The Future of NDT and the Upcoming Paradigm Shift

David Piotrowski
Delta TechOps - Principal Engineer
ASNT Level III – UT, ET, PT

Alex Melton
Product Line Manager
Delta TechOps - NDT Programs
Purpose

- Material properties – Bossi (2012)
  - Overtemp microstructure in turbine blades.
  - Grinding burns through chrome.
  - Bond strength.
- Technology is easy part; Persuasion difficult. WHY?
- Comfort-zone mindset.
- Traditional, established NDT protocols don’t fit new technologies (i.e., ‘box’).
  - Defect definition.
  - Calibration.
  - Validation (POD).
  - Training & Qualification.
  - Guidance issues.
  - Ownership of problems.
- We must adapt our protocols in order to utilize the next generation of NDT.

We must alter our thinking to move forward.
Comfort-zone Mindset

THE 2% MINDSET

2% of the population

98% of the population

Embracing the unknown

Excitement

Liking change

Living without limits

Abundance

Act in spite of fear

Going for your dreams

Confidence

Exploring new things

Choosing happiness

Fulfillment

2% of the population

Being like everyone else

Insecure

Surviving

Fear

Just getting by

A dull life

Play it safe

Procrastination

Regret

Settling for less

Getting the most out of life

Beautiful Mind in Chaos

Courtesy: imgur.com
Issue #1 – Defect Definition

- Hypnotized into traditional defect definitions => crack, corrosion, etc..
  - Increased use of composites brings new defect types.
    - Industry effort to educate, inform community.
  - Strive for fuel-efficiency drives increased need for vigilance.
    - Hotter engines, thinner materials.
    - Heat damage in composites, landing gear parts.
    - OEM designs assume ability for quality.

- Desire for MTC savings means part ‘out’ longer.
- PMA parts = meet dimensional, visual = good to go.
- Now defects include ‘overtemp’ microstructure, disoriented grains (Directionally solidified alloys), grinding burns, carbide precipitate clustering, resonance modes.
- New technologies capable of finding of finding these defects (Barkhausen Noise, PCRT, etc.).
- Fly ‘excrement’ in pepper?

Industry now can go after non-traditional defects.
Resonant Modes - Important

PMA parts ‘pick and choose’ resonant mode verification.
Superalloys – microstructure defects

- UCSB – Modeling work
  - Estimate elastic constants

- Affects Modulus
  - Can be detected with PCRT

- Recent finding of single crystal turbine blade with issues
  - Solidification flowlines


Microstructure ‘errors’ can affect part life.
Issue #2 - Calibration

• Years of “false calibration” ingrained into industry protocol.
  – FBH/EDM notch not representative of actual defect you are looking for.
  – 2006 Bode/Piotrowski paper – EDM Notch/Manufactured crack/Real crack.
    • Detectability difference!

• OEM Guidance is key =>
  – What do we need to find?

• OEM proprietary or “sole source”
  – Faux cost hurdle.

• EX: CVM Sensors =>
  “Continuity check” vs “calibration with known defect”.

• EX: Barkhausen Noise for heat damage through chrome.
  – Slow implementation due to lack of ref. std. (Conflict between Boeing and SAE document).
    • Now in Boeing NDT Manuals.

What do we need to find?
Issue #3 – Validation/POD

- How to apply validation criteria developed for legacy methods to novel methods?
- Sonic IR work (Sandia/Wayne State/Siemens/FTT).
- Remote vision – high resolution borescopes using traditional optics standards; how to reconcile?
- Barkhausen Noise – Grinding burns, but not yet cracked?
- MAPOD (Model Assisted Probability of Detection) efforts may help.
- Not crack length, but ‘affected area’?
- Signal-to-Noise is the key!

Capable of finding defects – what now?
Sandia attempted POD, Gage R&R study for OT.
Issue #4 – Personnel/Training

• Legacy Training and qualification schemes may not adequately address emerging, novel methods.

• Traditional organizational hierarchies were developed with six principal methods (ET, MT, PT, UT, RT & IR/TIR) in mind.
  – Inspection vs Mtc vs Unskilled.
  – Level I Special, Level I, Level II.

• Divergent skill requirements => No skill or ‘expert’.
  – Direct reading vs ‘blip on screen’ vs ‘Phased Array scan evaluation’.
  – Workforce computer proficiency.

• How does something like PCRT fit into the scheme (Operator’s see only red/green, lots of behind the curtain detail & engineering rigor)?

• ATA 105 has some language around “Emerging NDT” – but aimed at Level III qualification.

• NAS 410 has clear ‘Direct read guidance’, but this guidance was written in the context of traditional methods with simplified instruments in mind.

• Human Factor mitigation; More automation; Recognition Software.

Training, quals may need to be overhauled.
easyJet develops flying robots to inspect aircraft (BBC, 5/7/14)

easyJet is developing drones to inspect its fleet of Airbus aircraft, and may introduce the flying maintenance robots as early as next year.

easyJet Head of Engineering:
The drones are fitted with high definition video cameras, but can also use lasers to scan the outside of the aircraft. "We could zoom [the laser scanner] up and down the aircraft and map the surface," he said. "If we've mapped the aeroplane we can have a complete history of its full life."
Issue #5 – Guidance

• FAA SHM program/SAE SHM working group/ Committee K.

• Decrease in OEM participation in industry committees.
  – Intellectual Property (IP) concerns or “sole source” from OEM.
  – PP OEM Participation in NDT Forum.
  – Reduction in collaboration.
    • Aloha, SUX, PNS events all promoted industry collaboration on common challenges; NOW = “I’LL DO MY THING YOU DO YOURS”.

• Conflicts in industry => How do we resolve disagreements?
  – Resource constraints often lead to technology racing ahead of guidance.

• Records management & Data Archiving (ET/UT C-Scan imaging, Radiography, IR, etc.).
  – How do we leverage the capabilities?
  – How do we handle the limitations, liabilities?
  – Previous scans reviewed against current scans.
    • easyJet visual drones.
    • MAUS C-scan/ Resonance/Array Scans.
    • Process Compensated Resonance Testing (PCRT).

• OEM/FAA typically lead efforts – but not exclusive.

Path must be paved in order to progress.
PROFESSIONALISM
That's not my job.
**Issue #6 Ownership of Problems**

- Power plant OEM’s seeking greater share of life cycle product support (e.g. GE, Pratt, RR MRO’s & Partner MRO’s) leaving operators with limited options and increased cost.
  - Less willingness to partner, even participate in Industry Meetings.
  - Customer vs Competitor quandary.
  - Sign support contract at initial purchase or else.

- Airframe less pronounced, but Airbus, Boeing, and others are entering into strategic commercial partnerships with select MRO’s.

- Airlines are stuck with ‘events’ and ‘consequences’ both financially, and technically (ATB, UER, ODI etc.).

- Airframe vs Engine philosophy.

- Components now being examined.

- Casting house issues => before machining and OEM assembly!

- How to deal with increasingly fragmented product support environment via Sub- contractors, sub to sub etc..
  - STC issues
  - Second and third tier suppliers

**United we stand, divided we fall?**
Summary

• Future is here! Innovative, “game-changing” technologies.

• Comfort-zone mindset.

• Traditional, established NDT protocols don’t fit new technologies.
  – Defect definition/Calibration/Validation (POD) Training & Qualification.
  – Guidance issues/Ownership of problems.

• We must adapt or be left behind.

“Intelligence is the ability to adapt to change.”

Stephen Hawking
Questions?