Lessons Testers Can Learn From Astronauts

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DevelopSense

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Thanks and Acknowledgements

- James Bach
- Andrew Muns, Kathy Bruin and the STPCon staff
- Mike Mullane
- You!

The Mission

- NASA's mission is to pioneer the future in space exploration, scientific discovery and aeronautics research.
- NASA's mission statement:
  - To improve life here,
  - To extend life to there,
  - To find life beyond.
- NASA's vision statement:
  - To understand and protect our home planet
  - To explore the Universe and search for life
  - To inspire the next generation of explorers... as only NASA can.

Myths About Scientists

- Scientists are subject to two dominant myths

1. Scientists are absolutely special people.

2. Scientists are simply sophisticated cooks.

The field of science studies suggests that *neither* myth is right.

Mike Mullane's talk shows that astronauts (like other scientists) are highly motivated, highly trained, *and* quite human.

They are technical leaders, surrounded by other technical leaders.

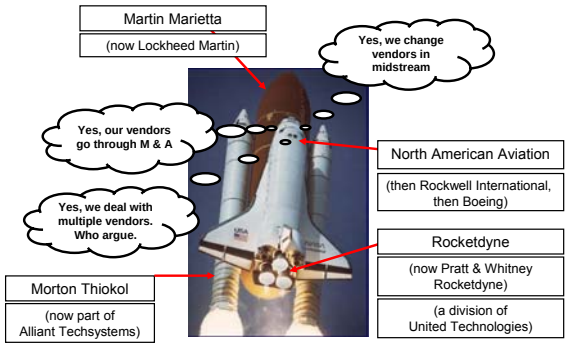
- **Simon Schaffer and Steven Shapin, *Leviathan and the Air Pump***
- ***How To Think About Science*, http://www.cbc.ca/ideas/features/science/**

NASA's ~~Not~~ Just Like Us

- NASA builds all its stuff itself
- NASA sticks to the plan
- NASA has found that you can't have faster AND cheaper AND better
- NASA's review process makes sure that communication always happens

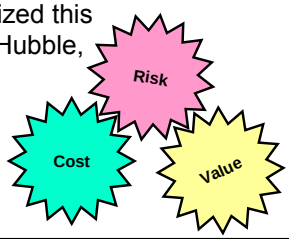
Just kidding!

Multiple Vendors, Anyone?



Sticking to the Plan

- After the Columbia accident, the CAIB recommended that the shuttle always orbit with the International Space Station
- But when NASA realized this meant not fixing the Hubble, the rule turned into a guideline
- To mitigate risk, they kept a shuttle ready



Cheaper, Faster, and Better

- The Mars Pathfinder and Mars Explorer missions showed a structural weakness in the Iron Triangle.

The problem with the "Iron Triangle" is that it ignores PEOPLE, INNOVATION, and SKILL.

Root Cause Analysis

- In the Apollo V (yes, 5) mission, a 38-second test burn was scheduled. It didn't happen.
- The conclusion:
  - the SERVICER program that controlled the factors in the descent turned off the engine BECAUSE…
  - it had concluded that the engine had failed BECAUSE…
  - even though there was a fudge factor to account for the fact that it takes time for the engine to start, THAT failed BECAUSE…
  - the Lunar Module's tanks were only partially pressurized

An Everyday Communications Foul-up

- Normal procedure: On arming, o
- several seconds before ignition.
- On LM-1 the control valve was suspected of being leaky, SO
- To prevent propellant getting into the engine too early (with explosive consequences), "the decision was made", shortly before flight, to delay arming the engine until the time of ignition, BUT
- The *real* reason the engine was slow to start was that propellant had further to travel to reach the engine, not because the tanks were less pressurized, AND
- "It would have been easy for us to adjust the parameter that controlled how long the delta-V monitor waited before testing the engine—but *nobody told us*."

Note, by the way, that no *person* made the decision.

http://klabs.org/history/apollo_11_alarms/eyles_2004/eyles_2004.htm

Nope, Nothing New Here

- Actual source code...

```
VRTSTART  TS  WCHVERT

# Page 801

    CAF TWO           # WCHPHASE = 2 ---> VERTICAL: P65,P66,P67
    TS  WCHPHOLD
    TS  WCHPHASE
    TC  BANKCALL      # TEMPORARY, I HOPE HOPE HOPE
    CADR  STOPRATE    # TEMPORARY, I HOPE HOPE HOPE
    TC  DOWNFLAG      # PERMIT X-AXIS OVERRIDE
    ADRES XOVINFLG
    TC  DOWNFLAG
    ADRES REDFLAG
    TCF VERTGUID
```

Source: http://lambda-the-ultimate.org/node/3522

http://code.google.com/p/virtualagc/source/browse/trunk/Luminary099/LUNAR_LANDING_GUIDANCE_EQUATIONS.s?r=258

Engineering Uses Heuristics

- Fallible, "fast and frugal" methods of solving problems, making decisions, accomplishing a task.

