper clothing and eye protection

Most people working in business and industry receive proper training on the equipment and systems they use. Their challenge is to follow the safe procedures they are shown and expected to learn.

Many people, however, also use technological devices in personal and educational settings. For example, they drive cars and work in home workshops and school laboratories. These setting require special attention to safety. Remember that safety is both a state of mind and a series of actions.

The student is working in a school chemistry lab dressed in appropriate clothing for her safety to work with chemicals.

Altering System Safety Standards

Walkers tend to think that a crosswalk ensures a safety system in crossing a street, but unfortunately that's just not the case. Communities nationwide are making efforts to educate both drivers and pedestrians of the potential dangers if proper caution is not exercised.

You must be concerned about your safety and the safety of those around you. Likewise, you must complete tasks using safe actions. Altering the way a system is supposed to be used or overriding the system procedure is an unsafe practice.

Here is a perfect example of how a person ignored safety and altered a device. This guy called this a lawn cycle. It is an accident waiting to happen.

Safety Standards Change

Continuous changes in technology, environmental regulation and public safety concerns make the analysis of complex safety-critical systems more and more demanding. For example, riding mowers have a tendency to roll over on a hillside if not used properly by the operator. This has prompted industry to add roll bars on certain types of riding lawnmowers.

This lawnmower has a roll bar to protect the operator from rolling over on an incline. These mowers also have seat belts that must be used for additional protection.

Accidents Happen

In spite of all the technological safety systems in place and the training that people receive in the workplace, more than 14,000 workers die from accidents in the U.S. each year while 2.2 million suffer disabling injuries.

Using systems, tools, and machines without altering or changing the design will help keep you safe from injury but is not guaranteed. Safety must be practiced as part of your daily routine.

Summary

- Instruction manuals should be carefully read and the instructions followed for proper maintenance
- All products should be used for the purpose for which they were designed. This reduces repair costs and increases safety.
- Upkeep refers to all the costs and actions required to keep products and systems operating properly
- Each product, structure, and system should receive periodic maintenance and necessary repairs
- Troubleshooting is a form of problem solving
- It is the systematic search for the source of a problem so that it can be solved
- Troubleshooting is used in many fields such as system administration and electronics
- Normally a process of elimination is used to isolate possible causes of problems
- Using safe procedures and following directions is absolutely essential to ensuring an accident-free environment
- Altering a system or changing the way it was designed to be used is unsafe
- In the workplace, more than 14,000 workers die from accidents in the U.S. each year while 2.2 million suffer disabling injuries