

# *Why Test?*



*Experts In Limited Access Testing*



## *Why Test? Agenda*

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- *Objective: Make you familiar with reasons to test and help identify opportunities.*
- *Types of Acculogic Test Systems*
- *Manufacturing Process, and what drives test and inspection*
- *Various types of test and inspection and pros and cons of each*
- *A brief economic analysis example to show payback of test*



**7000 Series MDA**



**Inline Scorpion**



**Flying Scorpion**



**Sprint 4510**

# *The Manufacturing Process*



*Experts In Limited Access Testing*

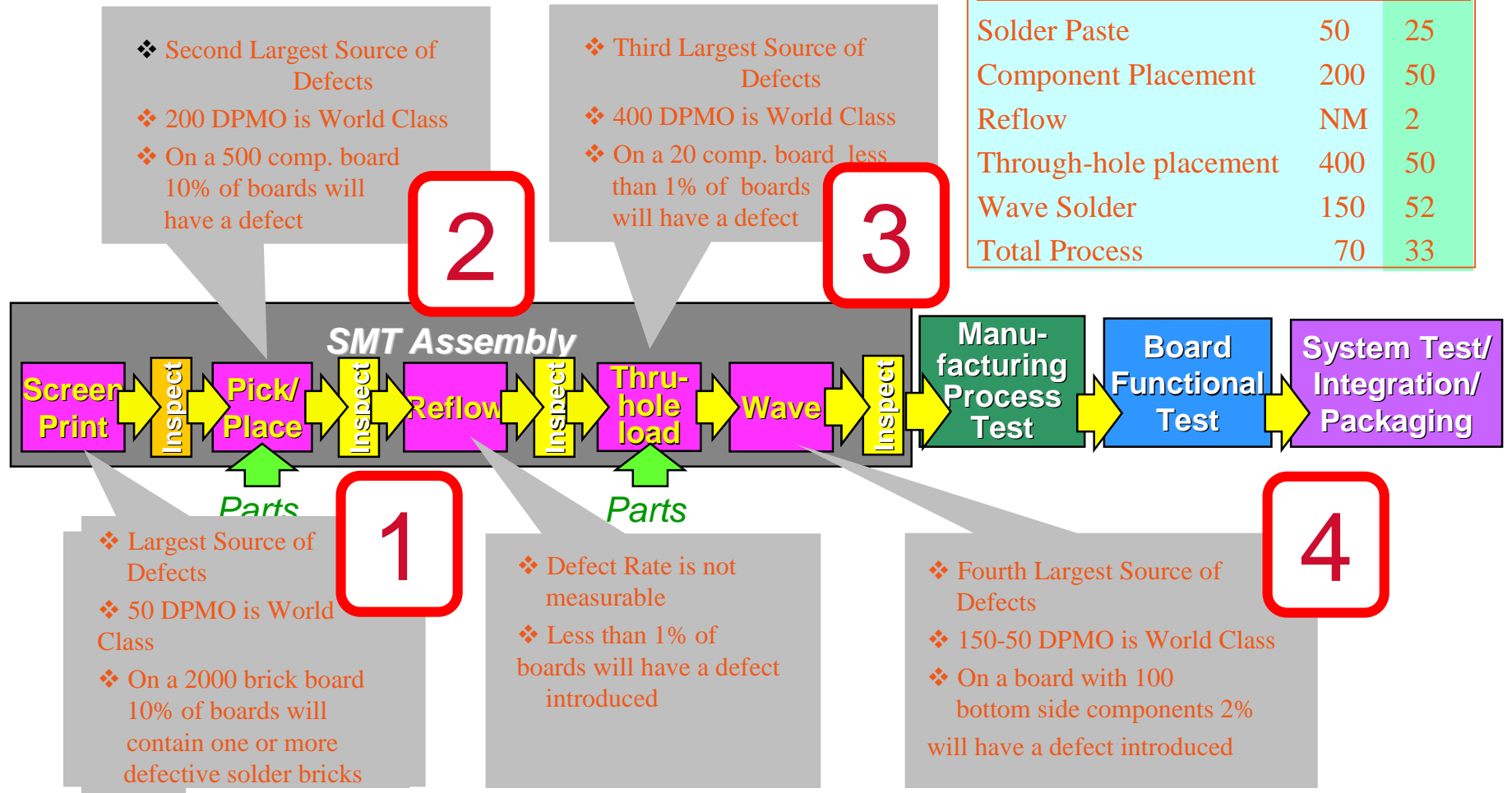


## Defects Arriving in Test Come From 4 Main Process Sources

### Best-In-Class Mfg Defect Survey Results

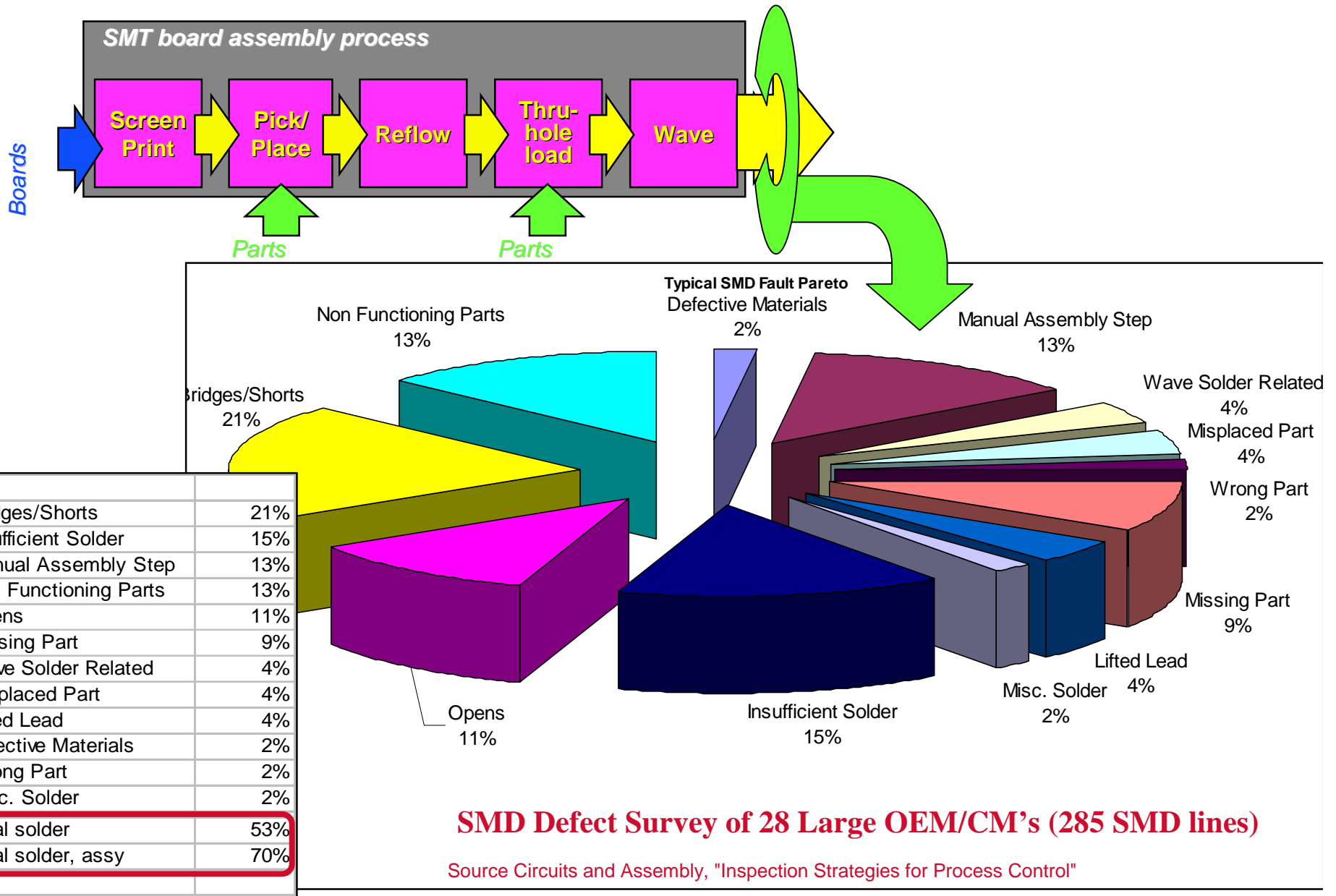
**Ex: PC Motherboard: 500 comps, 2000 solder conn**

