

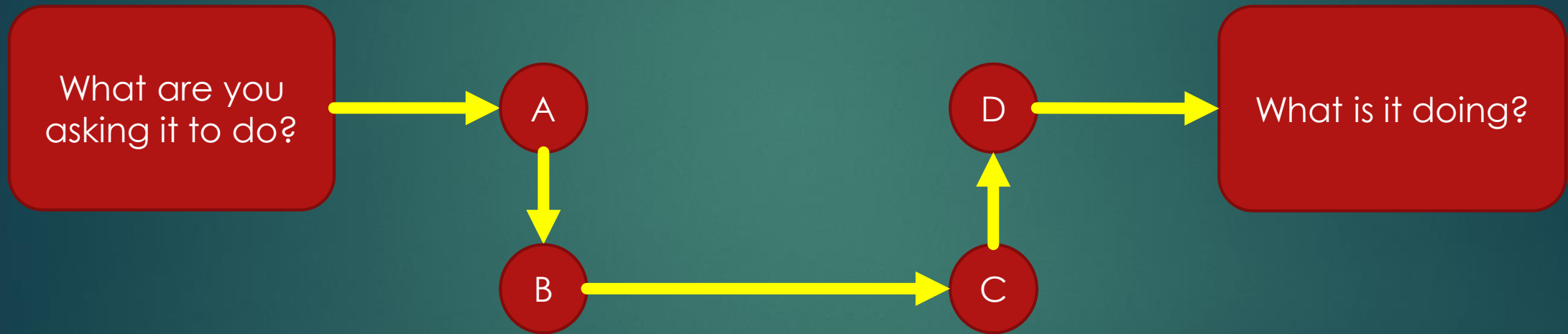
Troubleshooting Laboratory Equipment

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Objective

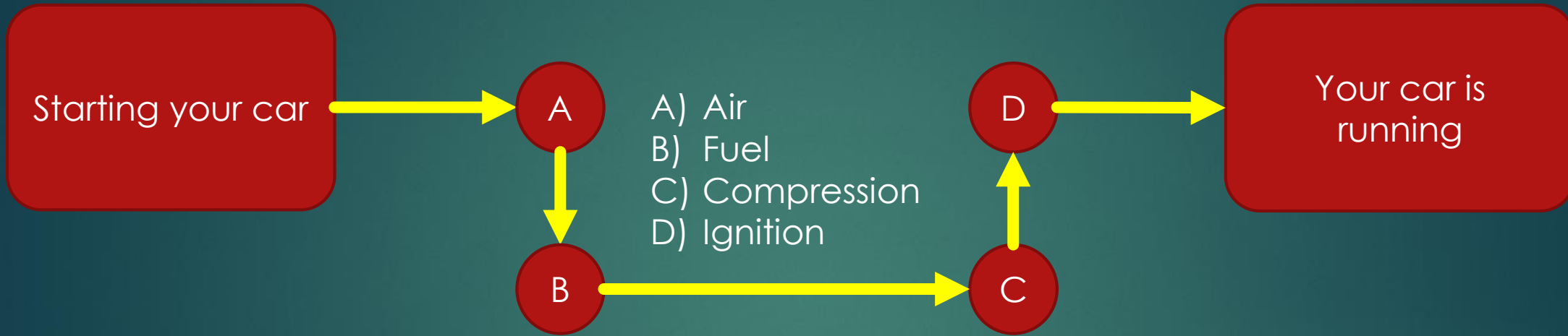
To understand the fundamentals of equipment failure and how to develop a response.

