```
namespace 'Rapid Software Testing';
```

We don't claim to present "a common language for software testing." We believe that any such claim is nonsensical. But within this class and the RST methodology, we, as *authors*, can declare authority. We have no authority over the words you use except within RST.

That said, we choose our words very carefully, and discuss them with others in order to sharpen our thinking and to reduce the chance of misunderstanding. We encourage you to do that within your context.

Critical Thinking For Testers.pdf - 2

It's easy to get the right answer for a simple problem.

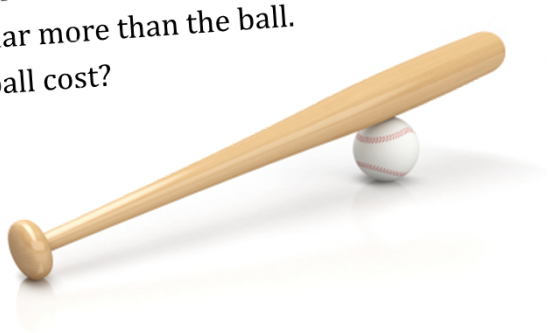
(Whenever you see a title slide like this one, think critically about it.)

Critical Thinking For Testers.pdf - 3

Simple Problems

Consider this problem:

A bat and ball together cost $1.10.
The bat costs one dollar more than the ball.
How much does the ball cost?



Daniel Kahneman
Thinking Fast and Slow

Critical Thinking For Testers.pdf - 4

A Simple Puzzle

"Steve, an American man, is very shy and withdrawn, invariably helpful but with little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail."

Is Steve more likely to be

a librarian?

a farmer?

Daniel Kahneman
Thinking Fast and Slow

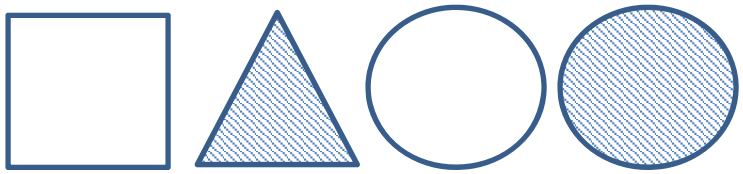
People shouldn't argue about semantics.

Is a Burrito a Sandwich?

Image Credit: www.dreamstime.com

Roy Sorenson
A Cabinet of Philosophical Curiosities

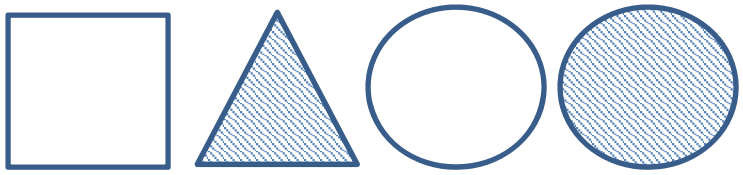
Wait, let's try something *really* simple…



Can we agree?
Can we share common ground?
"There are four geometric figures on this slide."
"There is one **square** among those figures."
"The square is shaded in **blue**."

Critical Thinking For Testers.pdf - 11

Wait, let's try something *really* simple…



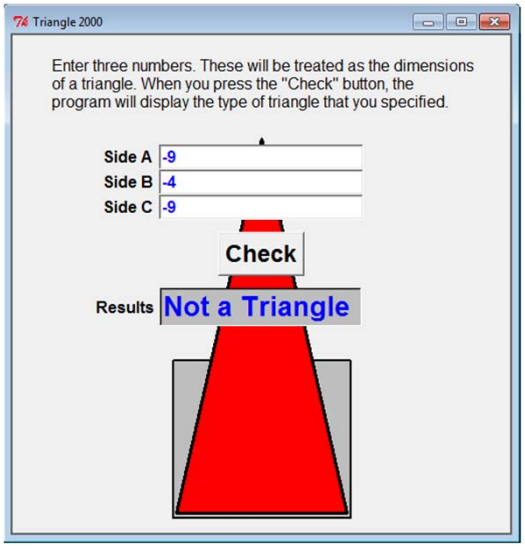
Beware of
Shallow Agreement!

Critical Thinking For Testers.pdf - 12

Some bugs are obvious.

Critical Thinking For Testers.pdf - 13

Do You See a Bug?



Critical Thinking For Testers.pdf - 14

Bugs are really problems in logic.

Critical Thinking For Testers.pdf - 16

What are We Seeing Here?

- Mental models and modeling are often dominated by **unconscious factors**.
- Familiar environments and technologies allow us to **"get by" on memory and habit**.
- Social conventions may cause us to value **politeness** over doing our disruptive job.
- Lack of pride and depth in our identity as testers may **sap our motivation** to think better.

Critical Thinking For Testers.pdf - 17

The Nature of Critical Thinking

- "Critical thinking is **purposeful, self-regulatory judgment** which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based." - *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction, Dr. Peter Facione*

(Critical thinking is, for the most part, about getting all the benefits of your "System 1" thinking reflexes while avoiding self-deception and other mistakes—including overdependence on System 2.)

Critical Thinking For Testers.pdf - 18

Bolton's Definition of Critical Thinking

Critical Thinking
is thinking about thinking
with the aim of not getting fooled.

- Michael Bolton

Testing is enactment of critical thinking about software to help people make better decisions.
Critical thinking must begin with our belief in the likelihood of errors in our thinking.

Critical Thinking For Testers.pdf - 19

To What Do We Apply Critical Thinking?

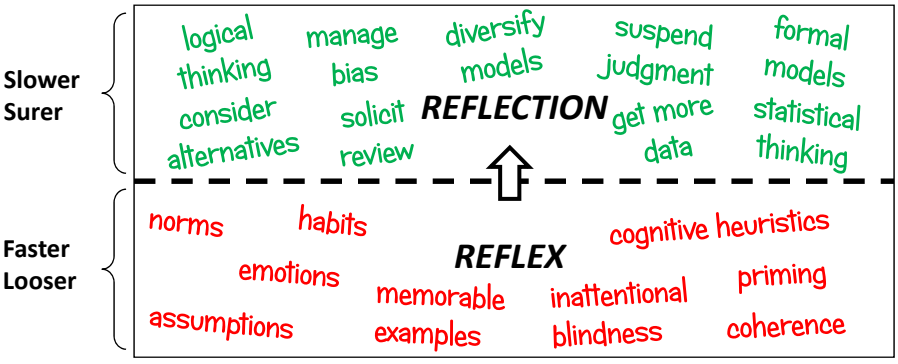
- **The Product**
  - What it is
  - Descriptions of what it is
  - Descriptions of what it does
  - Descriptions of what it's supposed to be
- **Testing**
  - Context
  - Procedures
  - Coverage
  - Oracles
  - Strategy
- **The Project**
  - Schedule
  - Infrastructure
  - Processes
  - Social orders

- Words
- Numbers
- Language
- Pictures
- Problems
- Biases
- Logical fallacies
- Evidence
- Causation
- Observations
- Learning
- Design
- Behavior
- Models
- Measurement
- Heuristics
- Methods
- …

Critical Thinking For Testers.pdf - 20

Reflex is IMPORTANT
But Critical Thinking is About Reflection

System 2



System 1

See Thinking Fast and Slow, by Daniel Kahneman

Critical Thinking For Testers.pdf - 21

Wason

Why You Should Care

Technology is way more tricky than regular life.

- Bugs exist in software because of bugs in the way people observe, model, think, and decide—and many of these bugs used to be features, for individuals or for humanity, at some point.
- People hire testers to help inform decisions about software products and projects.
- So testers are not supposed to get tricked.

Critical Thinking For Testers.pdf - 22

Themes

- Technology consists of complex and ephemeral relationships that can seem simple, fixed, objective, and dependable even when they aren't.
- Testers are people who ponder and probe complexity.
- *Basic* testing is a straightforward technical process.
- But, *excellent* testing is a difficult social and psychological process *in addition to* the technical stuff.

A tester is someone who knows that things can be different.

Jerry Weinberg

Critical Thinking For Testers.pdf - 23

Bugs in our Approaches: Calculator Test

"I was carrying a calculator.
I **dropped** it!
Perhaps it is **damaged**!
What might you do to test it?"

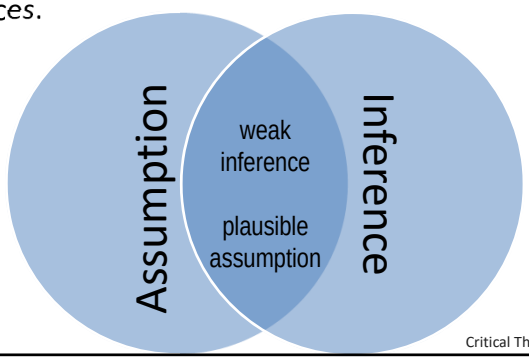
Critical Thinking For Testers.pdf - 24

Never make assumptions.