Ceeris Benchmark Data	DPM	DPM
Solder Paste	50	25
Component Placement	200	50
Reflow	NM	2
Through-hole placement	400	50
Wave Solder	150	52
Total Process	70	33

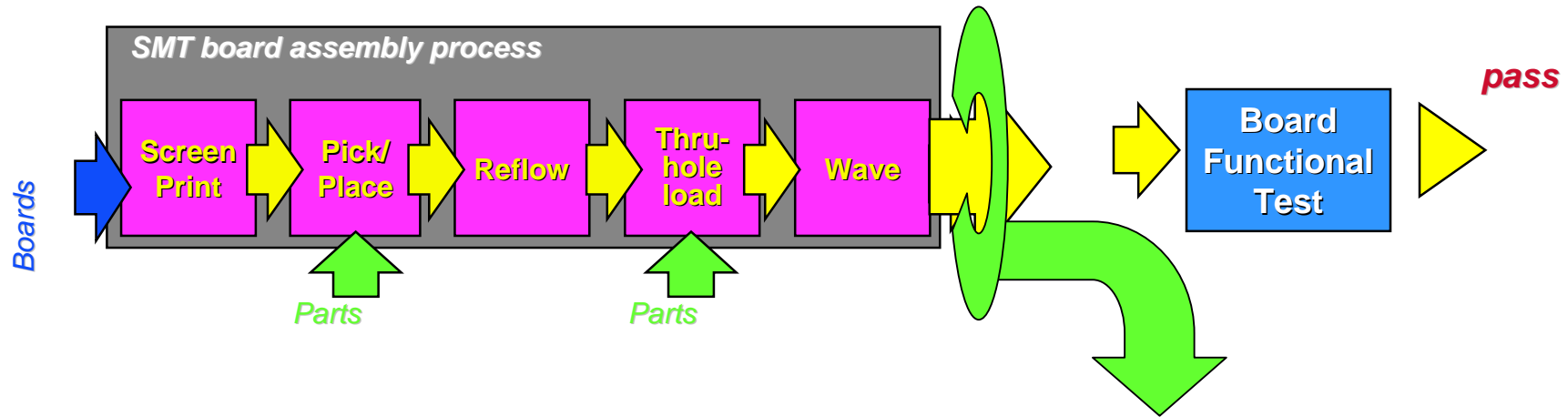


**Best in Class results not collectively achievable in real world, typical best results are 2x-5x**

**Typical Manufacturing Faults are Overwhelmingly Process Faults!**



## Scenario One –right to Functional



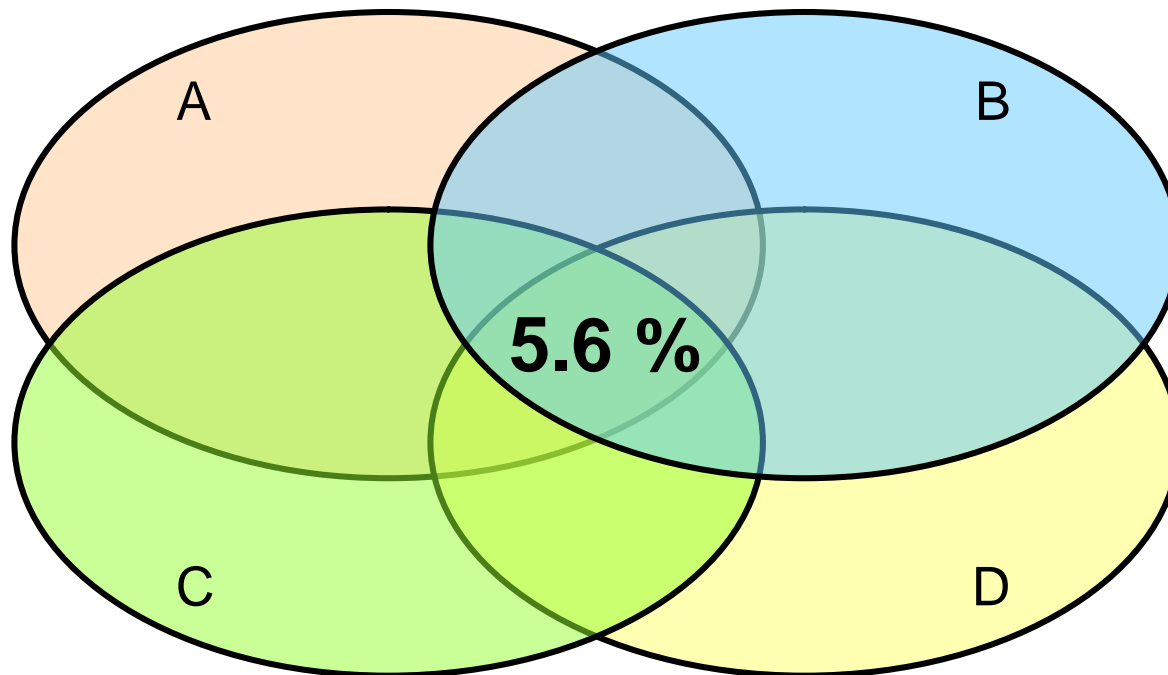
- *Problem with this approach:*
- *Low yields going into Functional*
- *Higher labor rates, expensive troubleshooting*
- *Poor diagnostics*
- *One fault at a time*
- *Many passes required*
- *Bottle neck at functional*

**SMD Defect Survey of 28 Large OEM/CM's (285 SMD lines)**

Source Circuits and Assembly, "Inspection Strategies for Process Control"