The basics



Components for successful operation

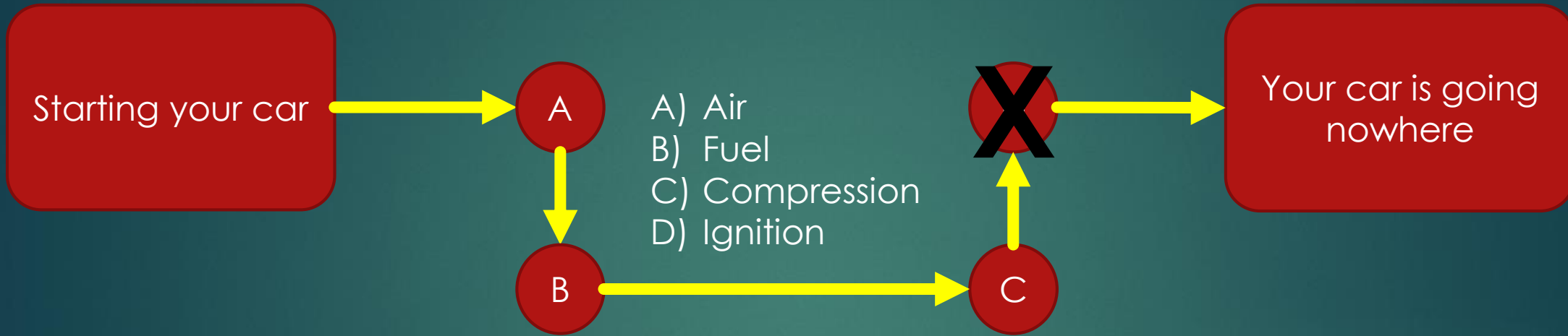
No problem



Components for successful operation



Problem



Components for successful operation



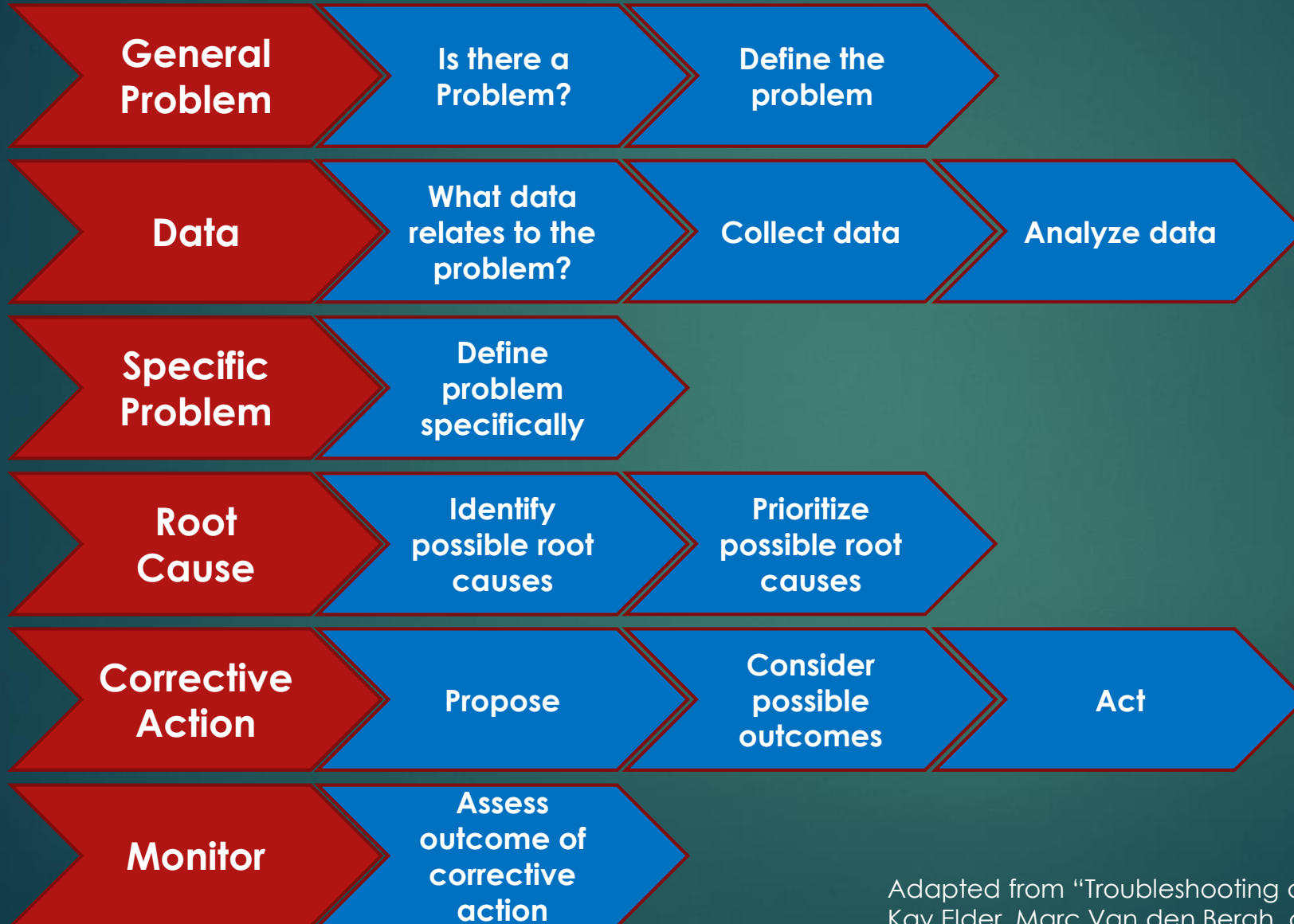
What constitutes “laboratory equipment”?



