Design for manufacture and inspection

Designing for today's manufacturing process

What does design have to do with anything?

The goals:

- Reduced manufacturing costs
- Improved quality
- Uncomplicated manufacture
- Improved product performance

The rules:

- Design for the manufacturing process
  - The designer should be familiar with the manufacturing process
- Design compatible with inspection process

Market globalisation

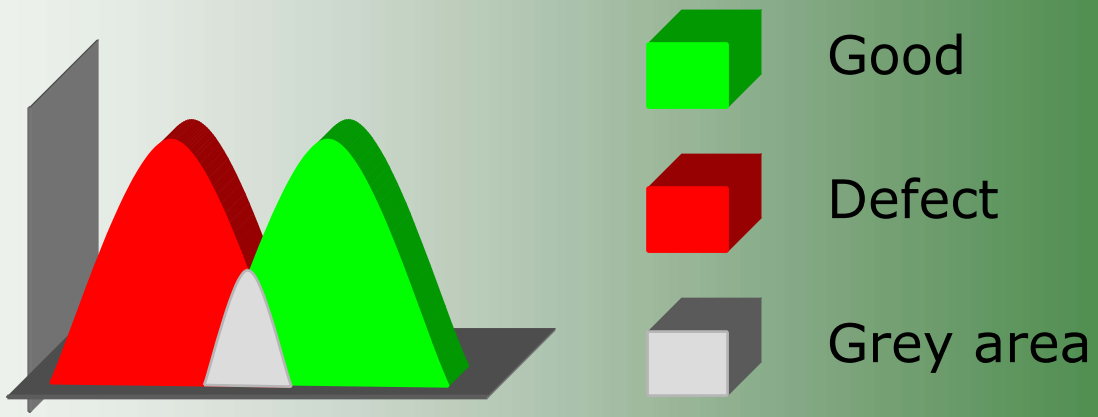
- Manufacturing in a global market
  - Design and manufacture is not always performed in the same location
- Design has become detached from the manufacturing process
  - Designers are unfamiliar with the manufacturing process
- Quality of product often suffers
  - Cost of manufacture compromises quality

Manual vs automated inspection

- Manual inspection:
  - Tolerant to bad design ✓
  - Poor coverage ✗
  - Judgmental ✗
  - Time consuming and costly ✗
- Automated inspection:
  - High false calls due to bad design ✗
  - Up to 100% coverage ✓
  - Pre-defined rules ✓
  - Fast and cost effective ✓

The grey area

- Automation is the solution and the problem
  - Pre-defined rules can be inflexible
  - Difficult to separate borderline defects, the grey area



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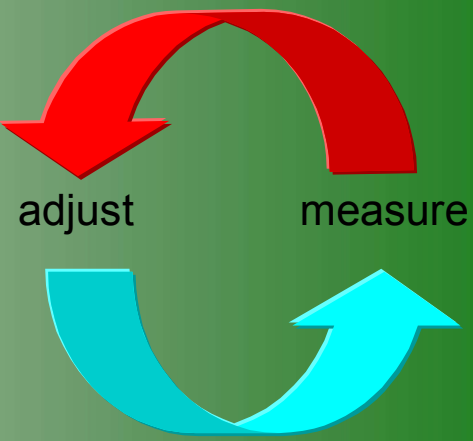
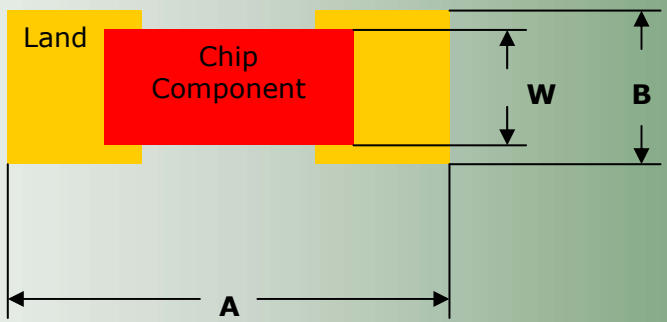
Automated inspection: the solution

- Zero defect manufacturing?
  - Nice to have but an unrealistic goal
- Automated inspection provides a window on the process
- Measure and adjust
  - Process feedback
- Design improvements complement process improvement
  - Reduce variability in the process