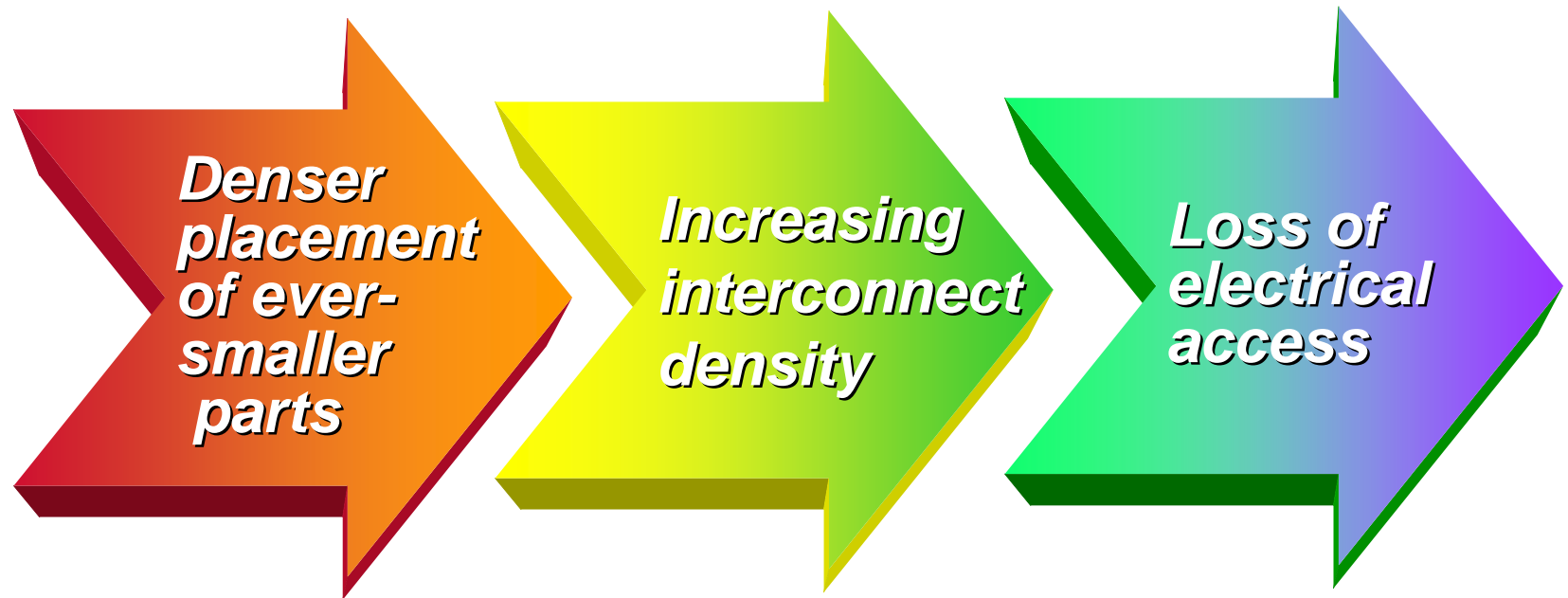
*Human inspection is unreliable and inconsistent*

Percent agreement between 4 inspectors on the same board set :



Human inspection at is not reliable and with increasing board density, it is getting worse

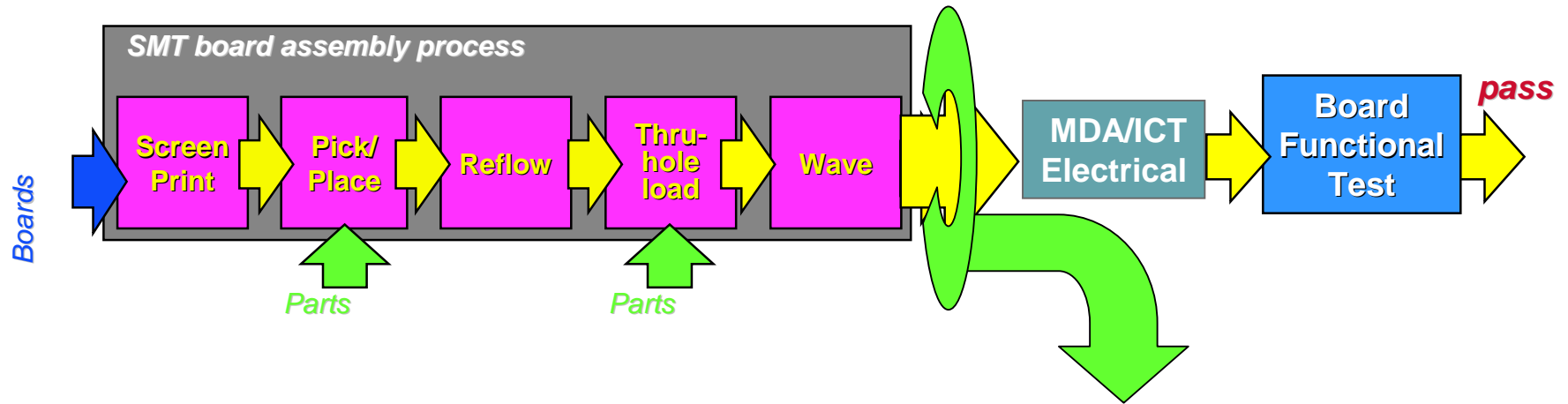
# What is driving Automated Test/ Inspection?



Implications:

1. Human inspection is increasingly becoming less consistent and less accurate.
2. Loss of electrical access decreases efficiency of bed-of-nails test technologies.
3. Lower yields at the end of the Assembly line.

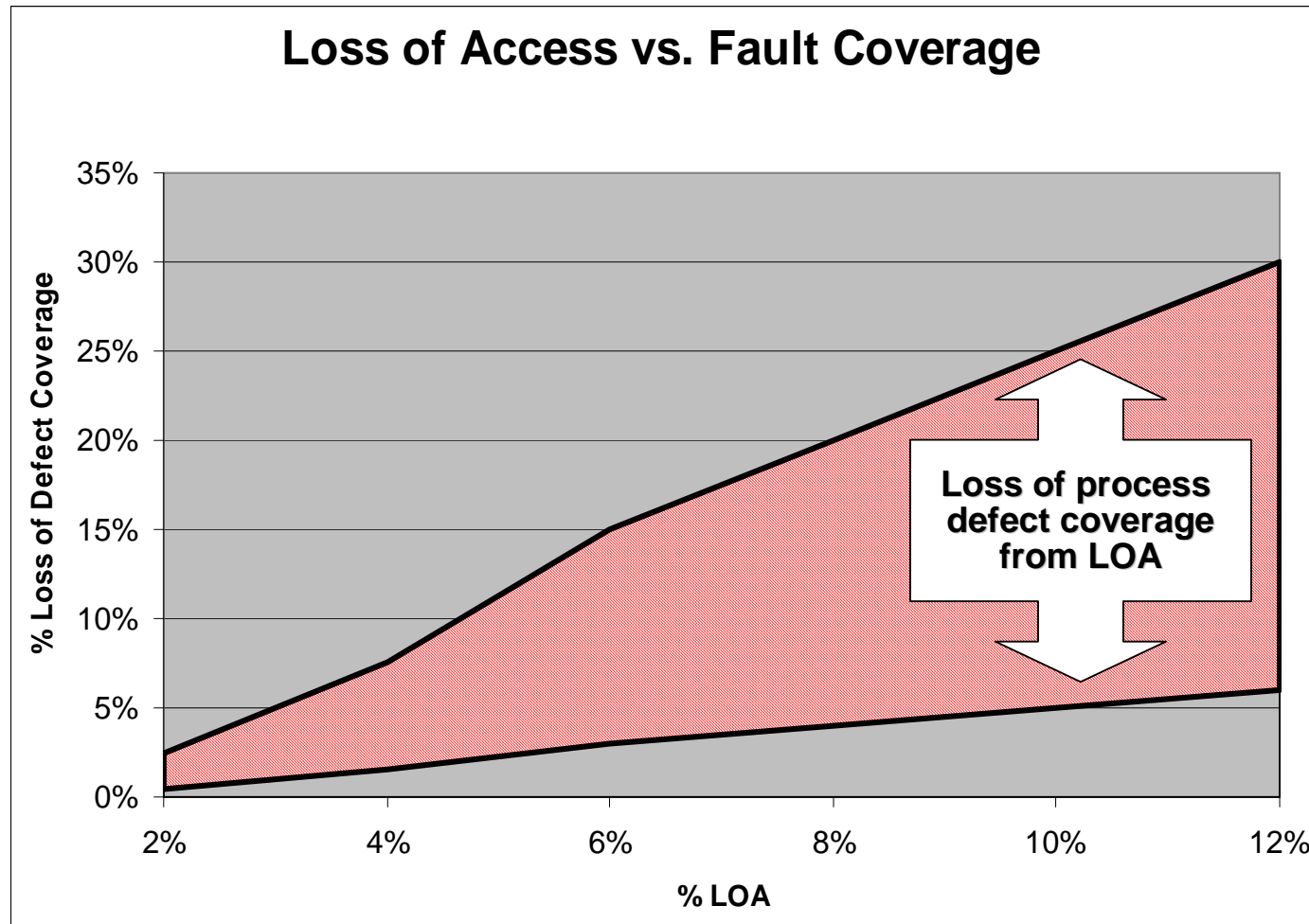
## Scenario Two MDA then Functional!



