

Critical Thinking for Testers

James Bach

<http://www.satisfice.com>
james@satisfice.com
Twitter: @jamesmarcusbach

Michael Bolton

<http://www.developsense.com>
michael@developsense.com
Twitter: @michaelbolton
+1 (416) 992-8378

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namespace 'Rapid Software Testing' ;
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We don't claim to present "a common language for software testing." We believe that any such claim would be nonsense. 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.

Calculator Test

“I was carrying a calculator.

I **dropped** it!

Perhaps it is **damaged**!

What should I do to test it?”

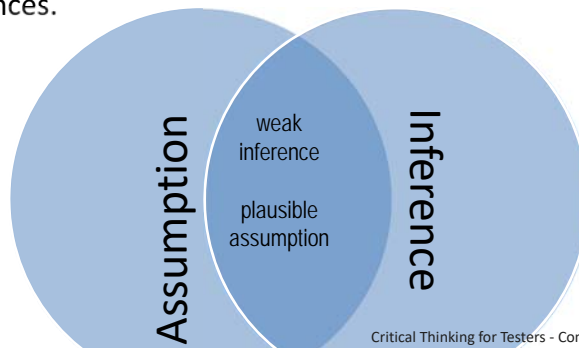
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Never make assumptions.

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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.



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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 <i>might</i> 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.”

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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?”

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What makes an assumption more dangerous?

1. **Consequential:** required to support critical plans and activities. Changing the assumption would change important behavior.
2. **Unlikely:** may conflict with other assumptions or evidence that you have. The assumption is counter-intuitive, confusing, obsolete, or has a low probability of being true.
3. **Blind:** regards a matter about which you have no evidence whatsoever.
4. **Controversial:** may conflict with assumptions or evidence held by others. The assumption may ignore controversy.
5. **Impolitic:** expected to be declared, by social convention. Failing to disclose the assumption violates law or local custom.
6. **Volatile:** regards a matter that is subject to sudden or extreme change. The assumption may be invalidated unexpectedly and explosively.
7. **Unsustainable:** may be hard to maintain over a long period of time. To be sustainable, the assumption and its context must be stable.
8. **Premature:** regards a matter about which you don't yet need to assume.
9. **Narcotic:** any assumption that comes packaged with assurances of its own safety, making us go to sleep—and maybe becoming addictive.
10. **Latent:** Otherwise critical assumptions that we have not yet identified and dealt with. The act of managing assumptions can make them less critical.

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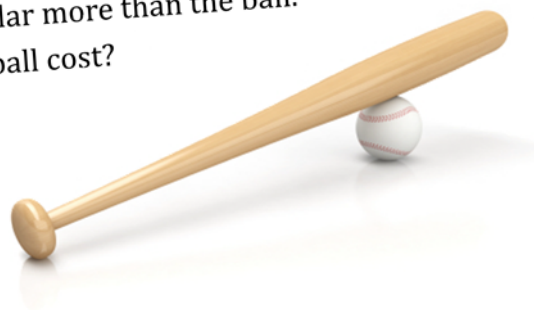
**It's easy to get the right answer
for a simple problem.**

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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?



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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?

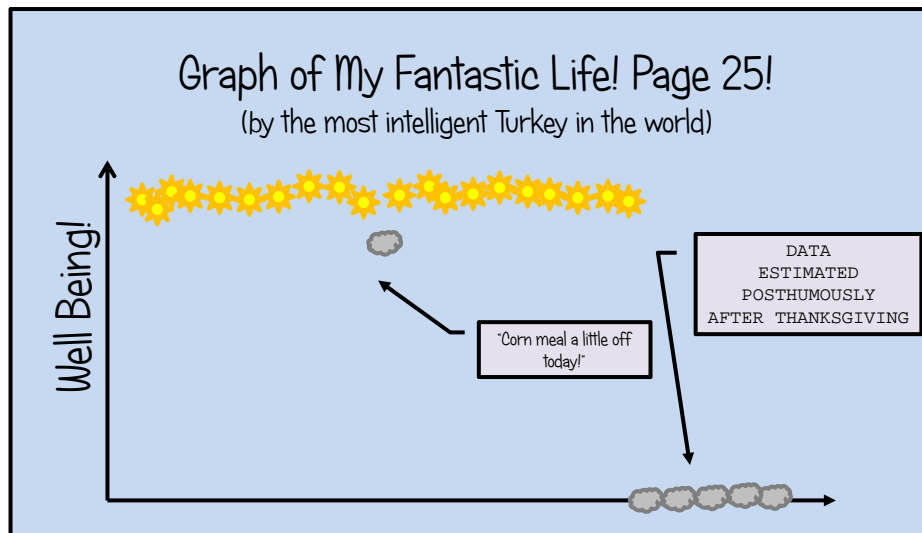


**Remember to
keep your eye on the ball.**



Experience is the best teacher.