"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

Heuristic

"guideline"

"rule of thumb"

noun:
A *fallible* method for *solving a problem* or *making a decision*

- Examples:
  - "Plant your corn early!"
  - Pull on the handle, push on the plate.
  - Problems are cheaper to fix the earlier they're found.

Heuristic

adjective:
"serving to discover"

- Examples:
  - a heuristic *approach*
  - heuristic *guidewords*
  - heuristic *models*

Trigger Heuristics

- Ideas associated with an event or condition that help you recognize when it may be time to take an action or think in a particular way.
  - Like an alarm clock for a slumbering mind
  - When you notice that you don't have questions, ask "Why don't I have any questions?"
  - When you feel an emotion while testing, look into it.

Subtitle Heuristics

- Help you reframe an idea so you can see alternatives and bring out assumptions during a conversation.

No user would ever do that.

"No user *that I've thought of*, and *that I like*, would do that *on purpose*."

Which Is Why…

All is heuristic.

- Billy Vaughan Koen

Heuristics of Consistency ("this agrees with that"): *an important theme in oracles*

- **History:** The present version of the system *is consistent* with past versions of it.
- **Image:** The system *is consistent* with an image that the organization wants to project.
- **Comparable Products:** The system *is consistent* with comparable systems.
- **Claims:** The system *is consistent* with what important people say it's supposed to be.
- **User's Expectations:** The system *is consistent* with what users want.
- **Product:** Each element of the system is *consistent* with comparable elements in the same system.
- **Purpose:** The system *is consistent* with its purposes, both explicit and implicit.
- **Statutes:** The system *is consistent* with applicable laws.
- **Familiarity:** The system ***is not consistent*** with the pattern of any familiar problem.

Internalize this checklist, and you'll have testing ideas.

Heuristics: A Catch

We only learn about the limits of a heuristic solution when it fails.

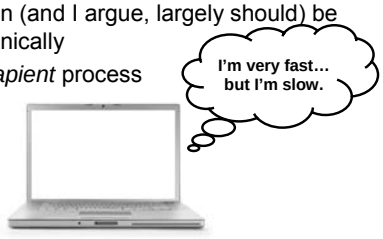
Heuristics Are Fallible

- Heuristics require *skilled* practitioners
- They're context-dependent
- They may contradict each other BUT
- Because they are *reasonable, low-cost* shortcuts, heuristics can present *more valuable* solutions for the present circumstances *because* they're less complete.
- They can substitute for complete and rigorous analysis.

"Heuristic reasoning is not regarded as final and strict but as provisional and plausible only, whose purpose is to discover the solution to the present problem."
- George Polya, *How to Solve It*

Testing Isn't Just *Checking*

- Checking is a process of confirming and verifying existing beliefs
  - Checking can (and I argue, largely should) be done mechanically
  - It is a *non-sapient* process



See http://www.developsense.com/2009/08/testing-vs-checking.html

What *IS* Checking?

- A *check* has three attributes
  - It requires an *observation*
  - The observation is linked to a *decision rule*
  - The observation and the rule can be applied

without sapience

Oh no! What Is *Sapience*?

- A sapient activity is one that requires a thinking human to perform
- A non-sapient activity can be performed by
  - a machine (quickly and precisely)
  - or by a human that has decided NOT to think (slowly and fallibly)
  - looks like machines win there, right?
- BUT our job is not merely to test for repeatability, but also for *adaptability and value*

These Guys Are COOL!

…but they are extensions of human capability, *not* replacements of it. They give us *mediated experience*.

These Guys Are COOL!

Humans invent them, design them, construct them, program them, launch them, direct them, control them, and decommission them.

Automation Can't…

Testing IS Exploring

- Testing as I see it is all about exploration, discovery, investigation, and learning
  - Testing can be assisted by machines, but can't be done by machines alone
  - It is a *sapient* process

See http://www.developsense.com/2009/08/testing-vs-checking.html

…and that's why people are *crucial*.

- Humans are variable, but also *adaptable*.
- Humans comprehend human value.
- Humans know how to *explore*.