- *Test times are fast and good diagnostic resolution*
- *Problems:*
  - *An expensive fixture is required for each board type*
  - *You need access to all electrical nodes on the board for good coverage*
  - *ECOs may require a new fixture*
  - *There is typically a two week turn around on fixtures*

# *ICT or MDA Test Fixture*

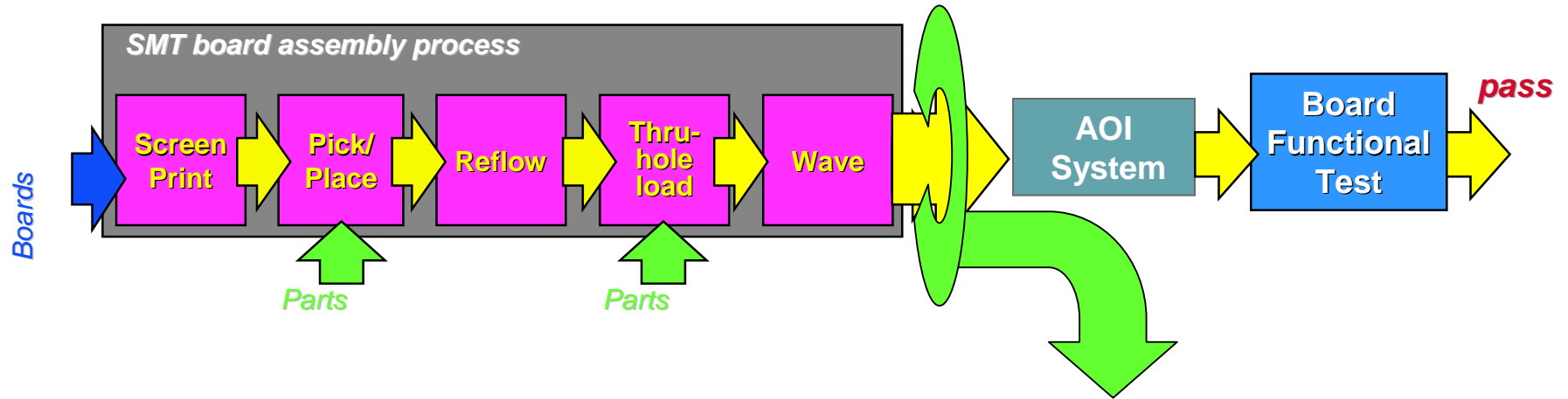




- *Loss of access represents holes in test coverage for assembly faults to propagate*
- *Each % of probe coverage loss translates into 0.5% - 2% of fault coverage*

- *Acculogic “Experts in Limited Access Testing”*
  - *BONs testers need to have test points for fixture nails. The smaller the target the finer, more expensive and fragile the fixture pins.*
  - *Boundary Scan helps solve the loss of electrical access by supplying access through the TAP port...*
  - *Flying Probe Systems*
    - *Both the Sprint and Scorpion can hit test pads, if none are available then it can hit VIAs, and component pads*
    - *The AOI option further helps increase coverage by checking for missing components, etc..*
  - *Our product line is well positioned for the direction the industry is going!*

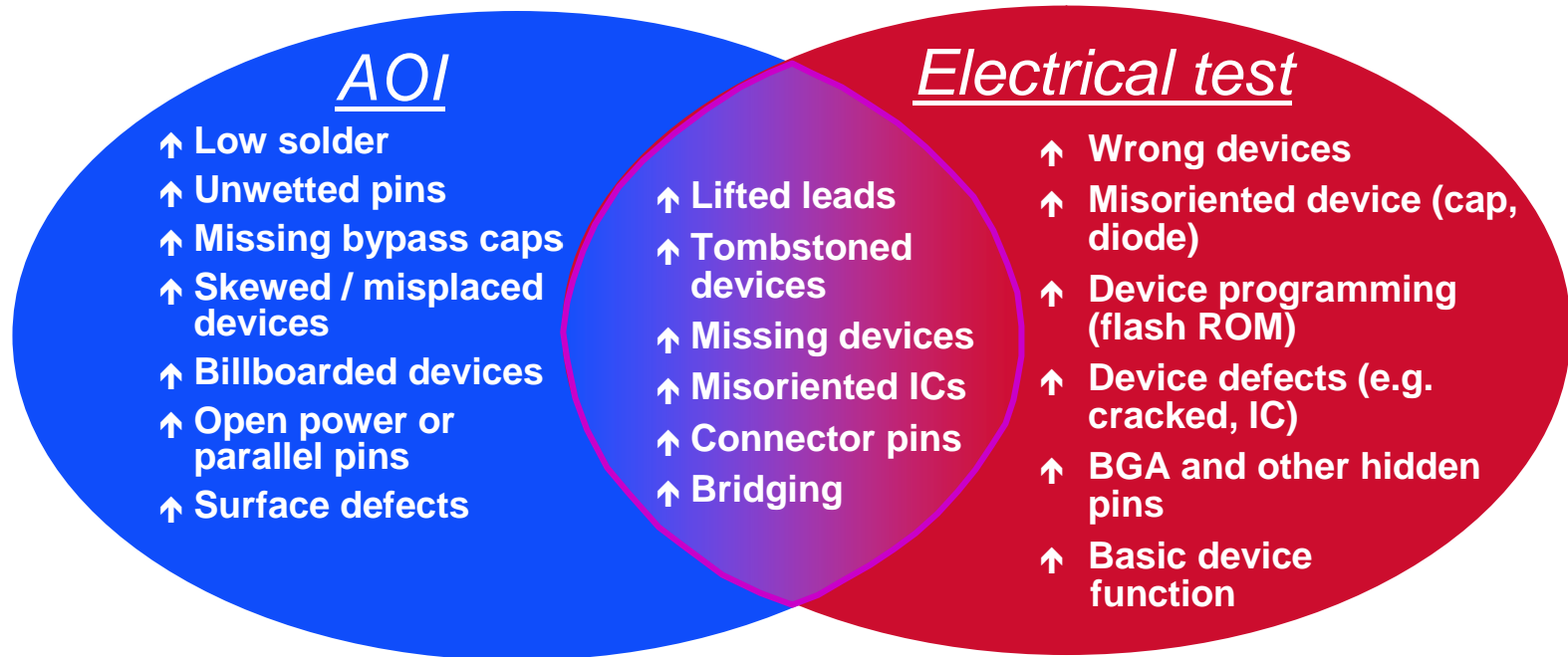
## Scenario Three AOI to Functional!