Learning from Experience



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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.**

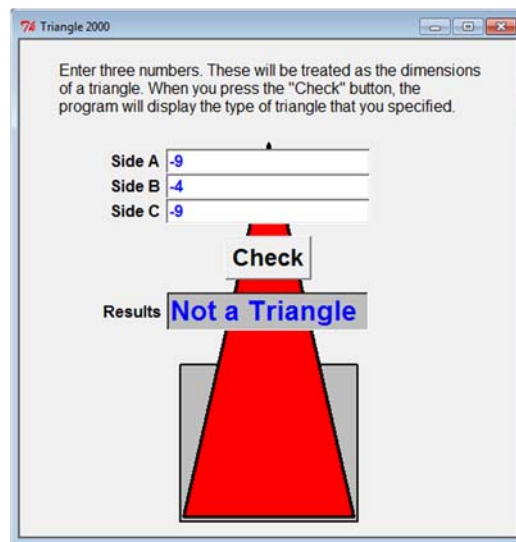


Based on a story told by Nassim Taleb, who stole it from Bertrand Russell, who stole it from David Hume.

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Some bugs are obvious.

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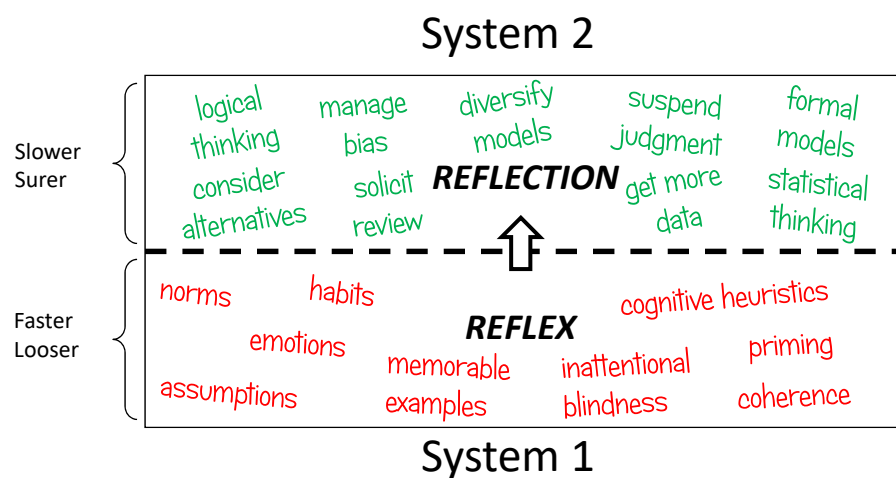
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What are We Seeing Here?

- 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.

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Reflex is IMPORTANT But Critical Thinking is About Reflection



See *Thinking Fast and Slow*, by Daniel Kahneman

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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.)

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My 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. We aspire to be professionally uncertain when everyone else is sure. Critical thinking must begin with our belief in the likelihood of errors in our thinking.

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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
- ...

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Cognitive biases are bad.

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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>

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Or 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”

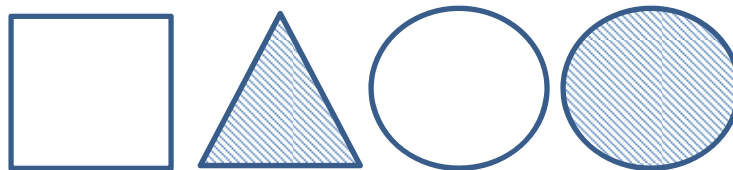
<https://betterhumans.coach.me/cognitive-bias-cheat-sheet-55a472476b18#.63xoq03zx>

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People shouldn't argue about semantics.

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Some Things Are Obvious



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.”

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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/>

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Heuristic workaround for our bugs: 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)

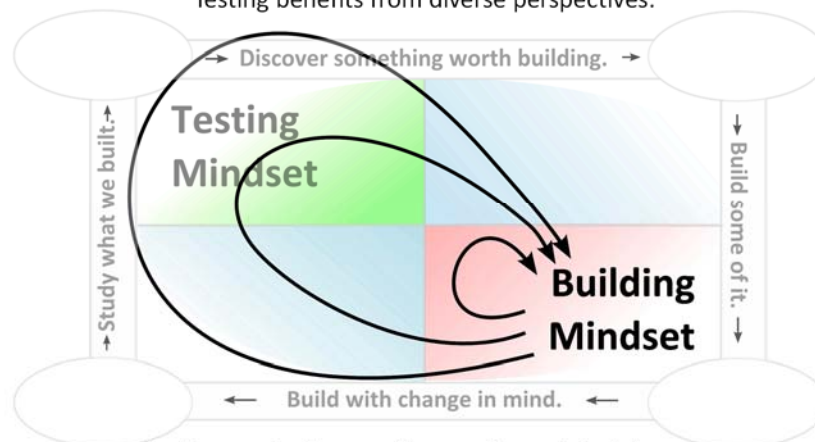
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It is generally accepted that it is more difficult for authors to find defects in their own work than it is for independent testers to find the same defects.

