Course "Debugging"

Debugging Rules 8 & 9

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- Rule 8:
  - Get a fresh view
- Rule 9:
  - If you didn't fix it, it ain't fixed

- Summary
- Exercise
The nine rules

1. Understand the system
2. Make it fail
3. Quit thinking and look
4. Divide and conquer
5. Change one thing at a time
6. Keep an audit trail
7. Check the plug
8. Get a fresh view
9. If you don't fix it, it ain't fixed
Rule 8: Get a fresh view

- "Nothing clears up a case so much as stating it to another person."

Sherlock Holmes
Get a fresh view: Brake light war story

- A car blew the fuse of the brake lights whenever you put the transmission into reverse gear
- Several attempts made it clear that this was repeatable
- Reason???
- Owner mentioned the problem to somebody familiar with repairing this brand of car
- Immediate answer: "The dome light is pinching a wire against the frame of the car. Insulate that wire and you will be fine."
Get a fresh view: What would have happened?

What would have happened if one had applied only the other rules:

• Understand the system
  • Obtain(!!) and study car wiring diagrams
• Make it fail; Quit thinking and look
  • He did this alright
• Divide and conquer
  • Rip out the car's wiring in parts?
  • Or obtain measurements throughout the wiring?
• Check the plug
  • There was no assumption that could be questioned
Get a fresh view: Ask an expert

Method 1 of getting a fresh view:
Ask an expert on the subject matter

- This avoids having to "Understand the system"
  - Which could be a gigantic effort in complex cases

- Make sure you can tell a real expert from a charlatan
  - Incomprehensible answers often indicate charlatans
  - Vague answers may as well

- In many cases, experts may be external consultants
  - They are expensive
  - They may or may not be worth the price
Get a fresh view:  The voice of experience

Method 2 of getting a fresh view:
Ask someone who has had such a situation before
  • preferably many times

• Note that an experienced person need not be an expert
  • The experienced person need only know the cause (or even only the solution)
  • S/he needs not "understand the system"
  • See the war story above:
    The "expert" may have known nothing about the specific wiring of this car, except this one problem

• Note that software-experienced persons often did have the problem before
  • but have forgotten the cause and solution
Get a fresh view: 
A breath of fresh insight

Method 3 of getting a fresh view: 
Explain your problem to someone completely unrelated

- Advantage 1: This person is not as biased (or at least differently biased) as to where the problem should be
  - If s/he does not have useful advice or questions to contribute, s/he may at least console you

- Advantage 2: Even just explaining the problem may give you a fresh view and an insight
  - It often even works to explain the problem to your pen, the leg of your table, or your favorite rag doll
Get a fresh view: Sources

Where to find expertise, experience, or insight:

- **Colleagues:**
  - can provide all three
- **Vendor support (telephone, online):**
  - usually expertise
  - often experience (perhaps via other users: online forum)
- **Knowledge management systems, the Web:**
  - perhaps experience,
  - often a pointer to a person with expertise/experience
- **Documentation:**
  - perhaps insight, always expertise (though both unspecific)
  - perhaps experience (troubleshooting guide)
- **Anybody/yourself: insight by explaining it all**
Get a fresh view: Subrules

- Subrule: Don't be proud
  - Asking someone is not a sign of weakness (if you've done your part before), but rather of good judgement
- Subrule: Do not assume the expert is a god
  - Mistrust expert judgement just like your own
- Subrule: Report symptoms, not theories
  - or you will reduce your chances of getting new insight
  - And if you are the helper: Don't get poisoned. Cover your ears and loudly sing LA-LA-LA-LA-LA.
- Subrule: Include observations you have not understood
  - If it is confusing for you, it may be just where somebody else can help
The nine rules

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Rule 9: If you don't fix it, it ain't fixed

- "It is stupidity rather than courage to refuse to recognize danger when it is close upon you."

Sherlock Holmes
After buying a used car:

- **Event 1:** While going up a hill, suddenly the engine stopped
  - After stopping in the breakdown lane, the motor started again at the first attempt
  - During the slow drive up the rest of the hill, the car did not fail again

- **Event 2:** After filling up at a dubious little gas station on a bitter-cold day, the engine stopped again while going up a hill
  - Again, it started again at the first attempt
  - Driver thought: Maybe water in the fuel line. Applied drygas spray.
If you don't fix it, ...:
Used car war story (2)

- Event 3: Engine stopped while driving fast on a perfectly flat road
  - Did not start on first attempt; but did start on the second
- Experimentation found that the engine would stop after going at more than 80 km/h for some short while
- Driver took the car to a repair shop
  - They replaced some wires and told him it was an electrical problem. Cost: 75 Dollars.
  - The car failed again the next day; just as before
- Idea: Maybe the carburettor does not receive enough fuel in high-load situations?
  - Get a fresh view: Asked a colleague at work. Answer: "Dirty fuel filter."
  - The repair cost 50 cents.
If you don't fix it, ...: Subrules

- **Subrule: Check that it's really fixed**
  - You made it fail before, did you? Try again.
- **Subrule: Check that it's really your fix that fixed it**
  - After checking that it was fixed, take out your fix and make it fail
  - Note: Sometimes this is unnecessary, too risky, or too cumbersome
- **Subrule: It never just goes away by itself**
  - If it stops failing without a proper fix, put in instrumentation to understand the failure next time
  - or analyze the differences to the failing version if you can
- **Subrule: Fix the cause**
  - Look behind the first-level cause of the failure and try fixing its root cause.
If you don't fix it, ...:
Transformer war story