- Good at finding visible faults, programming time about one day.
- Problems:
  - Can't find hidden faults (BGA pins for example)
  - Solder inspection is iffy, multi camera systems do better
  - False calls can be several percent resulting in the operators having to make a final call on the fault
  - Once a board is repaired then you can't re-inspect it because the solder

**SMD Defect Survey of 28 Large OEM/CM's (285 SMD lines)**

Source Circuits and Assembly, "Inspection Strategies for Process Control"

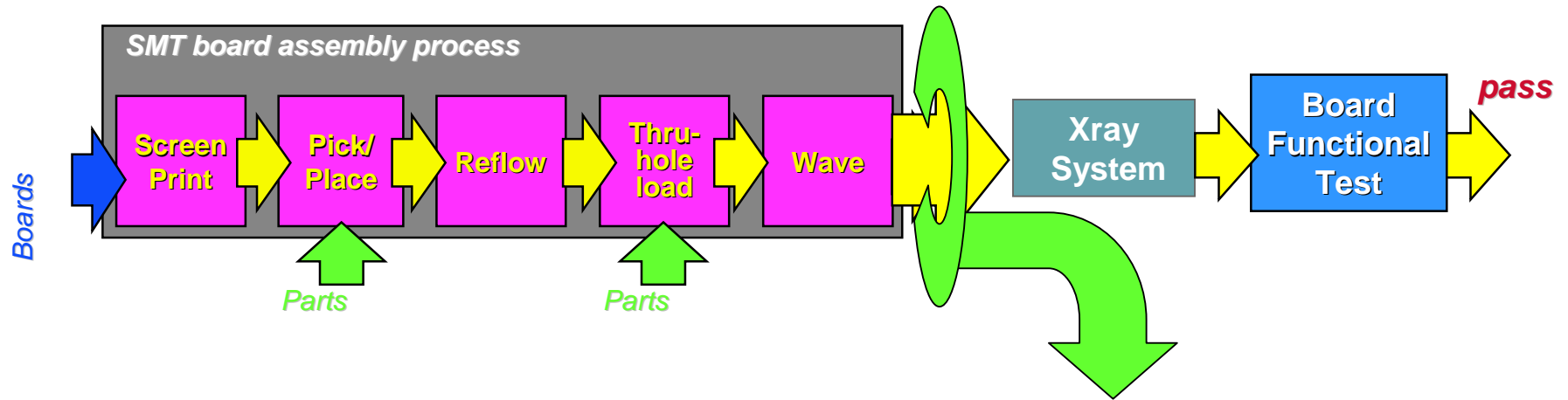


- Does not require a test fixture
- Easily applied to partially-built boards.
- Direct soldering process feedback.
- Improve process monitoring by detecting defects earlier.

- Applies board power
- Tests component function, tolerance and possibly board function
- Can test hidden features

**Implication: AOI and electrical test will be employed together as complementary inspection and test tools in-line.**

## Scenario four Xray to Functional!

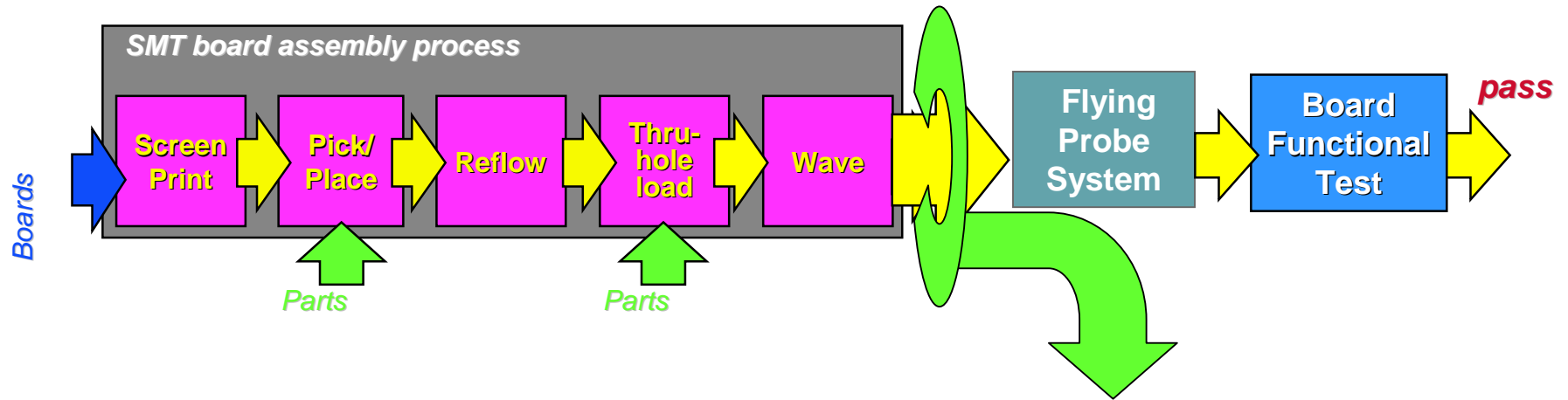


- *Xray is good at inspecting solder both hidden and visible joints*
- *Problems:*
  - *Two types transmission,*
    - *Can't inspect double sided boards*
  - *3D xray*
    - *Good for double sided boards*
  - *Very expensive, and typically slower inspection than AOI*
  - *Higher false calls than AOI*
  - *Typically used for first article inspection.*

**SMD Defect Survey of 28 Large OEM/CM's (285 SMD lines)**

Source Circuits and Assembly, "Inspection Strategies for Process Control"

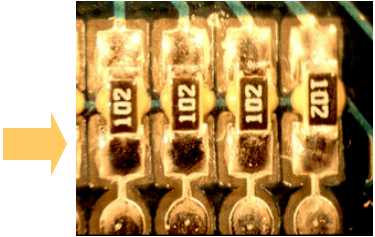
## Scenario Five Flying Probe then Functional!



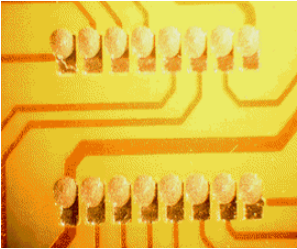
- *No fixtures needed, fast programming, one to two days*
- *Greater access than Bed of Nails testers, can probe down to 2 mils.*
- *With AOI option give very good fault coverage*
- *Boundary Scan helps with coverage and reduces test times.*
- *Problem:*
  - *Slow and can't be used in line*
  - *More expensive than an MDA*

**SMD Defect Survey of 28 Large OEM/CM's (285 SMD lines)**

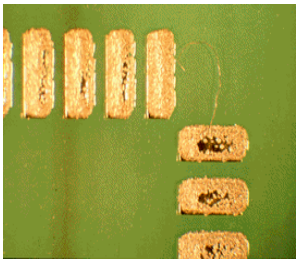
Source Circuits and Assembly, "Inspection Strategies for Process Control"