Critical Thinking For Testers.pdf - 27

Assumptions vs. Inferences

- An **inference** is something we treat as true based on evidence.
- An **assumption** is a something that we treat as true even though we have insufficient evidence.
- A **premise** is an assumption that begins a chain of reasoning. All logic is based on premises.
- Testers *question* assumptions & premises and *gather data* for better inferences.



Critical Thinking For Testers.pdf - 28

Exercise

What makes an assumption more dangerous?

- Not "what specific assumptions *are* more dangerous?"…
- But "*what factors* would make one assumption more dangerous than another?"
- Or "what would make the same assumption more dangerous from one time to the next?"

Critical Thinking For Testers.pdf - 29

Levels of Assumptions

Reckless	Assumptions that are too risky regardless of how they are managed. Obviously bad assumptions. Don't make them.
Risky	Assumptions that might be wrong or cause trouble, but can be okay with proper management. If you use them, declare them.
Safe	Assumptions that are acceptable to make without any special management or declaration, but still *might* cause trouble.
Required	Assumptions so safe that they cause trouble only IF you manage them, because people will think you are joking, crazy, or insulting.

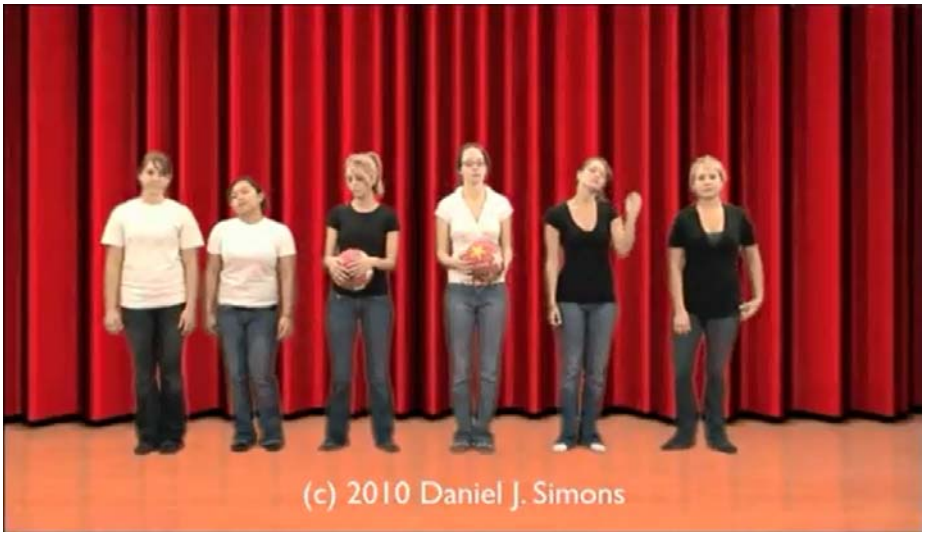
It is silly to say "don't make assumptions."
Instead, say "let's be careful about risky assumptions and avoid the reckless ones."

Critical Thinking For Testers.pdf - 31

Remember to keep your eye on the ball.

Critical Thinking For Testers.pdf - 32

Bugs in Observation

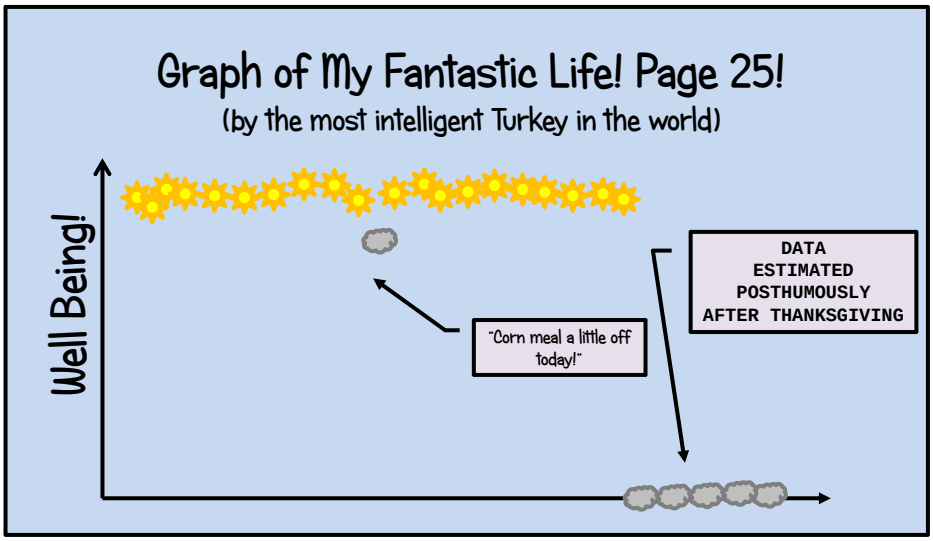


Critical Thinking For Testers.pdf - 33

Experience is the best teacher.

Critical Thinking For Testers.pdf - 34

Bugs in Our Models of the World



Critical Thinking For Testers.pdf - 35

Don't Be A Turkey!

- No experience of the past can LOGICALLY be projected into the future, because we have no experience OF the future.
- No big deal in a world of stable, simple patterns.
- **BUT SOFTWARE IS NEITHER STABLE NOR SIMPLE.**
- **"PASSING" TESTS CANNOT PROVE SOFTWARE GOOD.**

Based on a story told by Nassim Taleb, who stole it from Bertrand Russell, who stole it from David Hume.

Critical Thinking For Testers.pdf - 36

Cognitive biases are bad.

Let's go out and find a few.

Critical Thinking For Testers.pdf - 37

Cognitive Biases Are Features

- Cognitive biases help us with problems!
  - Too much information
  - Not enough meaning
  - Need to act fast
  - What should we remember

Remember these four problems!

See Buster Benson, "Cognitive Bias Cheat Sheet"

https://betterhumans.coach.me/cognitive-bias-cheat-sheet-55a472476b18#.63xoq03zx

Critical Thinking For Testers.pdf - 38

Cognitive Biases Are Bugs

- Cognitive biases lead us astray!
  - We don't see everything
  - Our search for meaning can conjure illusions
  - Quick decisions can be seriously flawed
  - Our memory reinforces errors

Remember these four consequences of our brain's problem-solving strategies!

See Buster Benson, "Cognitive Bias Cheat Sheet"

https://betterhumans.coach.me/cognitive-bias-cheat-sheet-55a472476b18#.63xoq03zx

Critical Thinking For Testers.pdf - 39

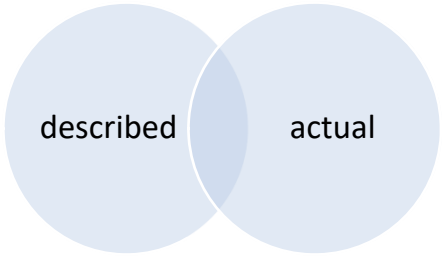
Exercise
Think critically about this statement:

"Automated testing allows more time for testers to do manual testing."

Critical Thinking For Testers.pdf - 40

Bugs in our Models of Testing: Is this what you do?