- Author was given a used integrated stero set (tuner, amplifier, 8-track tape deck)
  - Did not work at all
  - Measurements found: No output from the power supply
- Author ordered a new transformer from the vendor
  - Waited months before it arrived
- Replaced the old one and turned on the radio: Music!
  - until an hour later, the transformer goes up in smoke
- Solution: The tape deck had a short circuit
  - The fix (new transformer) had repaired only the symptom (broken transformer) not the cause.
  - Violated: Understand the system; quit thinking and look.
  - Misapplied: Make it fail.
If you don't fix it, ...: Fix the process

- Fixing the root cause often does not just touch the product
- Rather, it goes right into the production process

Example:
- Problem: Oil on the factory floor
- Bad fix: Wipe the oil up
- Better fix: Also repair the leaky fitting of the machine that dripped the oil
- Still better fix: Vibrations wrecked the machine's fitting. Also use two more bolts to mount the machine to the floor.
  - Are there other similar machines?
- Still better fix: Also change the vibration evaluation process used during the design of machine bolting configurations
The nine rules: Summing up again

1. Understand the system
2. Make it fail
3. Quit thinking and look
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5. Change one thing at a time
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7. Check the plug
8. Get a fresh view
9. If you don't fix it, it ain't fixed
1. Understand the system

- Read the manual
- Read everything in depth
- Know the fundamentals
- Know the mechanisms
- Understand your tools
- Look up the details
2. Make it fail

- Do it again
- Start at the beginning
- Stimulate the failure
- But do not simulate the failure
- Find the uncontrolled condition that makes it intermittent
- Record everything and find the failure signature
- Do not trust statistics too much
- Know that "that" can happen
- Never throw away a debugging tool
3. Quit thinking and look

- See the failure
- See the details
- Build instrumentation in
- Add instrumentation on
- Don't be afraid to dive in
- Watch out for Heisenberg
- Guess only to focus the search
4. Divide and conquer

- Narrow the search with successive approximation
- Find the right range
- Determine which side of the failure you are on
- Use easy-to-spot test patterns
- Start with the bad parts
- Fix all defects you learn (or know) about
- Fix the noise first (just don't get carried away)
5. Change one thing at a time

- Isolate the key factor
- Grab the brass bar with both hands
- Change one test at a time
- Compare it with a good one
- What have you changed since the last time it worked?
6. Keep an audit trail

- Write down what you did, in what order, and what happened as a result
- Understand that any detail could be the important one
- Correlate events
- Understand that audit trails of design are also good for debugging
- WRITE IT DOWN!
7. Check the plug

- Question your assumptions
- Start at the beginning
- Test the tool
8. Get a fresh view

• Ask for fresh insights
• Tap expertise
• Listen to the voice of experience
• Know that help is all around you
• Don't be proud
• Report symptoms, not theories
• Realize that you don't have to be sure
9. If you don't fix it, it ain't fixed

• Check that it's really fixed
• Check that it's really your fix that fixed it
• Be aware that it never just goes away by itself
• Fix the cause
• Fix the process
Small virtual debugging exercise

- Assume you move into a rather old house
- While cleaning on the first day, you tried to use the vacuum cleaner in the living room, but
  - when you switched it on, it did not start.
  - Instead, the room lights turned on.
- What do you do?
  - Now I am the house.
  - Debug me!
Remark: When at a help desk

For user-driven remote debugging situations:

- Follow the rules
  - despite the unenlightened user
- Verify actions and results
  - Misunderstandings of your instructions are very likely
- Use automated tools
  - Take the user out of the loop whenever you can
- Verify even the simplest assumptions
  - You cannot rely on anything
- Use available troubleshooting guides
- Contribute to troubleshooting guides
What is difficult when trying to apply the rules

...and what to do about it

1. Understand the system
   - Requires a lot of time
     - Learn it piece-by-piece; don't tell your boss
   - Requires a lot of interest and patience
     - Most systems contain a lot of great ideas; understand that understanding them is fun
   - May be just impossible
     - The thrill of software engineering: Manage anyway
What is difficult... (2)

• 2. Make it fail
  • May be arbitrarily difficult and the effort is unknown in advance
    • Invest not more than finding the defect would be worth
    • Use enough of your effort for building real good instrumentation (so you catch it next time it occurs)

• 3. Quit thinking and look
  • Pride gets in the way
    • Work on your personality

• 4. Divide and conquer
  • Some hypotheses are much harder to test than others
    • Invent alternative checking methods (perhaps partial ones)
    • Find cheaper surrogate hypotheses that are almost as useful
What is difficult... (3)

• 5. Change one thing at a time
  • Requires patience
    • Automate
    • Keep an audit trail and analyze how much it hurts to violate the rule

• 6. Keep an audit trail
  • Requires discipline and patience
    • Automate
    • Get help (pair debugging)

• 7. Check the plug
  • You may be unaware of your basic assumptions
    • Use brainstorming (with colleagues) to form a checklist
What is difficult... (4)

- **8. Get a fresh view**
  - You may be too deep into your problem to understand the fresh view you got
    - Take some time off

- **9. If you don't fix it, it ain't fixed**
  - Task pressure demands not working on it if it does not appear broken
    - This may even be acceptable
    - But keep some notes of what you learned so far

- **ALWAYS:**
  - You may be too ignorant to see that (or where or how) you can apply a rule
    - Talk to a colleague in intervals when debugging takes long
Summary: The nine rules

1. Understand the system
   • even if that is hard

2. Make it fail
   • even if that is hard

3. Quit thinking and look
   • even if you think you know what is the matter

4. Divide and conquer
   • and do not jump to conclusions

5. Change one thing at a time
   • even if it seems too simple

6. Keep an audit trail
   • in writing!

7. Check the plug
   • at least after a while

8. Get a fresh view
   • at least after a while

9. If you don't fix it, it ain't fixed
   • so fix it and make sure
Thank you!