Exploratory Skills and Tactics

- Modeling
- Resourcing
- Questioning
- Charter[illegible]
- [illegible]bserving
- Manipulating
- Collaborating
- Generating & Elaborating
- Overproduction
- Abandonment
- Recovery
- Refocusing
- Alternation
- Framing & Backtracking
- Conjecturing
- Recharging
- Reporting
- Tooling

OUT OF DATE
NEW VERSION
COMING SOON

"Exploratory Testing Dynamics"
James & Jonathan Bach
http://www.satisfice.com/articles/et-dynamics.pdf

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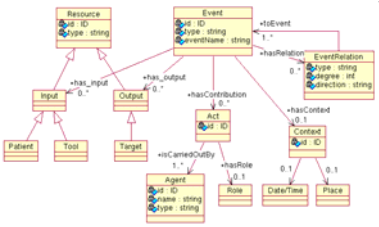
We're All Dealing With Complexity

- Modeling is the process of representing complex things with simpler things.

Modeling

- A simpler representation of a more complex idea, object, or system that helps you to understand, control, observe, or explore it.



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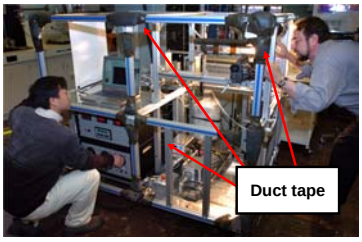
Resourcing

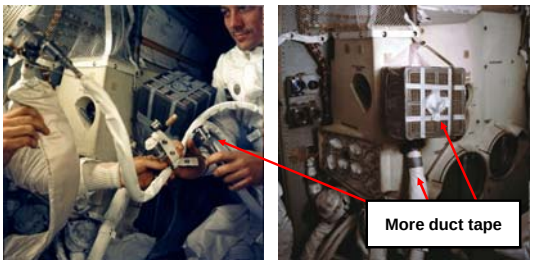
Sometimes we get all the funding, people, and equipment we need.

Resourcing



Sometimes we have to adapt our tools.

Resourcing



Sometimes we have to go with whatever's available at hand

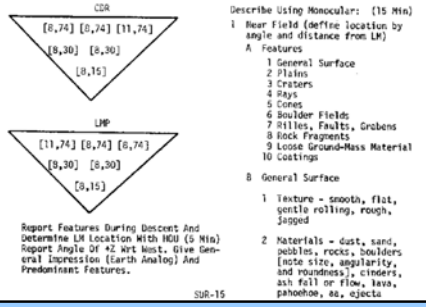
Chartering

- Chartering is the process of initiating and guiding exploration.
- How do we guide astronauts?
- How do we guide testers?
- With charters and skill, you can deal with
  - less supervision
  - less documentation
  - more challenging contexts

Guideword Heuristics

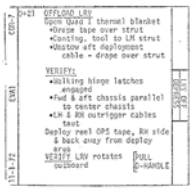
- Words or labels that help you access the full spectrum of your knowledge and experience as you analyze something.
- Often provided in the form of a *taxonomy*, a classification system in (typically) a hierarchical structure.
- Often provided as checklists

Guideword Heuristics for The Most Expensive Test Projects In History



A page from an Apollo 12 training manual.
http://history.nasa.gov/alsj/a12/A12Surf15.jpg

Concise Documentation



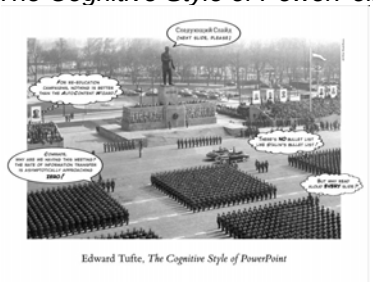
The Cuff Checklist

Plenty of Documentation ISN'T for Everyone

Some documentation is written and read with lots of information *missing*, for use by trained and skilled people.

Reporting

- Read *The Cognitive Style of PowerPoint*



Edward Tufte, *The Cognitive Style of PowerPoint*

Available at http://www.edwardtufte.com/tufte/books_pp

Review of Test Data Indicates Conservatism for Tile Penetration

- **The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data**
  - **Crater overpredicted penetration of tile coating significantly**
    - **Initial penetration to described by normal velocity**
      - Varies with volume/mass of projectile (e.g. 200ft/sec for 3cu. In)
  - **Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating**
    - Test results do show that it is possible at sufficient mass and velocity
  - **Conversely, once tile is penetrated SOFI can cause significant damage**
    - Minor variations in total energy (above penetration level) can cause significant tile damage
  - **Flight condition is significantly outside of test database**
    - Volume of ramp is 1920cu in vs 3 cu in for test

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Spray-On Foam Installation

Huh?

Buried the lead!

a 640:1 ratio!!