The joy of troubleshooting equipment

- 1) It's logical – things happen for a reason
- 2) It's predictable – a given input will always produce the same output unless the conditions are altered
- 3) It's modular – a given function can be broken down into component steps
- 4) It's typically repairable
- 5) When it isn't, it's replaceable

Principles



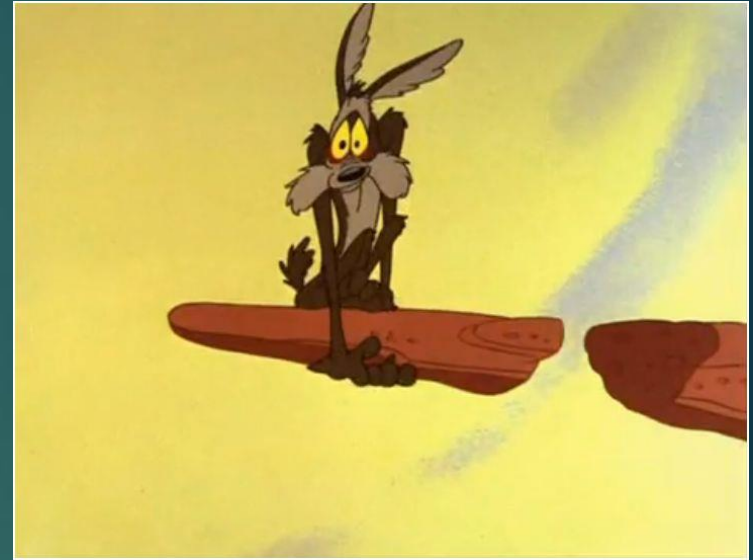
Adapted from "Troubleshooting and Problem-Solving in the IVF laboratory"
Kay Elder, Marc Van den Bergh, and Bryan Woodward

Principles - simplified

- 1) Recognizing a problem
- 2) Diagnosing the problem
- 3) Evaluating solutions
- 4) Planning a course of action
- 5) Executing your plan
- 6) Evaluating the results

1) Recognizing a problem

HOW DO YOU KNOW WHEN SOMETHING HAS GONE WRONG?



Recognizing a problem

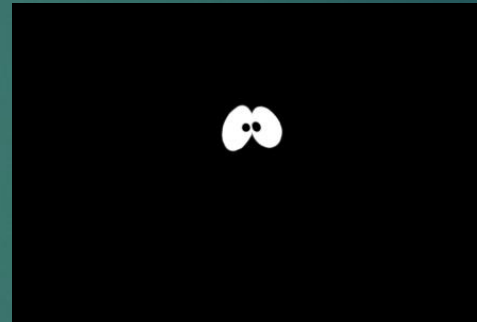
1. Know your equipment
 - a) What are the normal functional parameters?
 - b) What is out of range?
 - c) More than one issue?
2. Daily QC –
 - a) Must be adequate to detect out of range values, but not so tight as to cause alarm over normal variance
 - b) Some equipment has little or no daily QC
3. Cleaning and inspection
4. Common Sense
 - a) Does something seem off?
 - b) Was it doing this yesterday?
 - c) Do the traits you are observing make sense for the purpose of the device?

