Testing: Design Validation & Data Gathering

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Jim Shaw:
Mechanical Engineer & Business Owner

Rolling Meadows, IL

Wheeling, IL

Lake Zurich, IL

mHUB

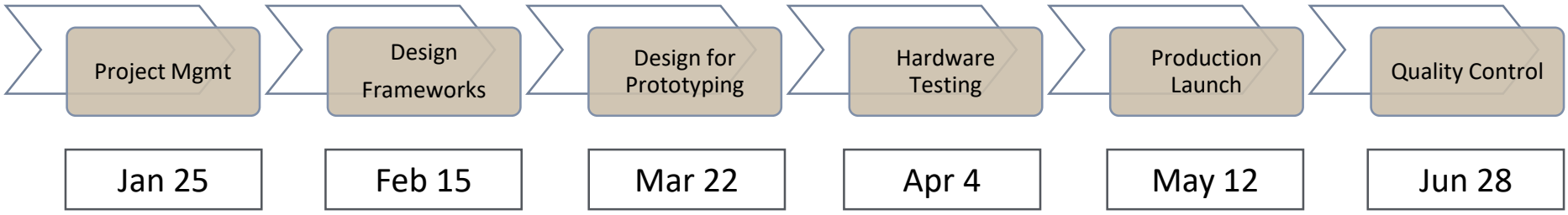
2002-2007
Missile Defense

2007-2011
Commercial Products

2011-2013
Automotive Aftermarket

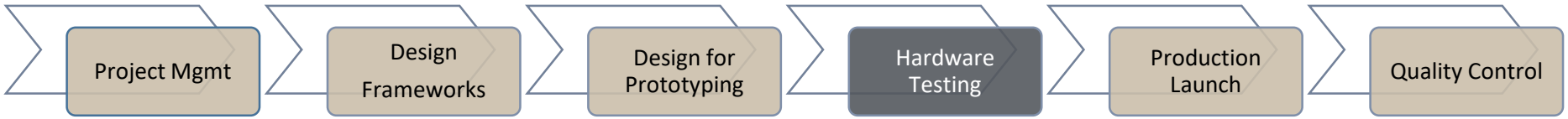
2013-now
CAD/CAE Training

mHUB Programming: Product Development



- Monthly Classes that cover the Product Development Process
- Introductory (January – June)
  - Align with the stages of your product
  - Correspond to funding milestones
- Advanced (July – December)
  - Deeper Dives into the core topics
  - Guest visits from Real Experts

Hardware Testing: Design Validation & Data Gathering

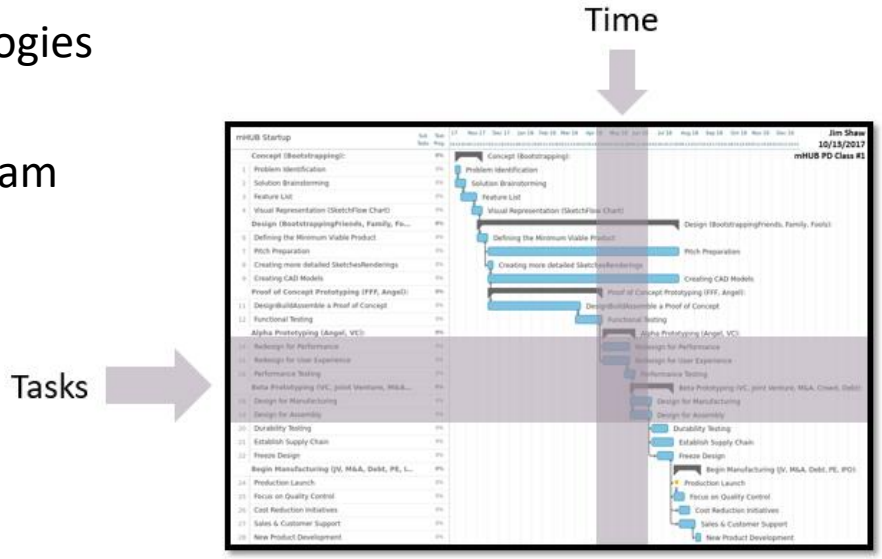


Today's Agenda

- Preparation/Project Management
- Testing Overview
  - Competitive Benchmarking
  - Performance
  - Durability
  - Environmental
  - Regulatory
  - Safety
- "Virtual Testing"
- Resources

Hardware Testing: Project Management

- How to prepare for “The Testing Phase”
  - Allocate time & resources in your Project Schedule
    - Expect it to fail, so budget for redesign
    - Risks = Greater potential to fail
      - Implementing New Technologies
      - Entering New Markets
      - Working on a Brand New Team
  - Allocate Fund$!
    - Multiple Prototypes
    - Engineering Oversight
    - 3Rd Party Service providers
    - Capital Investment
  - Create a Test Plan!