"Compare the product to its specification"

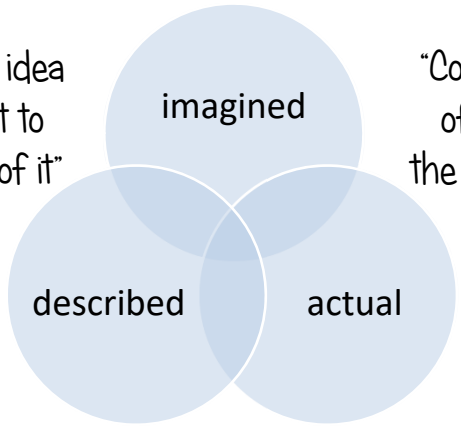


Critical Thinking For Testers.pdf - 41

This is more like what testers *really* do

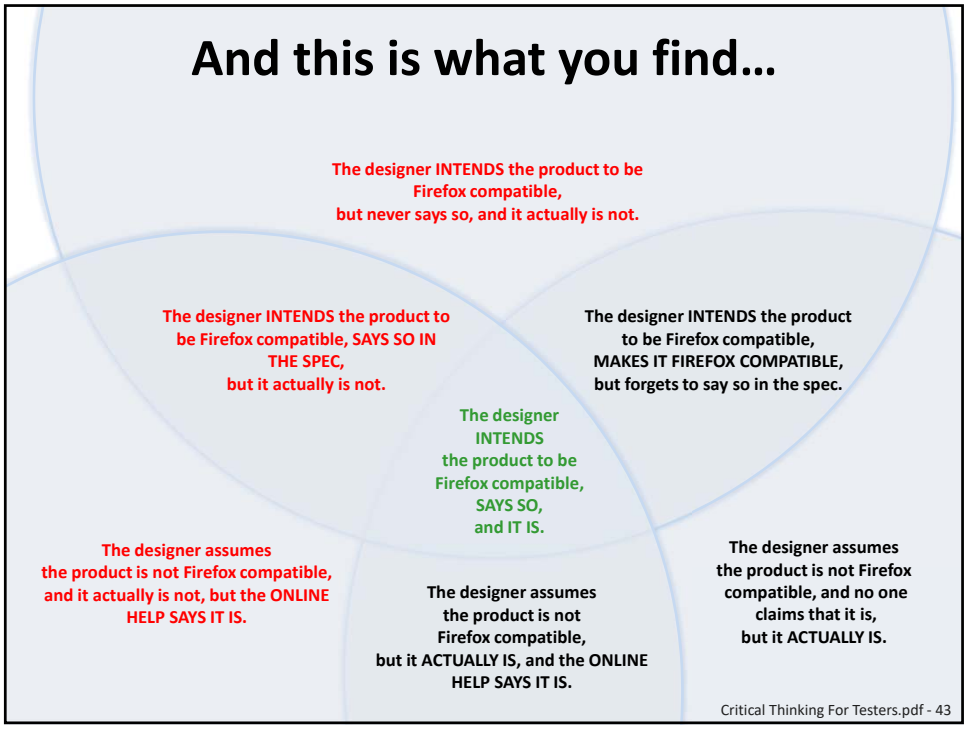
"Compare the idea of the product to a description of it"

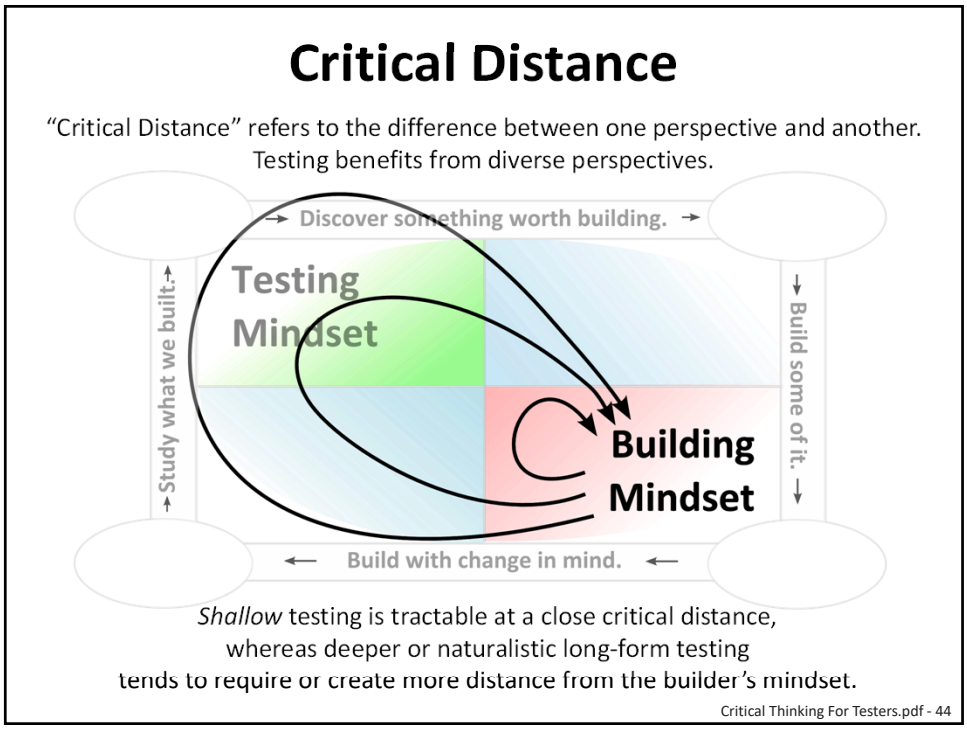
"Compare the idea of the product to the actual product"



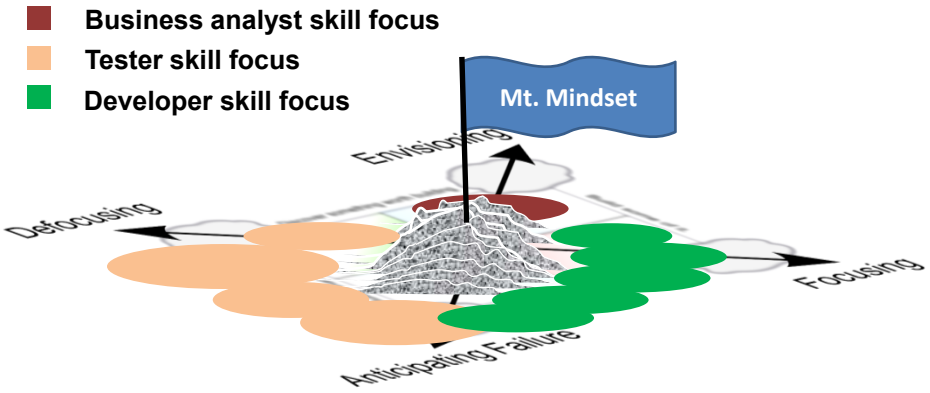
"Compare the actual product to a description of it"

Critical Thinking For Testers.pdf - 42


And this is what you find…
The designer INTENDS the product to be Firefox compatible, but never says so, and it actually is not.
The designer INTENDS the product to be Firefox compatible, SAYS SO IN THE SPEC, but it actually is not.
The designer INTENDS the product to be Firefox compatible, MAKES IT FIREFOX COMPATIBLE, but forgets to say so in the spec.
The designer INTENDS the product to be Firefox compatible, SAYS SO, and IT IS.
The designer assumes the product is not Firefox compatible, and it actually is not, but the ONLINE HELP SAYS IT IS.
The designer assumes the product is not Firefox compatible, but it ACTUALLY IS, and the ONLINE HELP SAYS IT IS.
The designer assumes the product is not Firefox compatible, and no one claims that it is, but it ACTUALLY IS.
Critical Thinking For Testers.pdf - 43


Critical Distance
"Critical Distance" refers to the difference between one perspective and another.
Testing benefits from diverse perspectives.
Discover something worth building.
Testing Mindset
Building Mindset
Study what we built.
Build some of it.
Build with change in mind.
Shallow testing is tractable at a close critical distance,
whereas deeper or naturalistic long-form testing
tends to require or create more distance from the builder's mindset.
Critical Thinking For Testers.pdf - 44

A Central Obstacle Divides Software Work



NOTE: We do NOT claim that this work *must* be done by different people, or that the people *must* have different roles. We DO claim that roles on a development team (collaborating with each other) are a powerful heuristic for solving the mindset switching problem.

Critical Thinking For Testers.pdf - 45

Questions for Testers and their Clients

- How should we test this product?
- Where should we look for bugs?
- Are there bugs here?
- Do those bugs matter?
- Whose decides? Whose values matter?
- Are we ready to ship?
- What might be getting in the way of testing work, or slowing me down?
- **How might we be fooling ourselves?**

Critical Thinking For Testers.pdf - 46

Call this "Checking" not Testing

operating a product algorithmically to check specific facts about it…

Think "spelling checker"

means

Observe → **Evaluate** → **Report**

Interact with the product in specific, *algorithmic* ways to collect specific observations.

Apply *algorithmic* decision rules to those observations.

Report the outputs of the evaluations *algorithmically*.

TestingIsTestingAgileIsContext.pdf - 23

A check can be performed…

by a machine
that *can't* think
(but that is quick and precise)

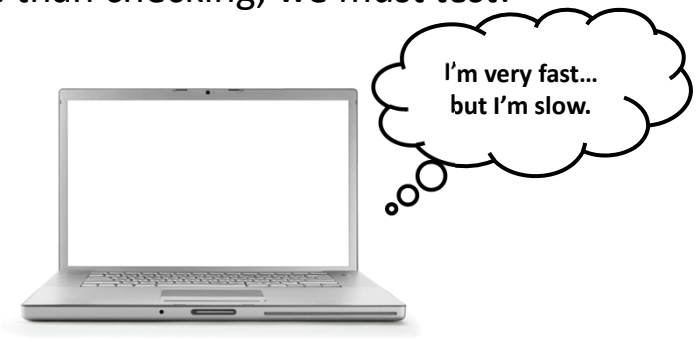
by a human
who has been told *not* to think
(and who is slow and variable)

Notice that "quick" and "slow" refer only to the speed of observable behaviours and algorithmic evaluations.
The machine is *infinitely* slow at recognizing unanticipated trouble.