Types of problem

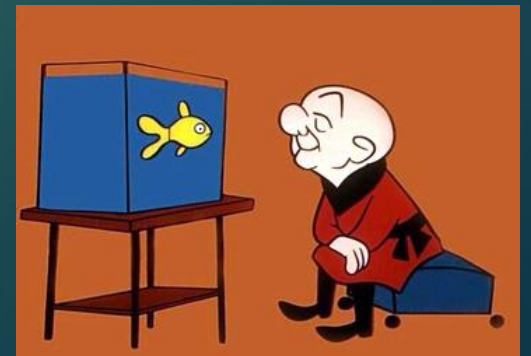
- 1) Subtle - Embryos suddenly growing poorly in some incubators



- 2) Obvious – Microscope lamp is out



- 3) Critical - Cannot see embryos under scope



Define the problem

What is actually wrong?

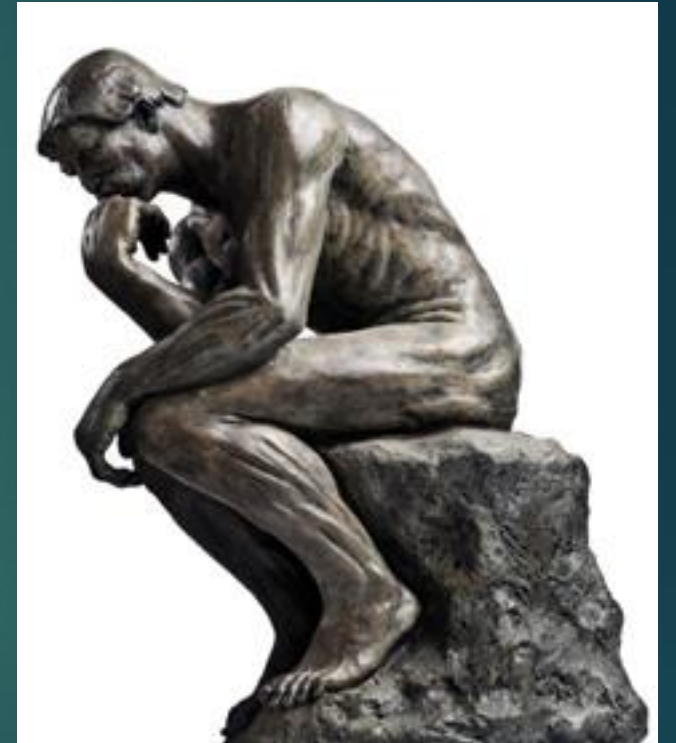
- ▶ If you cannot define the issue, you cannot address it.
- ▶ Is it actually an equipment problem?

Examples

- 1) Embryos suddenly growing poorly in some incubators
 - ▶ Equipment problem? Possibly, need data
- 2) Microscope lamp is out
 - ▶ Equipment problem? Clearly – must investigate further
- 3) Cannot see embryos under the microscope
 - ▶ Equipment problem? Unclear, must gather more information

II) Diagnosing the problem

STOP AND THINK



Collect data

- 1) When did you first notice the issue?
- 2) Study QC records (if there are any)
- 3) What has changed with respect to the suspect equipment recently?
- 4) What has changed in the lab or facility recently?
 - a) Any unusual events?
- 5) Who has interacted with the equipment recently? Question them.
 - a) Technician
 - b) Student
 - c) Embryologist



Examples

- 1) Embryos suddenly growing poorly in some incubators
 - a) Which incubators?
 - b) Are they all the same?
 - c) What location within the incubator?

- 2) Microscope lamp is out
 - a) Did it just go out?
 - b) Is it turned on?

- 3) Cannot see embryos under the microscope
 - a) At all, or just under certain conditions?
 - b) Any embryos, or a specific patient/dish of embryos?

Examples

1. Embryos suddenly growing poorly in some incubators
 - a) Which incubators? **Benchtop**
 - b) Are they all the same? **Yes**
 - c) What location within the incubator? **All locations**
2. Microscope lamp is out
 - a) Did it just go out? **No**
 - b) Is it turned on? **Yes**
3. Cannot see embryos under the microscope
 - a) At all, or just under certain conditions? **Just under the new stereoscope**
 - b) Any embryos, or a specific patient/dish of embryos? **Any embryos**

Define the problem specifically

- ▶ Start with the most general description of the problem
- ▶ Use the data collected to refine your analysis of the issue and state the problem explicitly
- ▶ Define the conditions before and after the problem occurred
 - ▶ “What changed?”
 - ▶ “Why do you think there is a problem?”