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Critical Distance

“Critical Distance” refers to the difference between one perspective and another. Testing benefits from diverse perspectives.



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.

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A Central Obstacle Divides Software Work

- Business analyst skill focus
- Tester skill focus
- Developer skill focus



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.

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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**.

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“Really?”
The Data Question

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

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“Really?”
The Relative Rule

For any abstract X,
X is X to some person,
at some time.

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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.

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“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

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“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, try appending “unless...” or “except when...”

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“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*.

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“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.

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“And?”

“What else could this be?”

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
- When presented with an apparent problem, ask “What's the worst thing this could possibly be?”
– Dr. Jerome Groopman, *How Doctors Think*

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“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!

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“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.”

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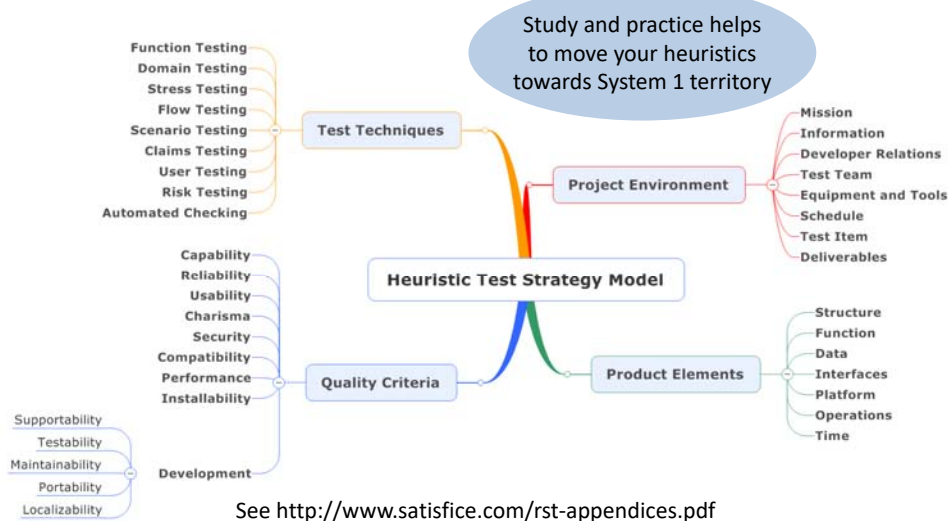
Heuristic Model: The Four-Part Risk Story

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*.

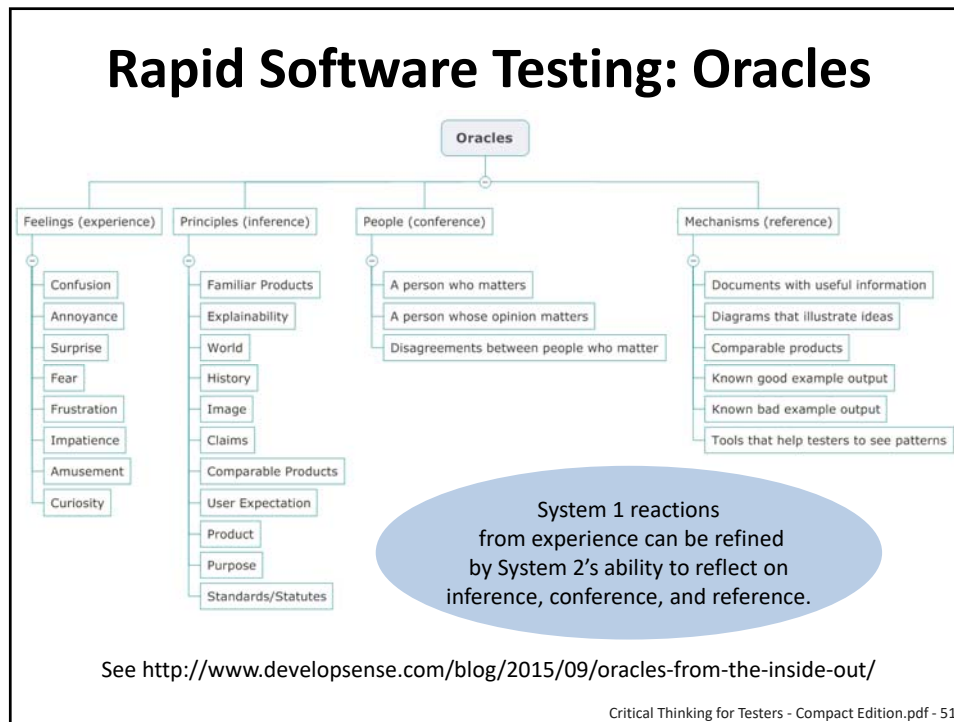
- **Victim:** Someone that experiences the impact of a problem. Ultimately no bug can be important unless it victimizes a human.
- **Problem:** Something the product does that we wish it wouldn't do.
- **Vulnerability:** Something about the product that causes or allows it to exhibit a problem, under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