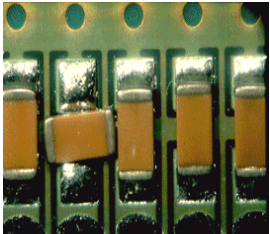
**Excess Adhesive**



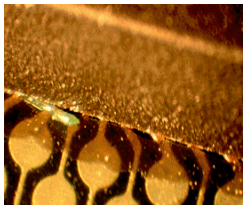
**Misaligned Dispense**



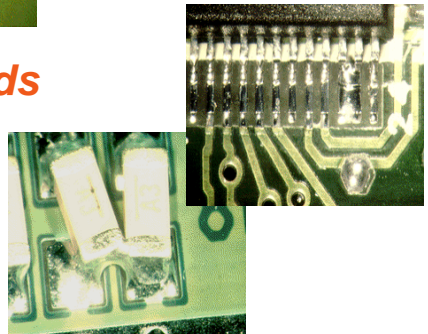
**Skipped Pads**



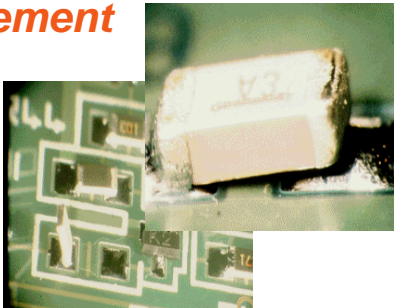
**Incorrect Placement**



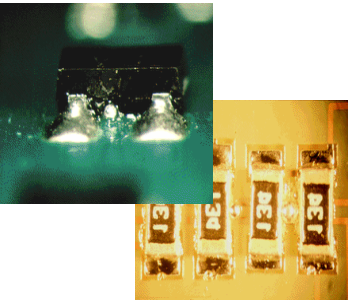
**BGA Misplaced**



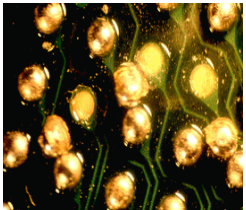
**Solder Shorts**



**Component Lift**

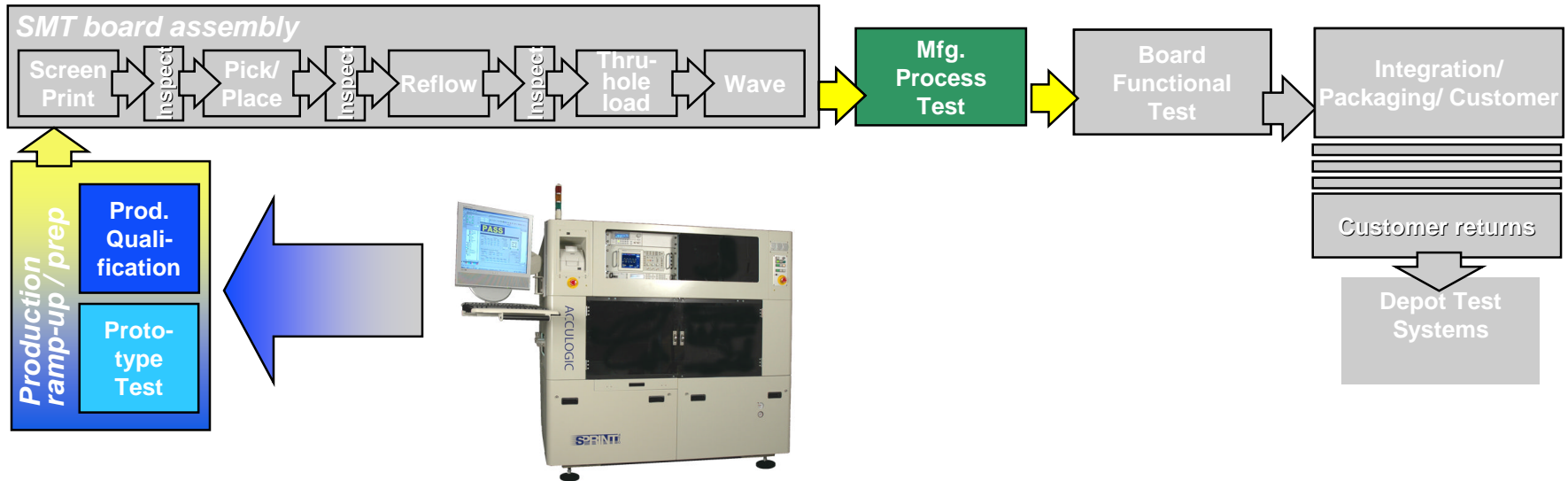


**Solder Beading**



**Ball Failure**

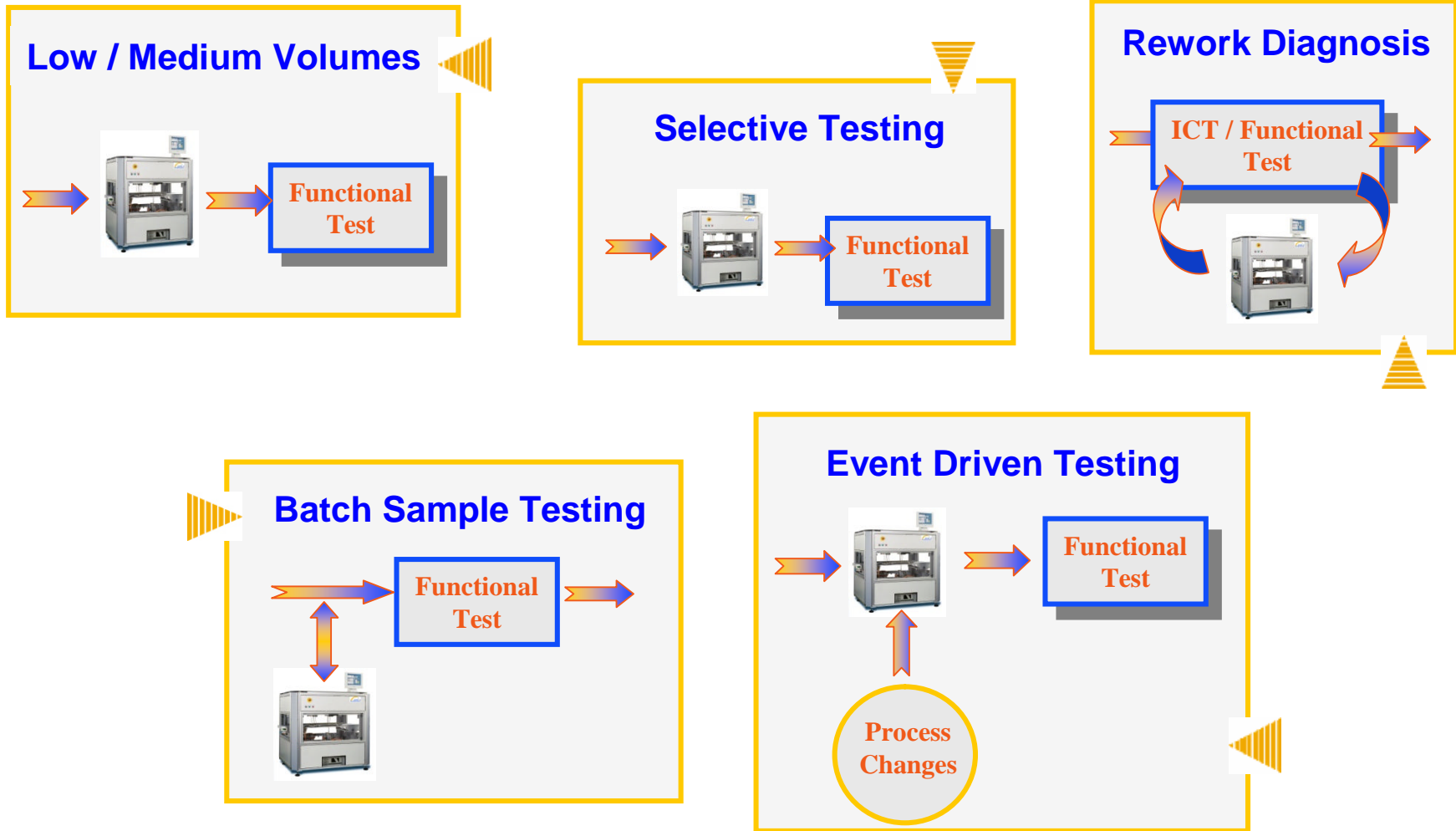
# Why is Flying Prober technology needed