Examples

- 1) Embryos suddenly growing poorly in some incubators
 - ▶ “Embryos growing poorly in all benchtop incubators after May 1”
- 2) Microscope lamp is out
 - ▶ “Microscope lamp not working since Brad last used the scope”
- 3) Cannot see embryos under the microscope
 - ▶ “Cannot see embryos with new stereoscope, but they are easily observed using an older model”

Quick fix

- 1) Is the problem effecting patient care?
- 2) Is the instrument critical to the task at hand?
- 3) Do I have a back-up?
- 4) What can I do to stabilize the situation?



Identify possible causes

- 1) Talk to your staff
- 2) Know your equipment
 - 1) Read the manual!
 - 2) Know what each knob and button does
 - 3) Understand the options
- 3) Research common issues with your particular device – talk to your peers!
- 4) Read manufacturer bulletins
- 5) Study all QC records
- 6) USE COMMON SENSE

Prioritize possible causes: Make a list!

- 1) Simplest explanation first
- 2) Include all possibilities
- 3) Review all steps to this point – Is anything missing?
- 4) Identify least likely causes and move these down your list

Knowing the source of a problem is
not the same as understanding the
problem

Main reasons for equipment issues

- 1) Something is broken – a part is no longer functioning at all
 - ▶ Burned out lightbulb
- 2) Something is damaged – a part is functioning improperly
 - ▶ Stripped gear, faulty sensor
- 3) Something is out of adjustment/alignment – all parts are working properly, but they are not working together
 - ▶ Hatching laser is out of focus
- 4) The operator is not using the equipment properly
 - ▶ No filter in place for phase contrast
- 5) There is no power to the equipment
 - ▶ A cord is unplugged/power strip is off
- 6) Something is interfering with the proper operation of the equipment
 - ▶ The janitor unplugs the incubator to plug in his vacuum each night

Examples

1. Embryos growing poorly in all benchtop incubators after May 1

What changed on May 1?

- a) Power?
- b) Gas?
- c) Media?
- d) Environment?

2. Microscope lamp not working since Brad used the scope

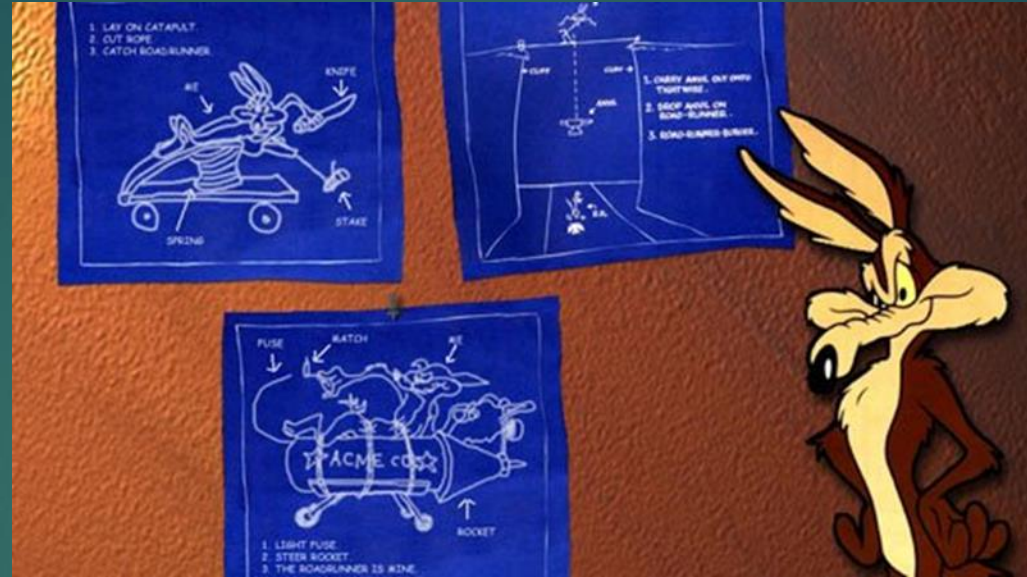
What changed after Brad used the scope?