TestingIsTestingAgileIsContext.pdf - 24

Testing Is *More Than Checking*

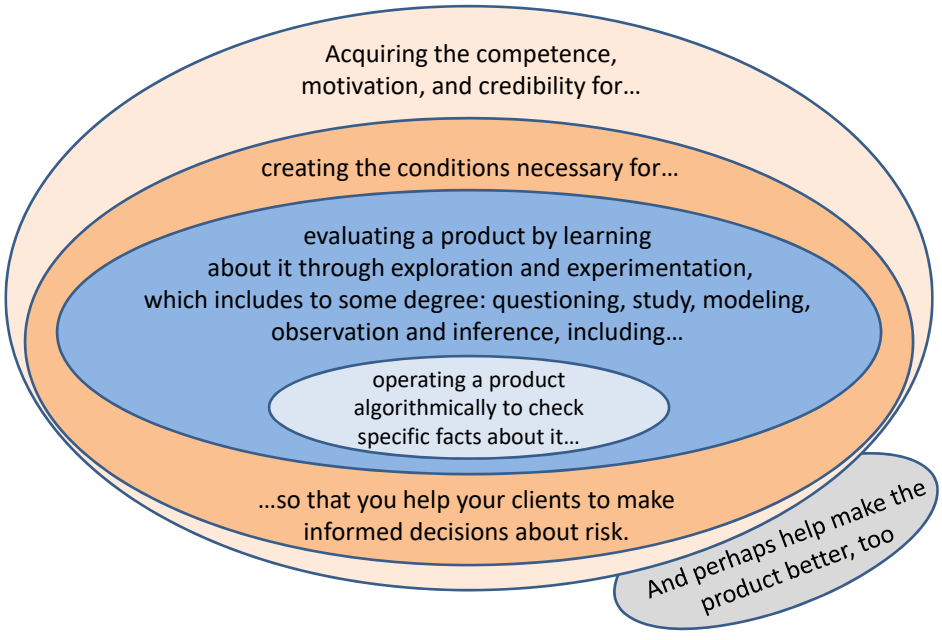
- *Checking* is okay, but it is mostly focused on confirming what we know or hope to be true.
- To escape problems with verification, we must do more than checking; we must *test*.



http://www.satisfice.com/blog/archives/856

The Logic of Verification - 49

Testing is…



Heuristics

bring useful structure to problem-solving skill.

"a **fallible means of solving a problem**"

- a heuristic is not a **rule**
- a heuristic **can work** but **might fail**

"The engineering method is
the use of **heuristics** to cause the **best change**
in a **poorly understood situation**
within the **available resources**."

Billy Vaughan Koen
Discussion of the Method

See "Heuristics for Understanding Heuristics"
http://www.developsense.com/blog/2012/04/heuristics-for-understanding-heuristics/

Critical Thinking For Testers.pdf - 50

Workarounds for Our Bugs: Introducing Pauses

Giving System 2 time to wake up!

Huh? • You may not understand. (errors in interpreting and modeling a situation, communication errors)

Really? • What you understand may not be true. (missing information, observations not made, tests not run)

And? • You may not know the whole story. (perhaps what you see is not all there is)

So? • The truth may not matter, or may matter much more than you think. (poor understanding of risk)

Critical Thinking For Testers.pdf - 51

"Huh?" Critical Thinking About Words

- Among other things, *testers question premises.*
- A *suppressed premise* is an unstated premise that an argument needs in order to be logical.
- A suppressed premise is something that should be there, but isn't…
- (…or *is* there, but it's *invisible* or *implicit*.)
- Among other things, *testers bring suppressed premises to light and then question them.*
- A diverse set of models can help us to see the things that "aren't there."

Critical Thinking For Testers.pdf - 52

Test Framing

- *Test framing* is the set of logical connections that structure and inform a test and its result
- The framing of a test consists of
  - premises; essentially ordinary statements
  - logical "connectors"
    - formal: if, then, else, and, or
    - informal: although, maybe,
- A change in ONE BIT in the framing of the test can invert its result.

Critical Thinking For Testers.pdf - 87

Exercise: Test Framing

- "We executed 20 test cases this week. There are 120 test cases remaining. Therefore we will be finished testing in six weeks."
- "I performed the tests. All my tests passed. Therefore, the product works."
- "The programmer said he fixed the bug. I can't reproduce it anymore. Therefore it must be fixed."
- "Microsoft Word frequently crashes while I am using it. Therefore it's a bad product."
- "It's way better to find bugs earlier than to find them later."

Critical Thinking For Testers.pdf - 53

Grand Truth? Rule? Or Heuristic?

Use "Huh? Really? And? So?"
to critique this sentence:

"It is generally accepted that it is more difficult for an author to find defects in their own work than it is for an independent tester to find the same defects."

Treating absolute statements as heuristics helps to defend you against critical thinking errors.

And yes, that's a heuristic.

Critical Thinking For Testers.pdf - 54

Grand Truth? Rule? Or Heuristic?

Use debate to analyse this proposal.

"Consider a minefield: if we always take the same path through the minefield, we will not expose the hidden mines. Therefore varying tests is more effective than repeating them.

Treating absolute statements as heuristics helps to defend you against critical thinking errors.

And yes, that's a heuristic.

Critical Thinking For Testers.pdf - 54

Example: Generating Interpretations

- Selectively emphasize each word in a statement; also consider alternative meanings.

MARY had a little lamb.

Mary **HAD** a little lamb.

Mary had **A** little lamb.

Mary had a **LITTLE** lamb.

Mary had a little **LAMB**.

Critical Thinking For Testers.pdf - 55

"Really?"
The Data Question

What did you
see or hear
(or smell, or taste, or touch)
that made you believe...?

Critical Thinking For Testers.pdf - 56

Really? Says Who?
Critical Thinking About Research

- Research varies in quality
- Research findings often contradict one another
- Research findings do not prove conclusions
- Researchers have biases
- Writers and speakers may simplify or distort
- "Facts" change over time
- Research happens in specific environments
- Human desires affect research outcomes

Asking the Right Questions: A Guide to Critical Thinking
M. Neil Browne & Stuart M. Keeley

ALL of these things apply to testing, too.

Critical Thinking For Testers.pdf - 58

"And?"

A vs. THE

Whatever we're focused on may be only one of several things we COULD focus on.

- Example: "THE problem…" instead of "A problem…"
- Using "A" instead of "THE" helps us to avoid several kinds of critical thinking errors
  - single path of causation
  - confusing correlation and causation
  - single level of explanation

Critical Thinking For Testers.pdf - 59

"And?"

Unless…

Whatever is true under these conditions may not be true under other conditions.

- When someone asks a question based on a false or incomplete premise, try adding "unless…" to the premise
- When someone offers a Grand Truth about testing, append "unless…" or "except when…"

Critical Thinking For Testers.pdf - 60

"And?"
Also…

**Whatever is happening,
something else may ALSO be happening.**

- The product gives the correct result! Yay!
- …It also may be silently deleting system files.
- There may be *more where that come from*.

Critical Thinking For Testers.pdf - 61

"And?"
"So far" & "Not yet"

**Whatever is true now
may not be true for long.**

- The product works… so far.
- We haven't seen it fail… yet.
- No customer has complained… yet.
- Remember: There is no test for ALWAYS.

Critical Thinking For Testers.pdf - 62

"And?"
"What else?"

Whatever your theory about "what is", other theories could describe "what is" as well, or better.

- The Rule of Three: if you haven't thought of at least three plausible and non-trivial interpretations of what you've taken in, you probably haven't thought enough.

  – Jerry Weinberg
- See also *How Doctors Think*, Dr. Jerome Groopman

Critical Thinking For Testers.pdf - 63

"And?"
"What's missing?"

You're rarely looking at the whole thing; far more often at a model or sample. What's missing?

U.S. airplanes returning from engagements over Europe, WWII

Section of the plane	Bullet holes per square foot
Engine	1.11
Fuselage	1.73
Fuel system	1.55
Rest of the plane	1.8

Jordan Ellenberg, *How Not To Be Wrong*

Beware of "random" samples that only *look* random!