"foam that hit the wing"

Questions to Ask About Reports

- Who is your audience?
  - People you've never met will read your report.
  - Consider that executives may be novice readers in your domain
  - Jargon is very useful, but context-specific
- What's the summary?
  - What is the meaning of your observation?
  - What is the significance?
  - What's the worst thing that could happen?
- What lies *beyond* the summary?
  - If you don't want to get fooled, you'd better look far beyond the summary

More Questions About Reports

- Does “significant” mean “detectable” or “everybody dies”?
- Watch for the scope of the analysis
  - what’s in, what’s out?
- Watch for pronouns and vague words
  - example: “it works”
  - example: “loss of crew”, vs. DEATH
- Watch for units of measurement expressed inconsistently
  - aggregation is always tricky

To test is to compose, edit, narrate, and justify two parallel stories.

You must tell a story about the product...
…about how it failed, and how it *might* fail...
…in ways that matter to your various clients.

But you must also tell a story about testing...
…how you configured, operated and observed it…
…about what you haven’t tested, yet…
…or won’t test, at all…
…and about why what you did was good enough.

From Rapid Software Testing, James Bach & Michael Bolton
Course Notes: http://www.satisfice.com/rst.pdf

Two Key Questions

(for yourself or others, from Tufte)

What is the presenters's story?

Can you believe the presenter's story?

Shuttle Training

Not just simula*tors*, but simula*tions.*
Increasingly challenging non-routine scenarios.
800 practice landings, before the pilots do it for real.

Pilot Training

- Commercial (regional) airline pilots used to spend 2000 hours in in-flight training time; now as little as 300 hours
  - at the majors, 5,000 hours of in-flight experience is typical
- Training time can shorter because, with simulators, pilots can be put into extreme or emergency situations quickly
- New pilots are paired with senior pilots
- "The quality of training is what's crucial, not the raw numbers of hours in a candidate's logbook. From a passenger's point of view, you don't want the most *experienced* crew, you want the best *trained* crew."
- *Why isn't testing more like this?*

http://www.salon.com/tech/col/smith/2007/12/07/askthepilot256/
http://www.salon.com/tech/col/smith/2008/09/05/askthepilot289/

What is Leadership?

- Leaders both require and grant freedom and responsibility to optimize the quality of work
- Leaders don't blindly follow scripts
- Leaders must respond, flexibly and adaptably, to whatever complexity the situation presents
- A leader must observe keenly, learn rapidly, and decide (appropriately) quickly
- A leader must motivate, organize, innovate

These are exploratory, not scripted skills.

Normalization of Deviance

An antidote:
POSITIVE DEVIANCE

So You Want Process Improvement?

The Positive Deviance approach is

- an asset-based,
- problem-solving, and
- community-driven
- approach that
- enables the community
- to discover these successful behaviors and strategies and
- develop a plan of action
- to promote their adoption by all concerned.

Source: The Positive Deviance Initiative
http://www.positivedeviance.org/

Positive Deviance

Positive Deviance is based on the observation that

- in every community
- there are certain individuals or groups
- whose uncommon behaviors and strategies
- enable them to find better solutions to problems than their peers,
- while having access to the same resources and
- facing similar or worse challenges.

Source: The Positive Deviance Initiative
http://www.positivedeviance.org/

Positive? Deviant?

- Positive
  - "doing things right"
- Deviant
  - "engaging in behaviour that others do not"

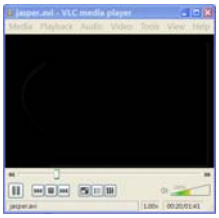
A tester is someone who knows that things can be different.
— Jerry Weinberg

PD isn't limited to testers, of course.
Anyone, everyone, can contribute.
Testers, as the antennae of the project, should be on the lookout for PD opportunities.

An Example of Positive Deviance

- Problem: Hospital staff wear disposable gowns that can become contaminated by contact with MRSA patients. The garbage gets full and overflows quickly, risking more contamination.

Enter Jasper Palmer



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Testing Is Strengthened By Diversity

- Educational experience
- Writing skill
- Cultural background
- Domain knowledge
- Temperament
- Gender
- Programming skill
- Testing experience
- Age
- Experience in the current culture
- Experience *outside of* the current culture

NASA's Mission

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  - To explore the Universe and search for life
  - To inspire the next generation of explorers... as only NASA can.

Testing's Mission

- Testing's mission is to pioneer the future in exploration, discovery, investigation, and learning (research).
- Development's mission statement:
  - To improve stuff here,
  - To extend stuff to there,
  - To find stuff beyond.
- Testing's vision statement:
  - To understand and protect our products
  - To explore the product and search for bugs
  - To inspire the next generation of explorers... as only testers can.