Hardware Testing:
The Big Picture

Sketch

Tools/Machines

Prototype

Test

Hardware Testing: The Test Plan

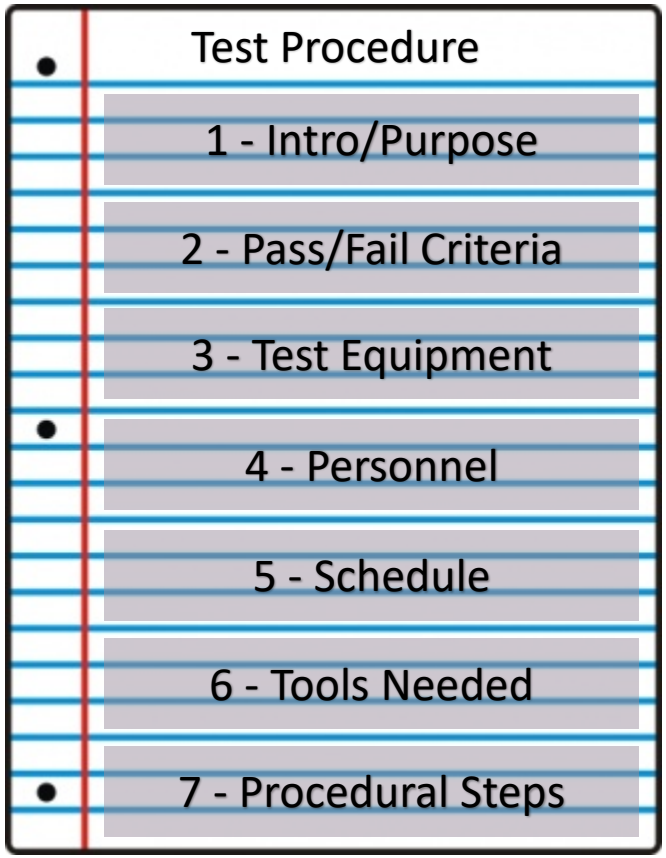
List (Spreadsheet) of all planned tests

1. What are you going to investigate
2. How are you going to investigate it
3. How are you going to interpret the data?

Description	QTY	Date	Pass/Fail
Waterproofness	3	Nov 2	✓
Shock Hazard	3	Nov 9	✓
Flammability	1	Nov 16	✓
Drop Test	3	Nov 29	✓
Life Test	10	Dec 1	✗