Critical Thinking For Testers.pdf - 64

"So?"
Critical Thinking About Risk

How do you test this?

"The system shall operate at an input voltage range of nominal 100 - 250 VAC."

Poor answer:

"Try it with an input voltage in the range of 100–250."

Critical Thinking For Testers.pdf - 65

Heuristic Model:
The Four-Part Risk Story

Some ***person*** may be ***hurt or annoyed***
because of something that might go wrong
while operating the product,
due to ***some vulnerability in the product***
that is ***triggered by some threat***.

- **Victim:** Someone that experiences the impact of a problem. Ultimately no bug can be important unless it victimizes a human.
- **Problem:** Something the product does that we wish it wouldn't do.
- **Vulnerability:** Something about the product that causes or allows it to exhibit a problem, under certain conditions.
- **Threat:** Some condition or input external to the product that, were it to occur, would trigger a problem in a vulnerable product.

Critical Thinking For Testers.pdf - 66

How Do We Know What "Is"?

"We know what is because we see what is."

Let's be more specific...

We believe
we know what is because we see
what we interpret as signs that indicate
what is
based on our prior beliefs about the world
and our (un)awareness of things around us.

Critical Thinking For Testers.pdf - 67

How Do We Know What "Is"?

We see the signs!

"If I see X, then probably Y, because probably A, B, C, D, etc."

- THIS CAN FAIL:
  - Ice cream that wasn't
  - Getting into a car– oops, not my car.
  - Bad driving– Why?
  - Bad work– Why?
  - Ignored people at my going away party– Why?
  - Couldn't find soap dispenser in restroom– Why?
  - Ordered orange juice at seafood restaurant– waitress misunderstood

Critical Thinking For Testers.pdf - 68

Remember this, you testers!

What you see is NOT all there is.

Critical Thinking For Testers.pdf - 69

Models Link Observation and Inference

- **A model is an idea, activity, or object…**

  such as an idea in your mind, a diagram, a list of words, a spreadsheet, a person, a toy, an equation, a demonstration, or a program

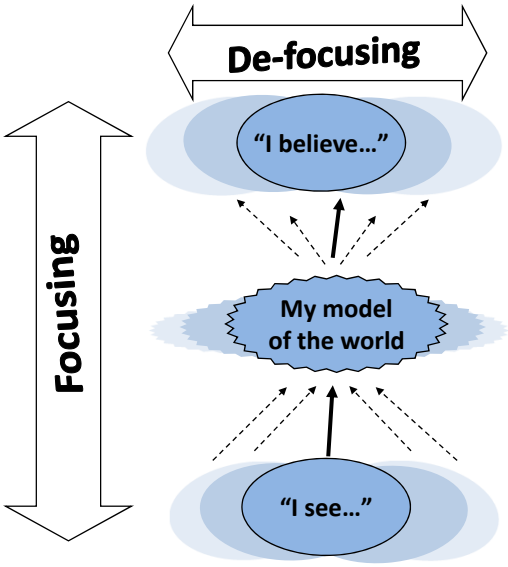
- **…that represents another idea, activity, or object…**

  such as something complex that you need to work with or study.

- **…whereby understanding the model may help you understand or manipulate what it represents.**
  - A map is a model that helps us to navigate across a terrain.
  - 2+2=4 is a model for adding two apples to a basket that already has two apples in it.
  - Atmospheric models help us to predict where hurricanes will go.
  - A fashion model helps us to understand how clothes would look on an actual (very skinny) human.
  - Your beliefs about what you test are a model of what you test.

Critical Thinking For Testers.pdf - 71

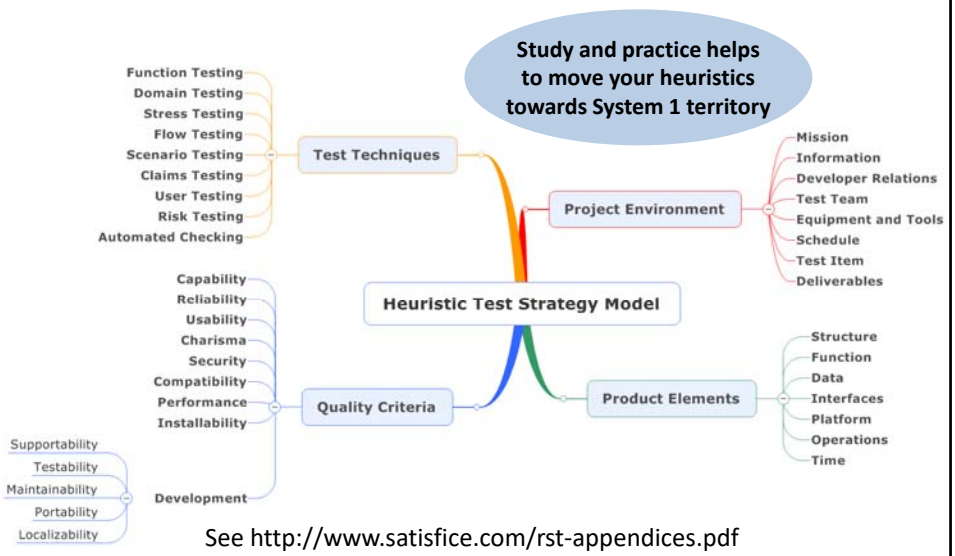
Models Link Observation & Inference



- Testers must distinguish observation from inference!
- Our mental models form the links between them
- Defocusing is lateral thinking.
- Focusing is logical (or "vertical") thinking.

Critical Thinking For Testers.pdf - 72

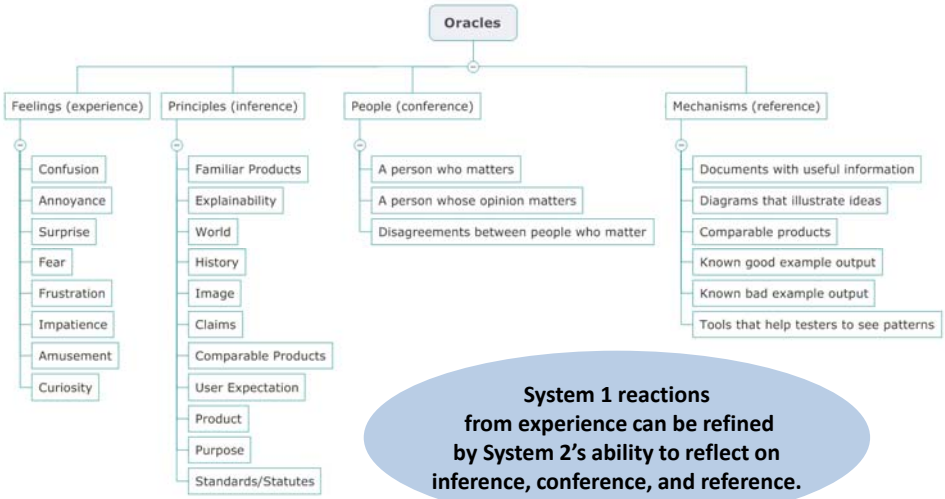
Rapid Software Testing
Heuristic Test Strategy Model



See http://www.satisfice.com/rst-appendices.pdf

Critical Thinking For Testers.pdf - 73

Rapid Software Testing: Oracles



System 1 reactions from experience can be refined by System 2's ability to reflect on inference, conference, and reference.

See http://www.developsense.com/blog/2015/09/oracles-from-the-inside-out/

Critical Thinking For Testers.pdf - 74

Modeling Bugs as Magic Tricks

- Our thinking is limited
  - We misunderstand probabilities
  - We use the wrong heuristics
  - We lack specialized knowledge
  - We forget details
  - We don't pay attention to the right things
- The world is hidden
  - states
  - sequences
  - processes
  - attributes
  - variables
  - identities

Magic tricks work for the same reasons that bugs exist

Studying magic can help you develop the imagination to find better bugs.

Testing magic is indistinguishable from testing sufficiently advanced technology

Critical Thinking For Testers.pdf - 75

Untangling Observation and Inference

- Observation and inference are easily confused.
- Observation is direct sensory data, but on a very low level it is guided and manipulated by inferences and heuristics.
- You sense very little of what there is to sense.
- You remember little of what you actually sense.
- Some things you think you see in one instance may be confused with memories of other things you saw at other times.
- **It's easy to miss bugs that occur right in front of your eyes.**
- **It's easy to think you "saw" a thing when in fact you merely inferred that you must have seen it.**

What can you do about it?