- a) Bulb?
- b) Power?
- c) Switch/controller?

3. Cannot see embryos with new stereoscope, but they are easily observed using an older model

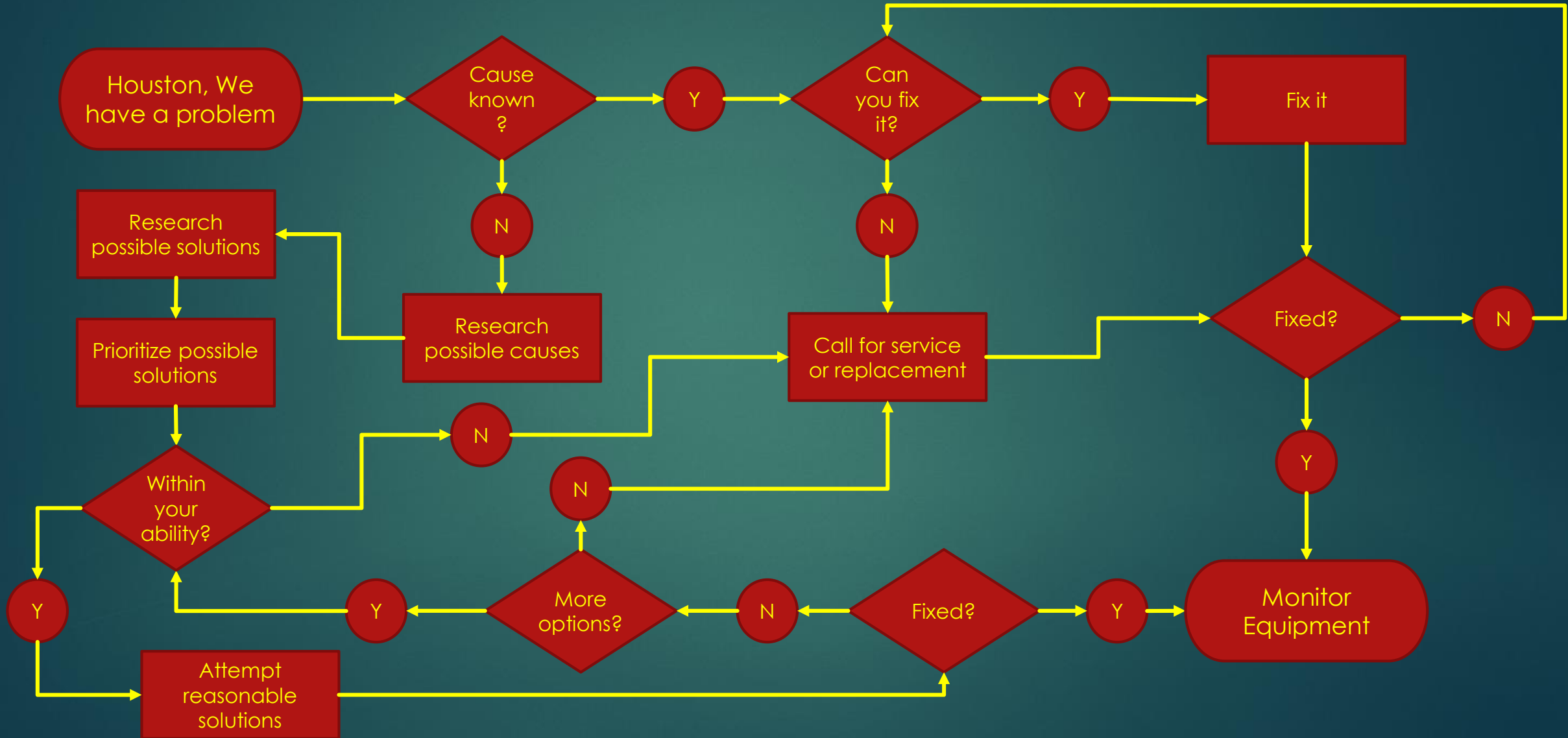
What is different about this scope?

- a) Optics?
- b) Focus?
- c) Lightsource?