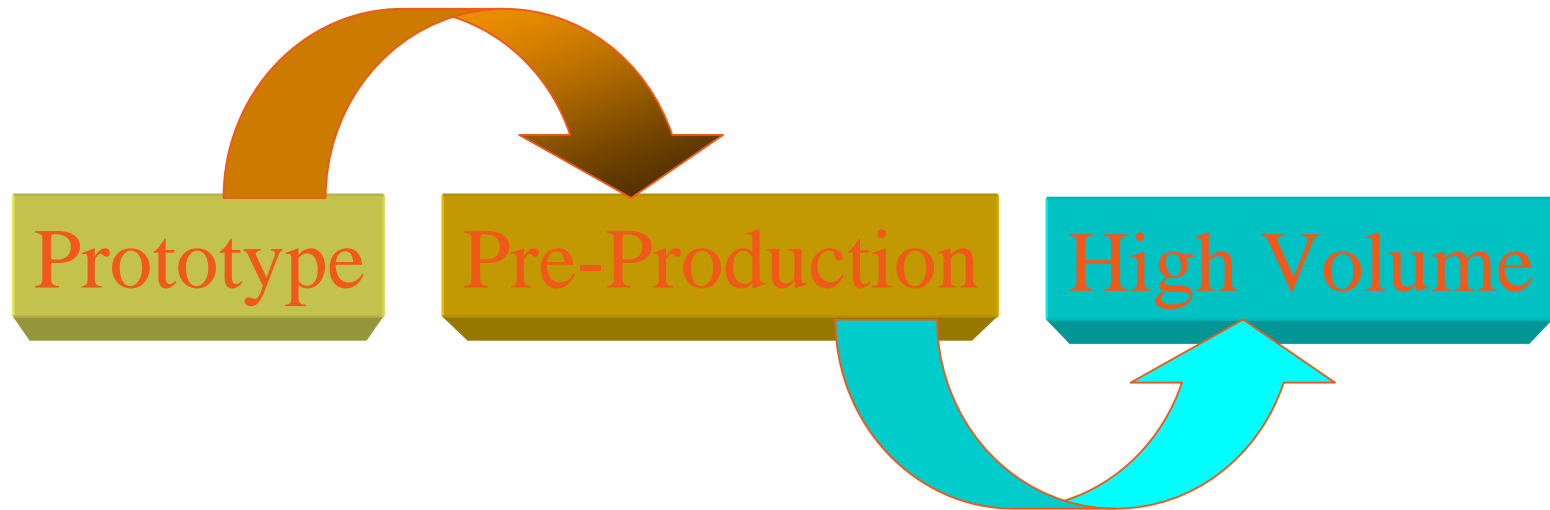


*Flying prober is the best solution to address new challenges:*

- ✓ *Time constraints and quality requirements for low volume high mix, prototype and production ramp-up*
- ✓ *Lack of access in manufacturing process test*