Critical Thinking For Testers.pdf - 76

Sharpening Observation and Inference

Here's what:

- Accept that we're all fallible, but that we can learn to be better observers by learning from mistakes.
- Pay special attention to incidents where someone notices something you could have noticed, but did not.
- Don't strongly commit to a belief about any important evidence you've seen only once.
- Whenever you describe what you experienced, notice where you're saying what you saw and heard, and where you are instead jumping to a conclusion about "what was really going on."
- Where feasible, look at things in more than one way.
- Collect more than one kind of information about what happened (such as repeated testing, paired testing, loggers and log files, or video cameras).

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Workarounds for Bugs in Speaking: Safety Language *(aka "epistemic modalities")*

- "Safety language" in Rapid Software Testing, means to qualify or otherwise draft statements of fact so as to avoid false confidence.
- **Examples:**

I think...
So far...
It appears...
I infer...
apparently...
It seems...
I assumed...

~~The feature worked~~ ⇨ I have not yet seen any failures in the feature...

Critical Thinking For Testers.pdf - 78

WASHINGTON—Responding to the ongoing nuclear crisis in Japan, officials from the Nuclear Regulatory Commission sought Thursday to reassure nervous Americans that U.S. reactors were 100 percent safe and posed absolutely no threat to the public health as long as no unforeseeable system failure or sudden accident were to occur. "With the advanced safeguards we have in place, the nuclear facilities in this country could never, ever become a danger like those in Japan, unless our generators malfunctioned in an unexpected yet catastrophic manner, causing the fuel rods to melt down," said NRC chairman Gregory Jaczko, insisting that nuclear power remained a clean, harmless energy source that could only lead to disaster if events were to unfold in the exact same way they did in Japan, or in a number of other terrifying and totally plausible scenarios that have taken place since the 1950s. "When you consider all of our backup cooling processes, containment vessels, and contingency plans, you realize that, barring the fact that all of those safety measures could be wiped away in an instant by a natural disaster or electrical error, our reactors are indestructible." Jaczko added that U.S. nuclear power plants were also completely guarded against any and all terrorist attacks, except those no one could have predicted.

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Qualification Quips: Safety and Possibilities

- proportional principle: "to some degree"
- relative rule: "to some person, at some time"
- context concept: "in some context"
- uncertainty umbrella: "probably but not certainly"
- necessity nudge: "necessary but not sufficient"
- heuristic heuristic: "the solution is a heuristic“
- model modifier: “not the thing, but our model of the thing”
- particularity premise: “true for us in the here and now”
- debate delay: “we will decide on this later”
- design deferral: “we will solve this problem later”
- the *et cetera* escape: “there may be more to this”
- *inter alia* interjection: “among other things…”

Critical Thinking For Testers.pdf - 81

Think Critically About Common Beliefs About Testing!

- “Every test must have an expected, predicted result.”
- “Effective testing requires complete, clear, consistent, and unambiguous specifications.”
- “Bugs found earlier cost less to fix than bugs found later.”
- “Testers are the quality gatekeepers for a product.”
- “Repeated tests are fundamentally more valuable.”
- “You can’t manage what you can’t measure.”
- “Testing at boundary values is the best way to find bugs.”

Critical Thinking For Testers.pdf - 82

Think Critically About Common Beliefs About Testing!

- "Test documentation is needed to deflect legal liability."
- "The more bugs testers find before release, the better the testing effort has been."
- "Rigorous planning is essential for good testing."
- "Exploratory testing is unstructured testing, and is therefore unreliable."
- "Adopting best practices will guarantee that we do a good job of testing."
- "Step by step instructions are necessary to make testing a repeatable process."

Critical Thinking For Testers.pdf - 83

Critical thinking about practices What does "best practice" mean?

Someone believes you might suffer unless you do this practice.

- **Someone:** Who is it? What do they know?
- **Believes:** What specifically is the basis of their belief?
- **You:** Is *their* belief applicable to *you*?
- **Might:** How *likely* is the suffering to occur?
- **Suffer:** So what? Maybe it's worth it.
- **Unless:** Really? There's no alternative?
- **You do this practice:** What does it mean to "do" it? What does it cost? What are the side effects? What if you do it badly? What if you do something else really well?

Critical Thinking For Testers.pdf - 84

Beware of…

- **Numbers:** "We cut test time by 94%."
- **Documentation:** "You must have a written plan."
- **Judgments:** "That project was *chaotic*. This project was a *success*."
- **Behavior Claims:** "Our testers follow test plans."
- **Terminology:** Exactly what is a "test plan?"
- **Contempt for Current Practice:** CMM Level 1 (initial) vs. CMM level 2 (repeatable)
- **Unqualified Claims:** "A subjective and unquantifiable requirement is not testable."

Critical Thinking For Testers.pdf - 85

Look For…

- **Context:** "This practice is useful when you want the power of creative testing but you need high accountability, too."
- **People:** "The test manager must be enthusiastic and a real hands-on leader or this won't work very well."
- **Skill:** "This practice requires the ability to tell a complete story about testing: coverage, techniques, and evaluation methods."
- **Learning Curve:** "It took a good three months for the testers to get good at producing test session reports."
- **Caveats:** "The metrics are useless unless the test manager holds daily debriefings."
- **Alternatives:** "If you don't need the metrics, you ditch the daily debriefings and the specifically formatted reports."
- **Agendas:** "I run a testing business, specializing in exploratory testing."

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The Regression Testing Fantasy

"I rerun my old tests to ensure that nothing has broken."

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The Regression Testing Fantasy

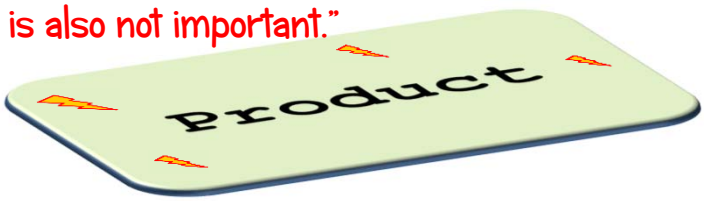
"I rerun my old tests to ensure that nothing has broken."

This can only be true if your old tests cover everything completely with perfect oracles so that all conceivable bugs are detected...

Critical Thinking For Testers.pdf - 89

The Regression Testing Reality

"We run a smattering of old checks to ensure that they still find no bugs... And we assume that any bug not found is also not important."



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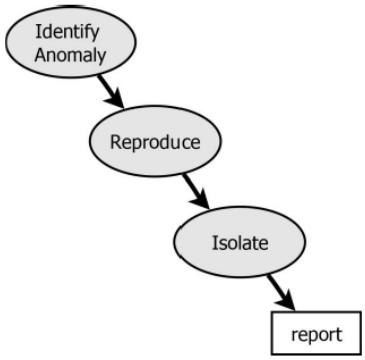
Critical Thinking About Processes

- This is a description of a bug investigation process that a particular company uses. Does it make sense?



See James Bach, "Investigating Bugs: A Testing Skills Study"
http://www.satisfice.com/articles/investigating-bugs.pdf

Critical Thinking For Testers.pdf - 91

Talking More Clearly About Testing

Try replacing…	with…
Verify that…	Challenge the belief that…
Validate	Investigate
Confirm that…	Find problems with…
Show that it works	Discover where it *doesn't* work
Pass vs. fail…	Is there a problem here?
Test case	Test conditions and test ideas
Counting test cases	Describing coverage
Automated testing	Programmed checking
Test automation	Using tools in powerful ways
Use cases	Use cases AND *mis*use cases AND *ab*use cases AND *obt*use cases…
KPIs and KLOCs	***Learning from every bug***

Talking More Clearly About Testing

Try Replacing	With…
"The environment's down. We're stuck. We can't test."	"What can we test, review, or analyze now… and *are you OK with this situation*, dear client?"
"They didn't give us good requirements documents!"	"Let's write down what *we* know—and then they'll tell us when they think it's wrong!"
"It's too hard to test this!"	"What can we do in the product and the project to things more testable?"
"We don' t have enough time to test!"	"What testing shall we do—what shall we cover—in the time we *do* have?"
"We have to…!"	"We choose to…"