The perfect solder joint

- What makes the perfect solder joint?
  - Symmetrical & well proportioned lands
  - Sufficient, not excessive, good quality solder paste
  - Clean contact areas
  - Optimum oven profiles
- Land design is often overlooked
  - Optimising can reduce process variability



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Design for manufacture

- Compatibility with process
  - Can the product be made?
- Land design
  - Guidelines published by component manufactures are frequently overlooked
- Commonality between products
  - Standardise design rules to simplify line set-up
- Dual sourcing
  - Ensure components are readily available
  - Avoid components with unique functionality where possible

Design for inspection

- Land design
  - Follow manufactures guidelines
  - Mirror shape and size to equalise surface tensions
  - Maintain consistency between designs
- Package selection
  - Where possible, select packages compatible with inspection technology
- PCB colour
  - Improve contrast between components and substrate
- Layout
  - Avoid placing small components in shadow of others
  - Maintain clearances to reduce avoidable defects
  - Consider track entry points and clearances

The case:

- For this case study, a Japanese manufacturer in the automotive industry has been chosen
- They introduced AOI in two phases to a high volume production process
- Their overall target is sub 10 PPM

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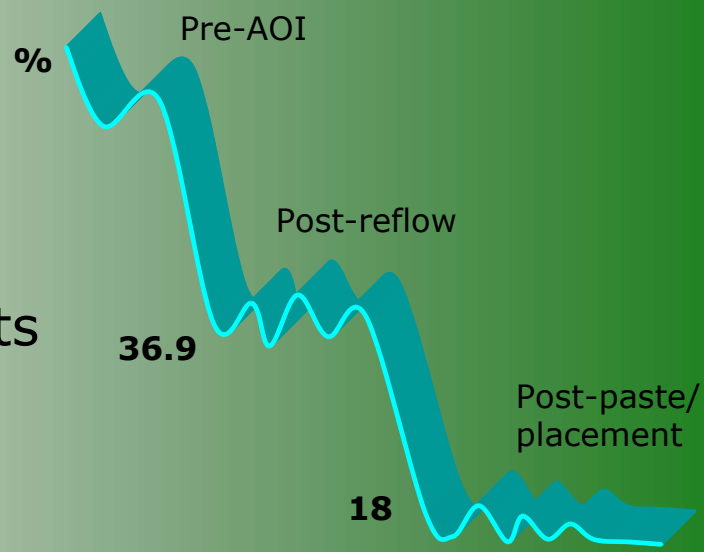
The case: design for inspection

- Implementation
  - Post re-flow AOI to analyse total process
- Optimisation
  - Process improvement
  - Design changes for improved repeatability
  - Simplification of inspection library
- Fine tuning
  - Post-paste and placement AOI added
  - Greater control over process
  - Further improvements to repeatability

The case: results

- Pre-AOI
  - Defect rate measured in %
- Post-reflow
  - Process & design improvements
  - PPM rate of 36.9 achieved
- Post-paste/placement
  - Fine tuning of process and design
  - 18 PPM achieved, continues to fall



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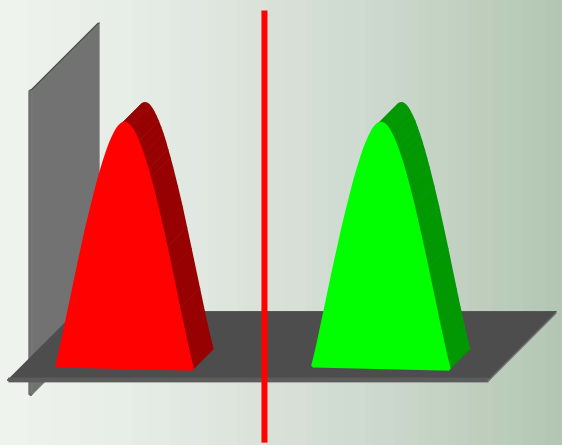
The case: key to success

- Near perfection
  - A more stable process results in lower PPM rates
  - Design the product to suit the process
  - Separate the acceptable from the defective, remove the grey area



Good

Defect

Grey area

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Who wins?

- The manufacturer
  - Improved yields result in less rework and scrap
  - Increased throughput provides more production capacity
  - Reduced ICT dependency
  - Fewer returns
  - Improved market reputation
- The customer/end user
  - Reduced field failures
  - Extended product life

The conclusion

- Design for inspection is just as important as design for manufacture
- The perfect production process does not exist, but it is possible to get extremely close

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