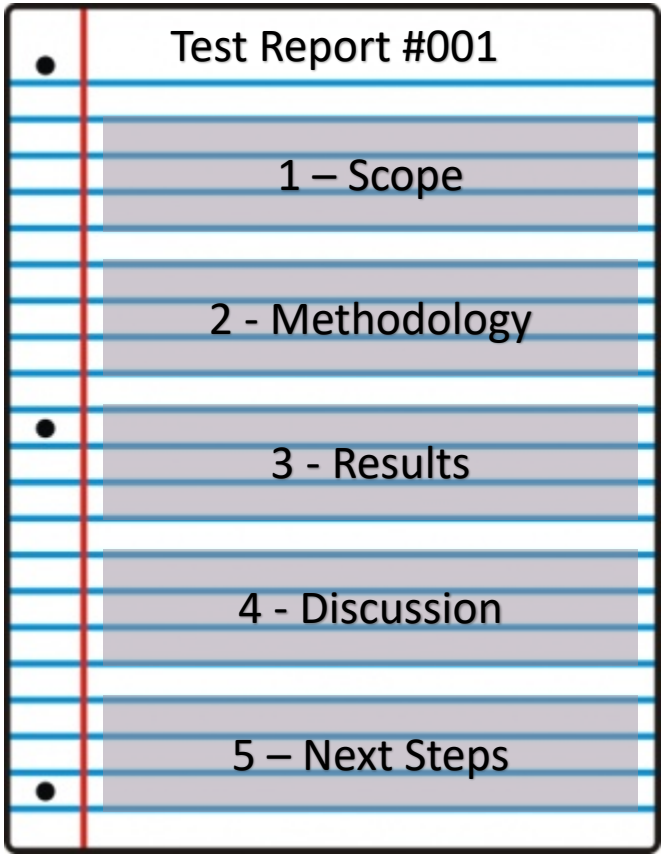
Hardware Testing:
The Test Procedure

1. What is the “Unit Under Test” (UUT), and why are we testing it?
2. What does the UUT need to do to pass?
3. Equipment, Calibration Data, etc.
4. Who is involved/has responsibility
5. Start? End?
6. Disassembly, Measurement, Fine tuning/Tweaking.
7. Do this, then that.



Hardware Testing: The Test Report

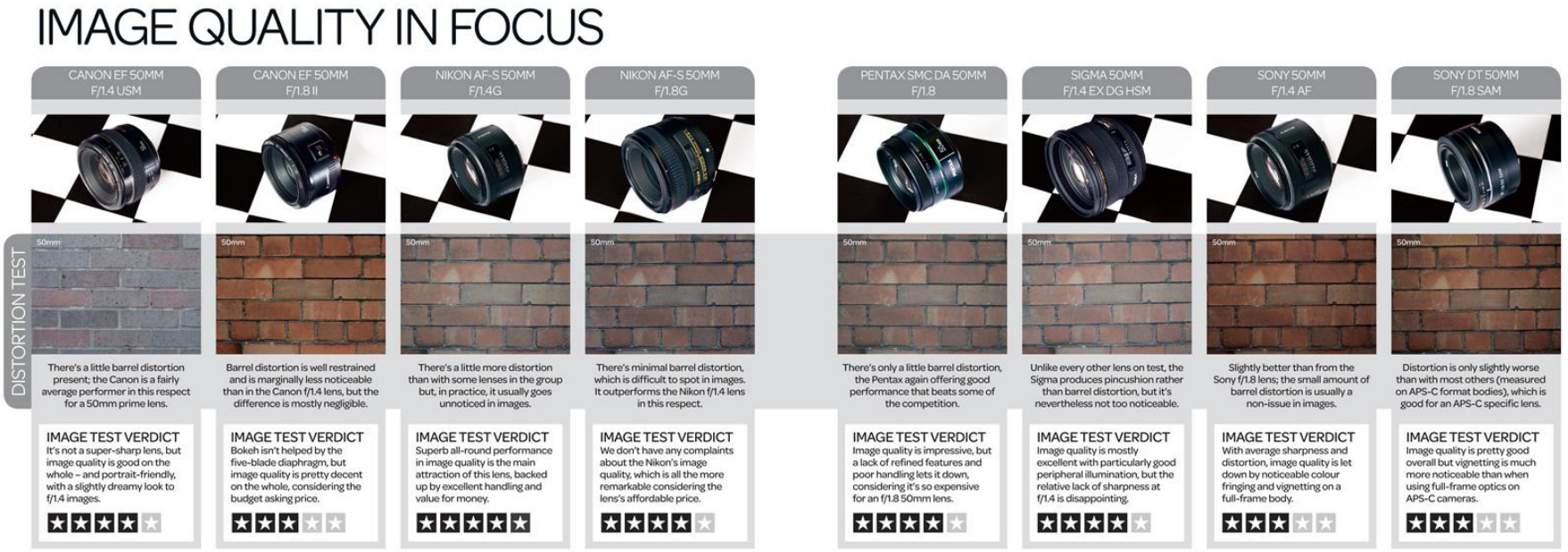
1. What did we just do?
2. How did we do it?
3. How did we do?
4. Conversational discussion about whether it passed/failed and why, and what was learned.
5. Dependencies, Next Steps



This is the most important part!!