26-ClassWrapUp - 4

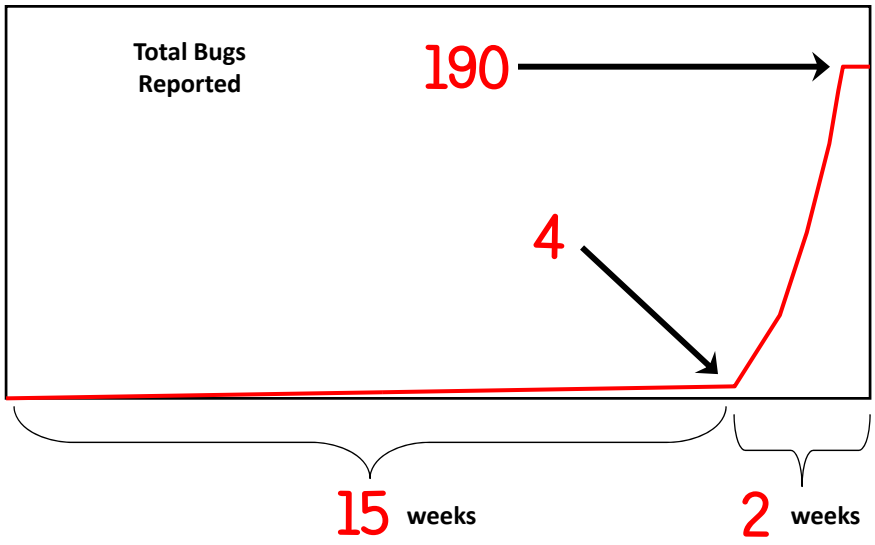
Part II:
Critical Thinking About Measurement

I Don't Hate Numbers!

- I love numbers *so much* that I can't stand to see them abused as they are by people in our profession.
- This workshop is designed to take you deeper into measurement, spotting critical thinking errors that might cause you to miss observations and mislead your client—or yourself.
- The intention is not only to suggest that measurement has problems, but also to expand our notions of what good measurement might be.

> Imperfections in measurement are always a problem, but they're a devastating problem only when we don't recognize them.
>
> **—Daniel Gilbert, Stumbling on Happiness**

Example: A Test Project



Critical Thinking For Testers.pdf - 94

Example: A Test Project

- The original tester was faking it.
- A tiger team took over for the last 2 weeks.
- The reporting system broke down in the last several days before the beta was shipped.
  (That's why the line goes flat–reports were still being prepared, but were not being formally logged in the tracking system.)

Lessons:

- **Pay attention to the whole story.**
- **Don't assume that all known problems are being reported.**
- ***Think critically about the numbers.***

Critical Thinking For Testers.pdf - 95

Exercise: Evaluating Claims

- Choose a claim from the next slide, and write it down.
  - Using a plausibility scale of 0-100 (where 0 is ridiculous and 100 is absolutely true), what is your assessment of the claim?
  - What is your thought process on encountering the claim?
  - What might change your evaluation of the claim?
  - Irrespective of your evaluation of the claim, what evidence would change your mind *to the opposite polarity*?
    - That is, if you disbelieved the claim, what could make you believe it? If you believed it, what could make you disbelieve it?

Critical Thinking For Testers.pdf - 96

The Claims

- The average cost of correcting a bug during the coding phase is $977.
- Time and motion studies of actual defect repairs shows that fixing most bugs in code requires about four hours, regardless of whether the bug is found before or after release.
- Defect Removal Efficiency averages vary from 73% to 96% depending on organizations.
- The cost of defects rises exponentially the later they are detected.
- Software defects cost the US economy $60Bn annually.
- 25% of total defects are from bad fixes.
- The average time to find and fix a defect is 10 to 20 hours.

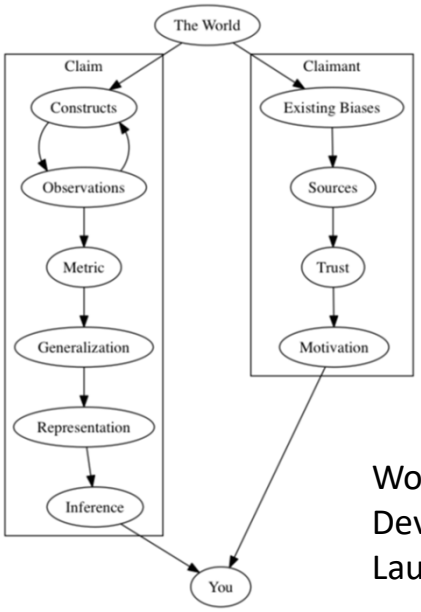
Critical Thinking For Testers.pdf - 97

The Assignment

- Using a plausibility scale of 0-100 (where 0 is ridiculous and 100 is absolutely true), what is your assessment of the claim?
- What is your thought process on encountering the claim?
- What might change your evaluation of the claim? How would you test your belief?
- Irrespective of your evaluation of the claim, what evidence would change your mind *to the opposite polarity*?
  - That is, if you disbelieved the claim, what could make you believe it? If you believed it, what could make you disbelieve it?

Critical Thinking For Testers.pdf - 98

A Model for Evaluating Claims



Work still in progress!
Developed in collaboration with Laurent Bossavit

Critical Thinking For Testers.pdf - 99

What is measurement?

What Is Measurement?

**"Measurement is
the empirical, objective assignment of numbers,
according to a rule derived from a model or theory,
to attributes of objects or events
with the intent of describing them."**
—Cem Kaner and Walter P. Bond

Source: "Software Engineering Metrics: What Do They Measure and How Do We Know?" (Cem Kaner and Walter P. Bond)
http://www.kaner.com/pdfs/metrics2004.pdf

**What happens when we walk through that definition?
What do we need to think critically about?
*What could go wrong?***

Exercise

Identify and describe
factors in measurement.

Critical Thinking For Testers.pdf - 102

Some measurement factors…

- Object or event
- Attribute(s) of that object or event
  - measured / unmeasured
  - observed / unobserved
- Measuring instrument(s)
- Metric (how numbers get assigned)
- Rule
- Model or theory
- Description
- Intention (inquiry or control?)
- Observation
- Observer

Critical Thinking For Testers.pdf - 103

…and some more measurement factors…

- Scale
- Precision
- Accuracy
- Validity
- Reliability
- Sample size
- Sample selection
- Errors

Critical Thinking For Testers.pdf - 104

Going deeper…

- People
  - observers, consumers, subjects…
- System
  - relationship of attributes, objects, and events to others
- Construct
  - how to count to one
- Representation
  - how the measurement is displayed and described
- Generalization
  - how observations and conclusions might apply outside this context
- Inferences
  - what conclusions we could draw from this measurement

Critical Thinking For Testers.pdf - 105

Problems and Sources of Error

- Validity
  - operationalization of constructs ("how to count to one")
  - relationship between what we're measuring and *what we think* we're measuring
  - degree to which we've accounted for alternative interpretations for our observations and conclusions
- Reliability
  - variations in attributes, instruments, observers
  - influenced by context: time, place, motivations…
- Biases and fallacies
  - too many to list here! See (e.g.) Wikipedia
- Side effects
  - distortion and dysfunction
  - people will often behave to optimize things that are being measured, at the expense of things that are not

Critical Thinking For Testers.pdf - 106

Objectivity, Reliability, Validity

- *Objectivity* is the simultaneous realization of as much reliability and validity as possible.
- *Reliability* is the degree to which the finding is independent of accidental circumstances of the research
- *Validity* is the degree to which the finding is interpreted in a correct way.

Kirk, Jerome, and Miller, Mark, *Reliability and Validity in Qualitative Research*

Critical Thinking For Testers.pdf - 107

Three Important Kinds of Reliability

- Quixotic reliability
  - the measurement yields consistent results in different circumstances
  - could be the result of a broken instrument, or socially acceptable answers
- Diachronic reliability
  - the measurement yields consistent results when taken multiple times
  - only reliable for things that don't change in a changing world; "may deny history"
- Synchronic reliability
  - similarity of observations within the same time period
  - reveals potentially significant questions when it fails

Kirk, Jerome, and Miller, Mark, *Reliability and Validity in Qualitative Research*

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Construct Validity & External Validity

- *Construct* validity is (informally) the degree to which your attributes and measurements can justified within an experiment or observation
  - How do you demarcate the difference between *one* of something and *not-one* of something?
  - How do you know that you're measuring what you think you're measuring?
- *External* validity is the degree to which your experiment or observation can be generalized to the world outside
  - How do you know that your experiment or observation will be relevant at other times or in other places?

"In the case of qualitative observations, the issue of validity is not a matter of methodological hair-splitting about the fifth decimal point, but a question of whether the researcher sees what he or she thinks he or she sees."

Kirk, Jerome, and Miller, Mark, *Reliability and Validity in Qualitative Research*

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Exercise

Analyse Kaner and Bond's definition.

How can we sharpen our analysis of a given measurement?

