The importance of measurement accuracy and the financial impact it can have on the bottom line

Maximizing top and bottom line by protecting the most valuable assets
What Senior Managers Care About

- Meeting shareholder expectations
  - Top and bottom lines

- TTM Pricing
- Competitive differentiators

- R&D

- MRKT

- Sales

- Support

- Mfg

- TST Eng

- Innovate products
- Schedule
- Component 2nd source
- Design margins
- Reliability
- Budgets

- Warranty costs
- Customer downtime
- Customer satisfaction

- Yields
- Throughput
- Quality

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Do they care about calibration?

Do they care about the impact a lack of calibration will have on their business?

Equipment uncertainties may never surface as a root cause of missing business objectives.

Calibration is looked upon as a maintenance cost of the equipment. But seldom are linkages made between measurement accuracy and meeting business objectives.
Investing in instruments to validate designs and manufacturing processes

Test equipment and associated tests are one of the highest costs to an organization
Get the most out of your design cycle. There’s a reason why investments are made to obtain the best possible measurement solution.

Engineering will go through a laborious decision-making process to chose state-of-the-art technology. Go to market quickly with lowest costs and highest value solution.

Yet, they’re not always involved in how their investment are being maintained.
Why Calibrate?

Fact....

- All measurement processes are accompanied by errors and uncertainties and they cannot be eliminated

So....

- Calibration quantifies and controls the errors or uncertainties of the measurement processes to an "acceptable level"
Definitions depend on who you ask. Metrologist, engineering, quality, P&L managers, purchasing...

Is it the measurement of instrument performance of all warranted specifications, for all options, consistently every time?

Or, is the definition of calibration and standards left up to interpretation - whatever is most convenient depending on supplier capabilities and capacity and customer budget?

I trust the supplier, what’s the TAT and price?

Who manages the risks and assesses the impact?

There are standards to close the loops:

Z540.3
So Why Do We Test……

- To measure the health of the process
- To reduce risk of variability
- To identify problems

Risk

Meet spec

Verify design

Ship product that works

Warranty cost

Support
Two Types of Test Errors Increase Testing Costs

<table>
<thead>
<tr>
<th>True state of product</th>
<th>Test outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Fail</td>
</tr>
<tr>
<td></td>
<td>Increases repair costs</td>
</tr>
<tr>
<td>Bad</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Increases warranty costs</td>
</tr>
</tbody>
</table>
Cost and Delays to Find Repair Defect
False pass and fail

- The part itself $X$
- At sub-assembly $10X$
- At final assembly $100X$
- At the dealer/distributor $1,000X$
- At the customer $10,000X$

Risk

Meet spec

Verify design

Ship product that works

Warranty cost

Design
Validation
Manufacturing
Support

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Product Lifecycles in R&D and Production

- **R&D investment**
  - Spec defined
  - Test strategy
  - Test HW and SW dev

- **Production ramp up**
  - Test coverage
  - Test repeatability
  - Test optimization

- **Making money**
  - Test time
  - Yield

### Graph
- Revenue
  - $0
- Time

**Agilent Technologies**

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Senior Managers Care About Accelerating the product lifecycles in R&D and production

What is the value of a product getting to market faster?

- Less R&D investment
  - ✔ Common test HW&SW measurement blocks

- Faster ramp up
  - ✔ Distributed test strategy
  - ✔ Process centric test

- More money sooner
  - ✔ Maximize utilization
  - ✔ Diagnostic aids

Revenue

Time

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Senior Manager Care About
Product lifecycles and the costs of losing a day

What are the costs of a delayed product to market?

- Spec creep
- No test HW&SW reuse
- Re-designs

Greater R&D investment

- Poor test definition
- Independent test steps
- Designs still in flux
- Bone piles?

Delayed production ramp up

- Poor coverage, poor yield
- Poor utilization
- Failures in the field?

Less revenue

How much is dependent on test equipment?

Assumptions are made that TE is performing according to OEM specs.

Are there any linkages to the above?

Revenue

$0

Time
The Potential Cost of Improperly Maintained Equipment – It’s All About the Risk

<table>
<thead>
<tr>
<th>Risks</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTM delays</td>
<td>Cost of opportunity</td>
</tr>
<tr>
<td>Design cycle</td>
<td>Unnecessary design turns, over design, under design</td>
</tr>
<tr>
<td>Components</td>
<td>Cost of single sourcing</td>
</tr>
<tr>
<td>Design margins</td>
<td>Market share, lower price; competitive differentiators</td>
</tr>
<tr>
<td>Bone piles</td>
<td>Productivity in manufacturing</td>
</tr>
<tr>
<td>Production delays</td>
<td>Delivery penalties</td>
</tr>
<tr>
<td>False pass in mfg; field defects</td>
<td>Warranty costs, field support, customer satisfaction</td>
</tr>
</tbody>
</table>
High Risk: Examples

- Food safety
- Nuclear facility
- Aerospace
- Construction safety
Are end users getting what they expect and need?

- TAT and price are easy to measure

Are suppliers cutting corners to meet TAT and budgets?

- Breadth of functions and the number of measurement points
- Adequate calibration standards (capital required to keep up with technology)
- Automated calibration software complying with OEM specifications
- Rigor of quality control
- Scope of accreditation/audits

Price erosion = margin erosion making it difficult for suppliers to invest in new technology to obtain and maintain capabilities
Are the R&D and production engineers aware of the risks with regards to how their investment is being looked after? Why take the risk...

- Decisions to save $200 can render $100,000 investment to something worth much less – buy lesser product and save much more during the buying process.

- Decision not to calibrate or save <1% of cost of equipment on lower quality calibration may affect measurement capabilities and impact business results.

<table>
<thead>
<tr>
<th>Capex</th>
<th>$100K</th>
<th>Senior mgmt approval required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration</td>
<td>$500-1K</td>
<td>1% of test equipment cost</td>
</tr>
</tbody>
</table>

$200 savings relative to OEM cal (0.2% of instrument cost)
Business success depends on accuracy and uncertainties throughout the product life cycle.

Cost of calibration is insignificant relative to cost of asset.

Impact of inaccuracies on engineering and manufacturing are not always known unless major problems occur.

Is enough importance (budget/resources) placed on maintenance programs to protect the investment and manage risks?

Not all calibrations are equal. How much faith do you put into a sticker and a certificate – do you exercise due diligence in selecting suppliers?

Are the right stakeholders involved in the maintenance process to protect their investments and manage risks?
Cost savings can be achieved in many other ways while managing risks:

- Properly managed cal cycles
- Asset management – increase asset utilization, capex avoidance
- Education: engineers, technologist and technicians need to be aligned with measurement techniques
- Rental cost reduction (reduce downtime with better TAT)
- Increase competencies – repair cost avoidance
- DFX, lean, common platforms, automation
- Short-term rentals for peak production periods
Thank You
(Actual equations from Mike Dobbert’s NCSLI 2007 paper!)