# Strategic production deployment



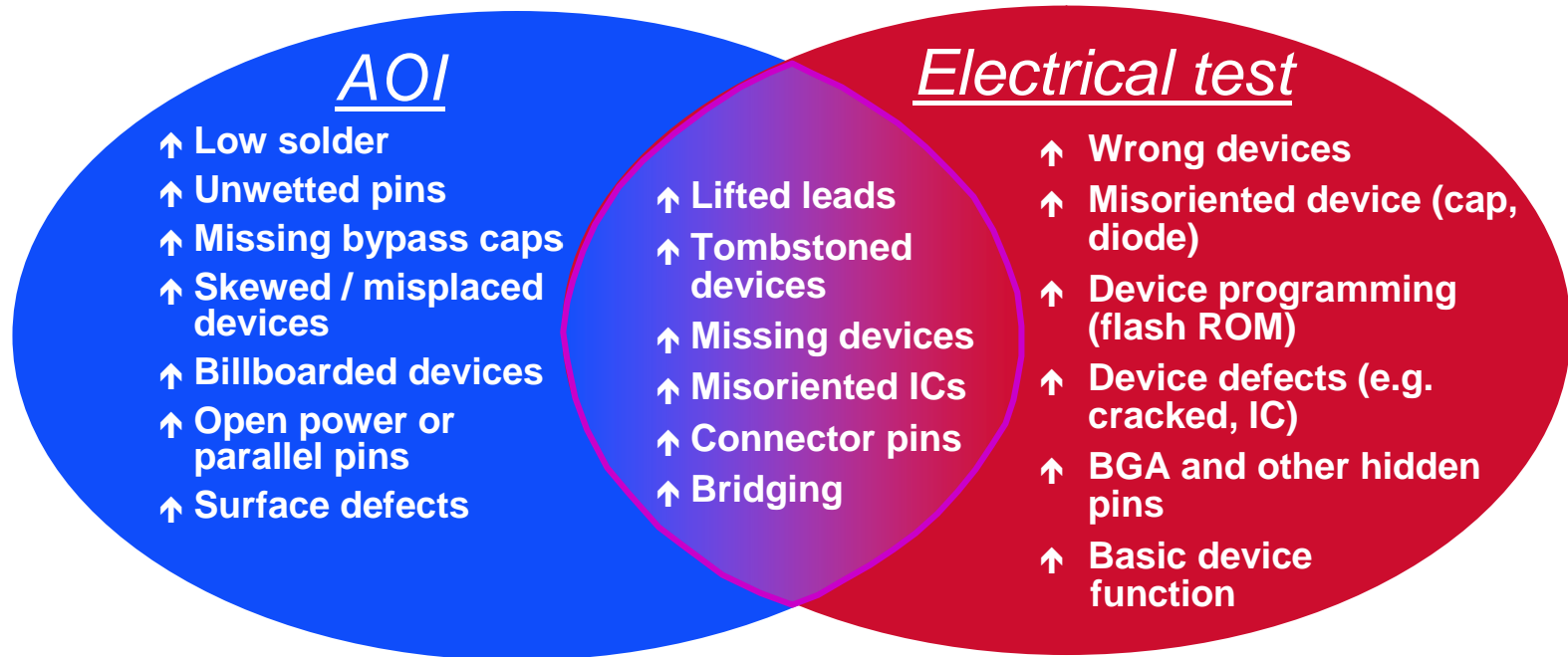


**Program**



## *What Test Inspection Strategy is best?*

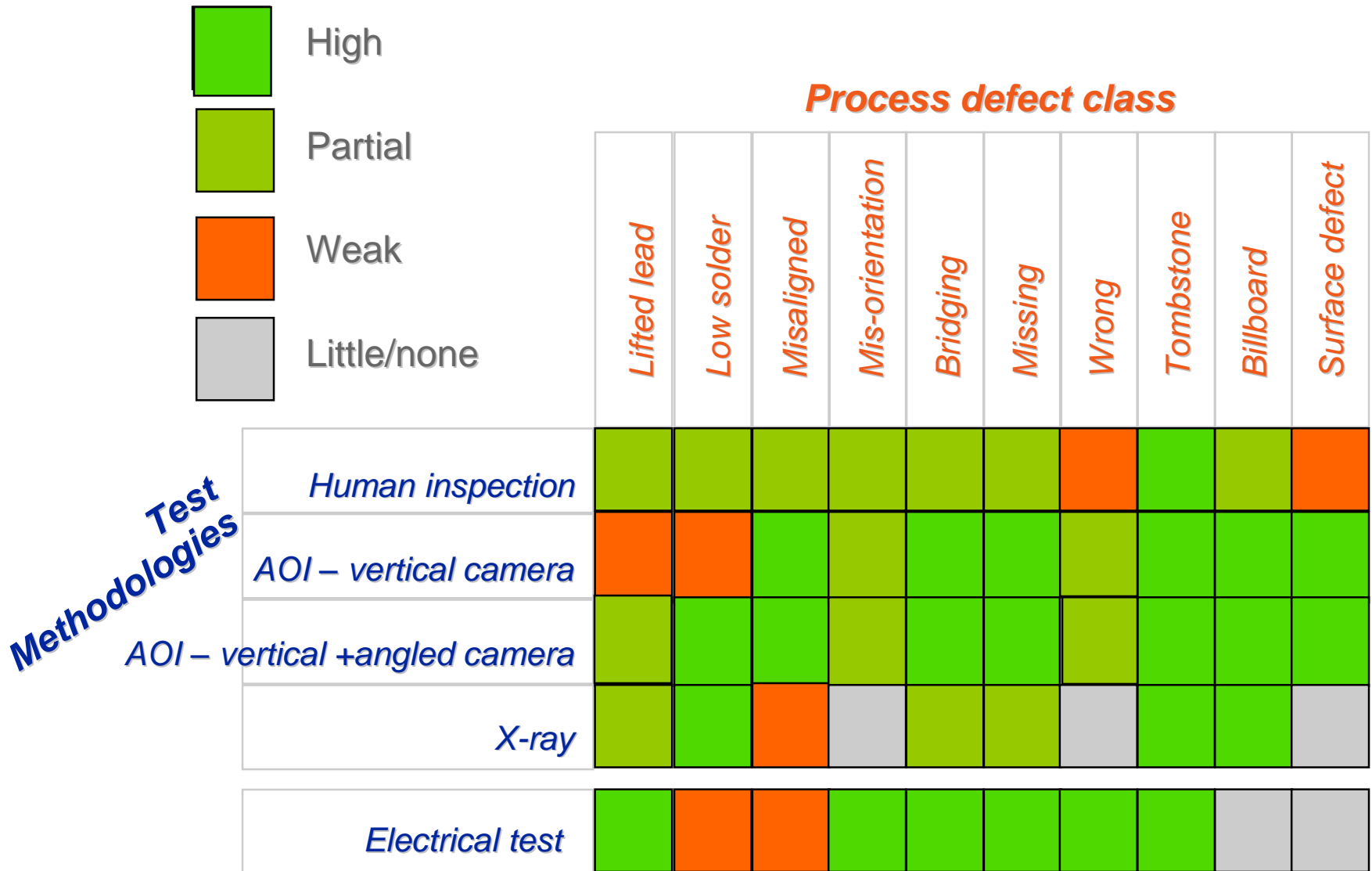
- *The question becomes not whether to test but what strategy makes the most sense?*
- *MDA, AOI, XRay, Flying Probe, Functional, or a combination?*
- *What Strategy is dependent on what faults the customers is experiencing and may vary from board to board.*
- *This can be done manually by doing homework with your customers*
  - *What is the fault spectrum going into functional/final test and what test strategy best addresses those faults?*
  - *More people are interested in Flying Probe, since in N. America most CMs and OEMs are mid to low volume, high mix. High volume is off shore.*



- Does not require a test fixture
- Easily applied to partially-built boards.
- Direct soldering process feedback.
- Improve process monitoring by detecting defects earlier.

- Applies board power
- Tests component function, tolerance and possibly board function
- Can test hidden features

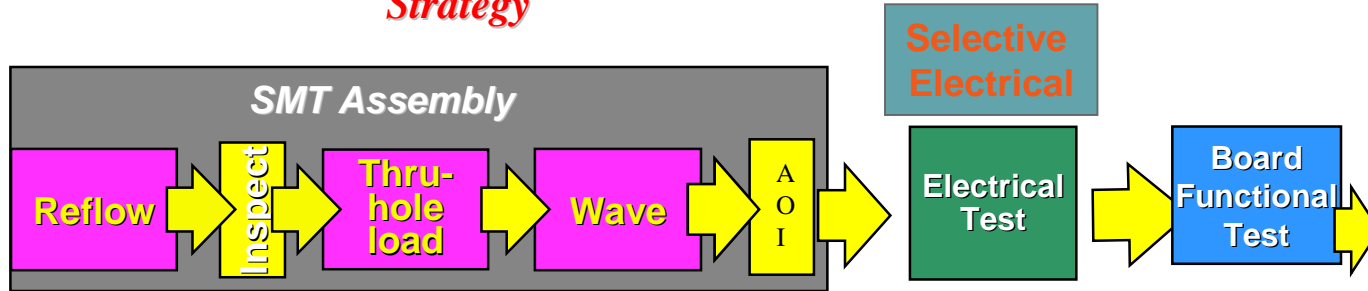
**Implication: AOI and electrical test will be employed together as complementary inspection and test tools in-line.**





ACCULOGIC

*Distributed Fixtureless Inspection and Test Strategy*



		Lifted lead	Low solder	Misaligned	Mis-orientation	Bridging	Missing	Wrong part/value	Tombstone	Billboard	Surface defect
	High										
	Partial										
	Weak										
	Little/none										
	AOI	Partial	Partial	High	High	High	High	Weak	High	High	High
	MPT or Selective Electrical	High	Weak	Weak	High	High	High	High	High	Little/none	Little/none
	<b>NET RESULT</b>	High	Partial	High	High	High	High	High	High	High	High

**Post Solder AOI**

- **ASP \$80-\$200K**
- **Inspects for visible defects**
  - **Solderability**
  - **Placement**
  - **Orientation**
  - **OCR/OCV**
- **Program development time 2-3 hrs**
- **False calls 1-3% of boards**
- **Keeps up with line rate**

**Xray**

- **ASP \$100 – \$500K**
- **Inspects visible and hidden defects**
  - **Solderability incl. Voids**
  - **Placement**
  - **Some orientation**
- **Program development time 2-5 days**
- **False Calls >5%**
- **Slower than AOI**
- **Need 3D Xray to handle double sided boards**
  - **Agilent 5DX Laminography**
- **Safety concerns...**

**■ ICT Capabilities**

- *BON access*
- *Shorts & opens*
- *Analog components*
- *Vectorless Testing*
- *Digital IC tests using Vectors from library*
- *Power up Functional*
- *Boundary Scan*
- *Flash Programming*
- *Cost \$150K plus*

**■ MDA Capabilities**

- *BON access*
- *Shorts & opens*
- *Analog components*
- *Vectorless Testing*
- *No Digital vectors.*
- *Power up Functional*
- *Boundary Scan*
- *Flash Programming*
- *Cost \$40K plus*

*Note: the failure rates on digital ICs is less than 50ppm and not worth the added time to develop the program*

### *BONs Testers*

- *Uses a fixture specific to the Device Under Test*
- *Fixture costs can run \$5K-30K or higher*
  - *Typical two week turn around on a fixture*
- *Program times and debug are typically 3-5 days*
- *Test times are typically 15-30 seconds average*
- *Cost 50K-400K*

### *Flying Probe Systems*

- *Access is through flying probes –no fixtures*
- *Program times typically run 1-3 days*
- *Test times are typically 1-5 minutes*
- *Cost 180K 350K*

*Used for low volumes high mix, prototypes, first articles, etc.*

*Used for high volume low mix*

- **Example of Functional test savings**
- **Current situation**
  - *Volumes* 160 per day -40,000 per year
  - *First Pass Yields* 70%
  - *Functional Test Time* 4 minutes
  - *Troubleshooting time* 15 minutes
  - *Repair time* 5 minutes
  - *F. Test Technican wages* \$35 per hour
  - *Average # faults/board* 2.0
  - *Test cost/year at functional* 10,266.66 hrs x35 = \$359,333
  - *Head count needed (2000 hrs per year) =5 people*

## *Economics of adding test Cont'd*

- **Functional Test with a F.P system**
  - Board volumes per day            160 =40,000 per year
  - First pass yields                    97% (assuming 90% test coverage)
  - Test Time                              4 min
  - Troubleshooting time            15 min (1200 bds at 3% failure rate)
  - Retest time                            4 min
  - Average faults per bd            1
  - Functional Test Tech. wages \$35 per hour
  - Test cost per year functional 3047 hrs x \$35/hr = \$106,633
  - Annual savings wages            = \$252,700
  - Head count needed =2
  - Head count savings =3 at \$72,800 per year total svg. \$218,400
  - Total savings = \$252,700 +\$218,400 = \$471,100



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