Critical Thinking For Testers.pdf - 110

Exercise

Using Kaner and Bond's questions, analyze this statement:

"Defect Detection Efficiency is a good way to evaluate the performance of the testing group."

Critical Thinking For Testers.pdf - 111

An Alternative View of Measurement

Measurement is the art and science
of making reliable and significant observations.
—Jerry Weinberg, *Quality Software Management Vol. 2*

- Since the time of Aristotle (at least), we've known about two kinds of measurement that inform decisions
  - "Two pounds of meat"
  - "Too much", "too little", "just right".

We waste time and effort when we try to obtain
six-decimal-place answers to whole-number questions.

- **http://www.developsense.com/articles/2009-05-IssuesAboutMetricsAboutBugs.pdf**
- **http://www.developsense.com/articles/2009-07-ThreeKindsOfMeasurement.pdf**
- **http://www.developsense.com/articles/2007-11-WhatCounts.pdf**

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How Do We Measure?

- Third-order measurement
  - highly instrumented, used to discover natural laws
  - "What *will* happen? What *always* happens?"

- Second-order measurement
  - often instrumented, used to refine first-order observation
  - used to tune existing systems
  - "What's *really* going on here? What's happening right now?"

Critical Thinking For Testers.pdf - 113

How Else Do We Measure?

- First-order measurement
  - minimal fuss, direct observation, minimal instrumentation
  - used to inform a control action OR to prompt search for more refined information
  - "What's going on? What should we do? Where should we look?"

Weinberg suggests that, in software development, we're obsessed with trying to make third- and second-order measurements when first-order measurements might be all we need—and tend to be much cheaper and easier.

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Why Prefer First-Order Measures?

- When you're driving, are you mostly concerned about…
  - your velocity, acceleration, vehicle mass, drag co-efficient, frictional force? (third-order)
  - your engine temperature, RPMs, and current rate of gas consumption? (second-order)
  - looking out the window to avoid hitting things (first-order)?

I've observed *many* projects that have crashed because managers were overly focused on the dashboard instead of the traffic and obstacles around them, and the road ahead.

What kind of driver do you trust?

Critical Thinking For Testers.pdf - 115

Control vs. Inquiry Measurement

- A **control measurement** is a measurement that **drives decisions**.
  - *Any measurement you use to control a self-aware system will be used by that system to control YOU.*

- An **inquiry measurement** is any measurement that **helps you ask the right questions at the right time**.
  - Inquiry measurements are also vulnerable to gaming, but the stakes are far lower, so there's less incentive for manipulation.

Text here is taken from the work of my colleague, James Bach.
http://www.satisfice.com

Critical Thinking For Testers.pdf - 116

Control vs. Inquiry

- Remove *control metrics* that are linked to pay, bonuses, performance evaluation, etc.
  - control metrics trigger some action, usually automatically
  - a metric that is used to control something will eventually be used to control you
- Foster *inquiry metrics*
  - inquiry metrics prompt us to ask questions
- Relax measurement when the metric stops changing
  - if you're not obtaining new information, try measuring something else of interest for a while

Critical Thinking For Testers.pdf - 117

Kaner & Bond's Tests for Construct Validity

from http://www.kaner.com/pdfs/metrics2004.pdf

- What is the purpose of your measurement? The scope?
- What is the attribute you are trying to measure?
- What are the scale and variability of this attribute?
- What is the instrument you're using? What is its scale and variability?
- What function (metric) do you use to assign a value to the attribute?
- What's the natural scale of the metric?
- What is the relationship of the attribute to the metric's value?
- What are the natural, foreseeable side effects of using this measure?

The essence of good measurement is a model that incorporates answers to questions like these.

If you don't have solid answers, you aren't doing measurement; you are just playing with numbers.

Critical Thinking For Testers.pdf - 118

Exercise
Apply critical thinking to this statement:

"Management wants numbers."

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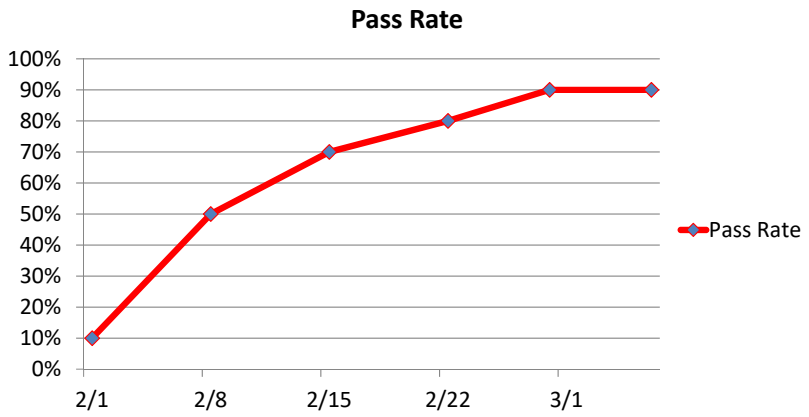
"Pass Rate" is a Popular Metric



Critical Thinking For Testers.pdf - 120

Critical Thinking About Measurement

from an actual client

DER – Defect Escape Rate

The Defect Escape Rate measures the number of undiscovered defects that escaped detection in the product development cycle and were released to customers. An escape is a defect found while using a released product. DER is defined as:

$$DER = (Defect\ Escapes\ /Total\ Defects) * 100$$

DER is a lagging indicator of product quality. The number of escapes is always zero until after the product is released. It is reported as a percentage and a low number is desired. Each business unit has a target DER percentage and an Escape Analysis should be performed on each defect to improve test coverage. It is desirable for the DER for a product line to decline over time. See appendix for calculation details.

Look! Measurement!

What could possibly go wrong?

Critical Thinking For Testers.pdf - 121

"But they ask us for numbers!"

What are they *really* asking for?

- "We want to know if we're improving."
- "We want to know if we're happy."
- "We want to know if we should be *un*happy."

Critical Thinking For Testers.pdf - 122

"But they ask us for numbers!"

- Are they asking for *specific* numbers?
  - Perform the Kaner/Bond checklist
  - Offer a list of threats to validity
  - Provide a number, and include commentary

Critical Thinking For Testers.pdf - 123

"But they ask us for numbers!"

Are they asking for *numbers*? Or *evidence*?

- Offer an *observation*
  - e.g. "cold enough to freeze the water in the bird bath"
- Offer a *description*
  - e.g. a product status report; a coverage outline
- Offer a *list*
  - e.g. a list of problems in the product; a list of project problems
- Offer a *table*
  - e.g. time spent on classes of activities
- Offer a *visual model*
  - e.g. diagrams of effects, Wiggle charts, mind maps…
- Offer a comparison or ranking

Critical Thinking For Testers.pdf - 124

"But they ask us for numbers!"

- Prefer first-order measurement
- Prefer measurement for *inquiry* to measurement for *control*
- Ask “compared to what?”

Critical Thinking For Testers.pdf - 125

What *could* we measure?

Critical Thinking For Testers.pdf - 126

Degrees of Coverage

Level 0	**We don't really know anything about this area.** We're aware that this area exists, but it's a black box to us, so far.
Level 1	**We're just getting to know this area.** We've done basic reconnaissance; surveyed it; we've done smoke and sanity testing. We may have some artifacts that represent our models, which will helps us to talk about them and go deeper.
Level 2	**We've learned a good deal about this area.** We've looked at the core and the critical aspects of it. We've done some significant tests focused on the most important quality criteria, and we're collecting and diversifying our ideas on how to cover it deeply.
Level 3	**We have a comprehensive understanding of this area.** We've looked deeply into it from a number of perspectives, and applied a lot of different test techniques. We've done harsh, complex, and challenging tests on a wide variety of quality criteria. If there were a problem or unrecognized feature in this area that we didn't know about, it would be a big surprise.

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Time Spent on Testing Work

Testing (T)	Active test design; experimentation, interaction, learning about the product; increasing test coverage.
Bug (B)	Study and investigation of bugs; finding repro steps; looking for similar bugs inside a session. B–time interrupts T-time.
Setup (S)	Work within a session to prepare for testing, to support it, **or to follow up on it**. Setting up products, tools, environments; studying; analyzing non-bug behaviour… S-time interrupts T-time.
Opportunity	Work within a session that is NOT directed towards fulfilling the charter, but towards the general mission of testing. Chasing after a risk, helping other testers, testing while waiting for something else to happen…
Non-session	Meetings, lunches, breaks, chat, work-related or personal business done outside of a testing session.

Critical Thinking For Testers.pdf - 128

You can't measure quality… but you can discuss it.

—James Bach

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