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Rapid Software Testing Heuristic Test Strategy Model



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Test automation saves time for exploratory testing later on.

Try a critical evaluation of this and the
statements on the following two pages.

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Some 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.

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Some Common Beliefs About Testing

- Test documentation is needed to deflect legal liability.
- The more bugs testers find before release, the better the testing effort.
- Rigorous planning is essential for good testing.
- Exploratory testing is unstructured testing.
- Because exploratory testing is unstructured, it is 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.

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Some Common Thinking Errors

- Reification Error
 - believing that a mental construct has an objective existence in the world; “thingifying” an idea
 - mistaking relationships for things—“its purpose is...”; “that product **has quality**”
 - purpose and quality are *relationships*, not attributes
 - testing is often reified into “tests”, or “test cases”

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Some Common Thinking Errors

- Fundamental Attribution Error
 - “it always works that way”; “he’s a jerk”
 - failure to recognize that circumstance and context play a part in behaviour and effects
- The Similarity-Uniqueness Paradox
 - “all companies are like ours”; “no companies are like ours”
 - any two similarities *and* differences
- Missing multiple paths of causation
 - “A causes B” (even though C and D are also required)

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Some Common Thinking Errors

- Assuming that effects are linear with causes
 - “If we have 20% more traffic, throughput will slow by 20%”
 - ignoring non-linearity and feedback loops
- Reactivity Bias
 - the act of observing affects the observed
 - a.k.a. “Heisenbugs”, the Hawthorne Effect
- The Probabilistic Fallacy
 - confusing unpredictability and randomness
 - after the third hurricane hits Florida, is it time to relax?

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Some Common Thinking Errors

- Binary Thinking Error / False Dilemmas
 - “all manual tests are bad”; “that idea never works”
 - failure to consider gray areas; belief that something is either entirely something or entirely not
- Unidirectional Thinking
 - expresses itself in testing as a belief that “the application works”
 - failure to consider the opposite: what if the application *fails*?
 - to find problems, we need to be able to imagine that they *might* exist

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Some Common Thinking Errors

- Availability Bias
 - the tendency to favor prominent or vivid instances in making a decision or evaluation
 - example: people are afraid to fly, yet automobiles are far more dangerous per passenger mile
 - to a tech support person (or to some testers), the product always seems completely broken
 - spectacular failures often get more attention than grinding little bugs
- Confusing concurrence with correlation
 - “A and B happen at the same time; they must be related”

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Some Common Thinking Errors

- Nominal Fallacies
 - believing that we know something well because we can name it
 - “equivalence classes”
 - believing that we don’t know something because we don’t have a name for it at our fingertips
 - “the principle of concomitant variation”; “inattentional blindness”
- Evaluative Bias of Language
 - failure to recognize the spin of word choices
 - ...or an attempt to game it
 - “our product is full-featured; theirs is bloated”

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Some Common Thinking Errors

- Selectivity Bias
 - choosing data (beforehand) that fits your preconceptions or mission
 - ignoring data that doesn't fit
- Assimilation Bias
 - modifying the data or observation (afterwards) to fit the model
 - grouping distinct things under one conceptual umbrella
 - Jerry Weinberg refers to this as “lumping”
 - for testers, the risk is in identifying setup, pinpointing, investigating, reporting, and fixing as “testing”

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Some Common Thinking Errors

- Narrative Bias
 - a.k.a “post hoc, ergo propter hoc”
 - explaining causation after the facts are in
- The Ludic Fallacy
 - confusing complex human activities with random, roll-of-the-dice games
 - “Our project has a two-in-three chance of success”
- Confusing correlation with causation
 - “When I change A, B changes; therefore A must be causing B”

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Some Common Thinking Errors

- Automation bias
 - people have a tendency to believe in results from an automated process out of all proportion to validity
- Formatting bias
 - It's more credible when it's on a nicely formatted spreadsheet or document
 - (I made this up)
- Survivorship bias
 - we record and remember results from projects (or people) who survived
 - the survivors prayed to Neptune, but so did the sailors who died
 - What was the bug rate for projects that were cancelled?

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