Hardware Testing: Competitive Benchmarking

- Engineers can do anything with enough TIME, MONEY
- Often, performance is a relative measurement
- Use competitors to establish your Test Pass/Fail Criteria



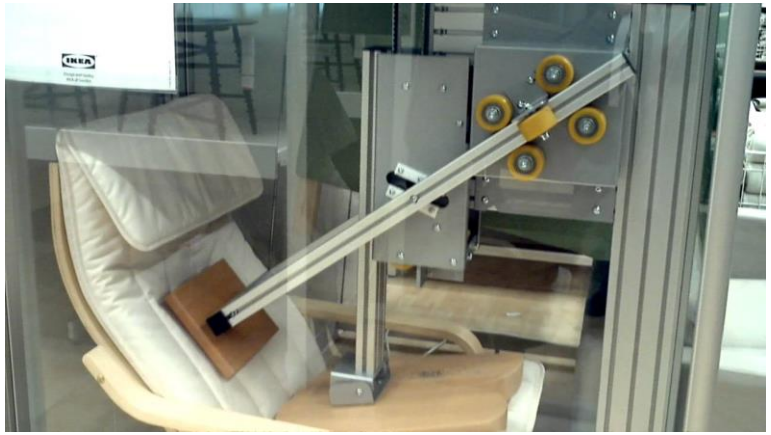
Hardware Testing: Performance

- Validate the features you are claiming, under normal conditions.
- Things to Measure:
  - Speed
  - Weight
  - Ease of use
  - Medical Efficacy
  - Electronic performance
    - Sensor Accuracy
    - False Alarm Rate
    - Repeatability
  - Compatibility
- Directly relates to:
  - Your Product's Value
  - Market Positioning


GM Facing Class Action Lawsuit Over C7 Corvette Z06's Cooling Issues

Hardware Testing: Durability

- Also known as “Accelerated Life Testing”
- Pushes your product to the limit, without waiting
- Things to Measure:
  - Performance, Before
  - Performance, After
  - Difference in performance
- Lifetime = # Cycles
  - Mechanical
  - Thermal
  - Electrical/Power
- Used to determine the Warranty

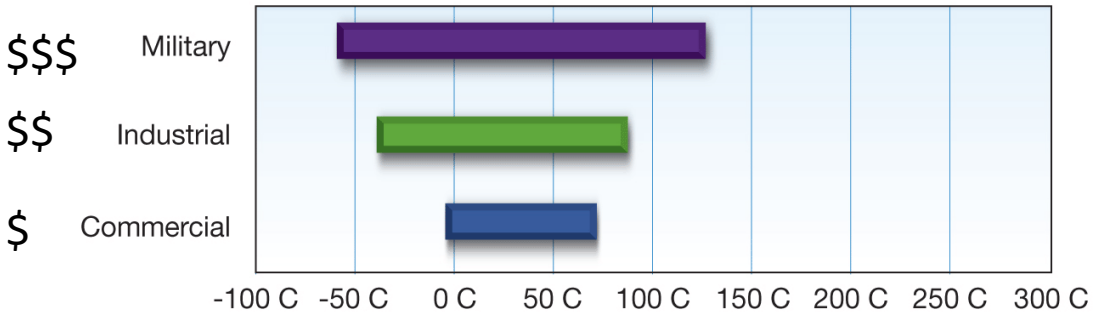


The life of electronics is directly related to their average operating temperature.

Hardware Testing: Environmental Testing

- Waterproofness
- Salt, Sand, Humidity
- Drop Test (Shipping & Handling)
- Extreme Temperature Ranges

Temperature Ranges for Electronics:



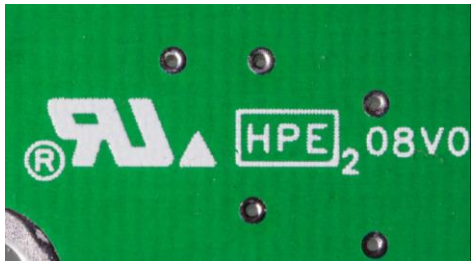
Hardware Testing: Safety

Company	Role	Mark
UL (Underwriters Laboratories)	Publish safety standards Test in accordance with standards Certify to the standards	
CSA (Canadian Standards Association)	Similar to UL in Canada, now North America	
ETL (Intertek)	Test in accordance with standards Certify to the standards	
CE (European health, safety, and environmental requirements)	Publish standards Does NOT test or list "self certifying"	
Demko/Semko/VDE EU country marks	Test in accordance with standards Certify to the standards	
CCC (Chinese Safety Mark)	Regulatory mark Test/certify with Authorized Certification Body (ACB)	