III) Evaluating solutions

How do we fix the problem?



How to evaluate a solution

- 1) Does it make sense?
- 2) How complicated is it?
- 3) Can you attempt it yourself?
- 4) What supplies do I need
- 5) Can you evaluate the outcome?
- 6) What are the consequences of it not working?
- 7) Is it a permanent fix?

Examples

1. Embryos growing poorly in all benchtop incubators after May 1

What changed on May 1? – The Environment: Building switched from winter to summer HVAC

- a) Move to new building
- b) Use different incubators
- c) Gather data to convince building of detrimental effects of turning off AC at night

2. Microscope lamp not working since Brad used the scope

What changed after Brad used the scope? – Bulb failed to light up again when turned on

- a) Change Bulb
- b) Buy new scope
- c) Check power to bulb

3. Cannot see embryos with new stereoscope, but they are easily observed using an older model

What is different about this scope? – New light source is LED

- a) Adjust light source to see if it improves the image
- b) Speak with manufacturer/installer about adjustments
- c) Buy a new lightsource



IV) Planning a course of action

Corrective action

- 1) For each possible cause:
 - a) Identify an appropriate course of action
 - b) Consider the magnitude of the action to be taken
 - c) Consider the effect on the equipment
 - ▶ Short term
 - ▶ Long term
 - d) Consider the effect on the lab
 - ▶ Short term
 - ▶ Long term
- 2) Prioritize by
 - a) Difficulty
 - b) Impact
 - c) Permanence

Critical considerations

1. Can you fix the problem yourself?
 - a) Temporary fix
 - b) Permanent solution
2. Professional intervention?
 - a) Downtime
 - b) Alternate approaches
3. Replacement necessary?
4. Is there a better course of action?

First, do no harm!



Examples

1. Embryos growing poorly in all benchtop incubators after May 1

What changed on May 1? – The Environment: Building switched from winter to summer HVAC

- a) **Move to new building** – Long term, expensive, overkill?
- b) **Use different incubators** – Short or long term, good acute fix
- c) **Gather data to convince building of detrimental effects of turning off AC at night** – long term solution

2. Microscope lamp not working since Brad used the scope

What changed after Brad used the scope? – Bulb failed to light up again when turned on

- a) **Change Bulb** - Easy, inexpensive, immediate fix, may or may not solve problem
- b) **Buy new scope** - Long term, expensive, overkill?
- c) **Check power to bulb** – Easy, quick, diagnostic

3. Cannot see embryos with new stereoscope, but they are easily observed using an older model

What is different about this scope? – New light source is LED

- a) **Adjust light source to see if it improves the image** - Easy, quick, diagnostic
- b) **Speak with manufacturer/installer about adjustments** - Easy, quick, diagnostic
- c) **Buy a new lightsource** - Long term, expensive, overkill?



V) Executing your plan

Taking action

- ▶ Start with the simplest fix to the simplest explanation
- ▶ Record every intervention in detail
 - ▶ Time
 - ▶ What was changed
 - ▶ Can you put it back the way it started?
- ▶ Whenever possible, make one change at a time and evaluate

Monitor

- ▶ Check, recheck, and triple check all pertinent measurements
- ▶ Look for collateral effects – evaluate
- ▶ Simple question: is the problem fixed?



VI) Evaluating the results

Were you successful?

1. Is the problem truly fixed, or just temporarily fixed?
2. QC
3. Do you know how the problem was fixed?
("My car is making a funny noise"... "Have you tried turning up the radio?")
4. Does the situation require follow-up or professional intervention?

Were you unsuccessful?

- ▶ If the problem is not fixed, what effect has the intervention had on the instrument?
 - ▶ Does it need to be restored to previous conditions before proceeding?
 - ▶ Will the new conditions effect your investigation of other possible causes?
- ▶ Repeat process to address the next possible cause
- ▶ Know when to call in professional assistance

Summary

- ▶ Always be monitoring your equipment
- ▶ Understand your equipment
- ▶ Have a back-up plan
- ▶ Break a problem down into its most basic elements – ask simple questions/create simple hypotheses
- ▶ Test what you can
- ▶ Fix what fails your test
- ▶ Call for help when you need it

Go forth and troubleshoot!