Courtesy of mHUB Mentor, Deb Brown

Hardware Testing: UL and Requirements

- UL: publishes safety standards, tests to those standards, and authorized use of a Listed/Classified/Recognized mark to the products.
- UL does NOT enforce standards! Local codes or agencies (i.e. building inspector, fire marshal) require that products are tested and marked by ANY listing agency. Typically UL, CSA or ETL are accepted.
- Local codes or agencies may require UL standards, but CSA/ETL can test and list per a UL standard
- Large stores (Home Depot/Target) may also require products they sell to have a Mark to limit their liability. But for home use, you are free to buy products without UL
- UL has 3 different levels of testing and marking: LISTED, CLASSIFIED, and RECOGNIZED COMPONENT

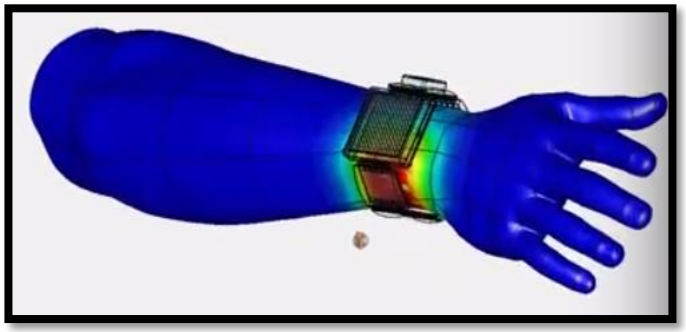


Courtesy of mHUB Mentor, Deb Brown

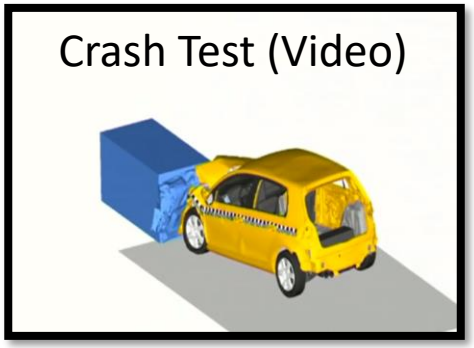
Testing:
Virtual Testing

- AKA “Computer Simulation”
- Can replace expensive Testing in a wide range of physics
- Shortens the iterative design process

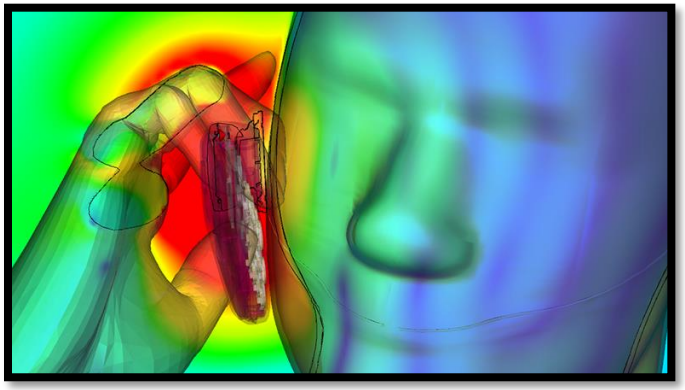
Thermal Analysis of Smartwatch



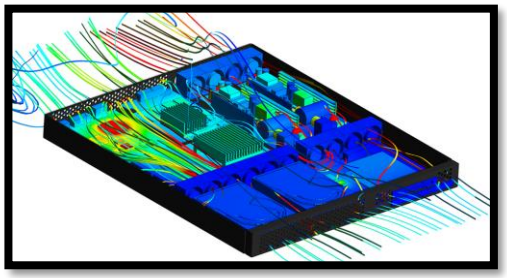
Crash Test (Video)



Electromagnetic Energy from a Cell Phone



Electronics Cooling



Testing: mHUB Resources

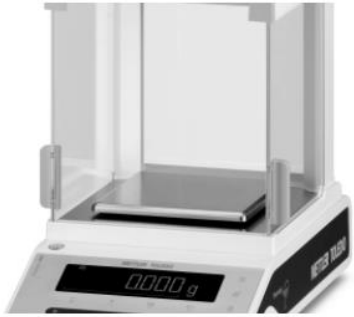
- List of Machines/Capabilities:

Digital Force Gauge

Environmental Test Chamber

Granite Surface Height Gauge

Motorized Stand



Precision Microgram

Radio Frequency (RF) Chamber

Stereo Microscope

Tension Compressor Tester

Testing: mHUB Resources

- Thank You!

- Next Class: May 17 Designing for Product Launch Success!!