



In conjunction with JM Engineering Consulting



## 2016 International Forum on DFMA Boothroyd Dewhurst

## Using DFM to Understand Printed Circuit Board Costs

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# Using DFM to Understand PCB Costs

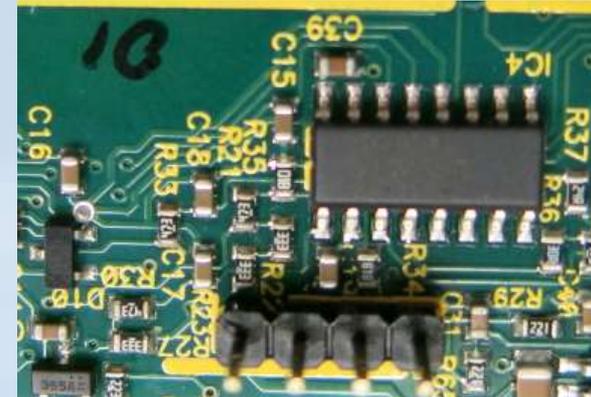
- How much cost do PCB's represent as a % of your design?  
Don't know?
- Dynisco example products:
  - Product 1 - PCB's comprise  
24% of total product cost
  - Product 2 - PCB's comprise  
10% of total product cost



If you're using DFM for fabricated components  
why leave your PCB's to chance?

# When to Utilize DFM for PCBs

- DFM for PCBs areas of deployment:
  - Product Development
    - Lets you know the PCBA cost allocation as a percentage of the project early on
  - Should Cost Activities
    - Ensures you are paying proper prices for your legacy designs
    - Gives you data for negotiating proper prices
  - Competitive Benchmarking
    - How does your design compare to competitors
    - Requires identification of the components which can be challenging. Not all components have clear markings.

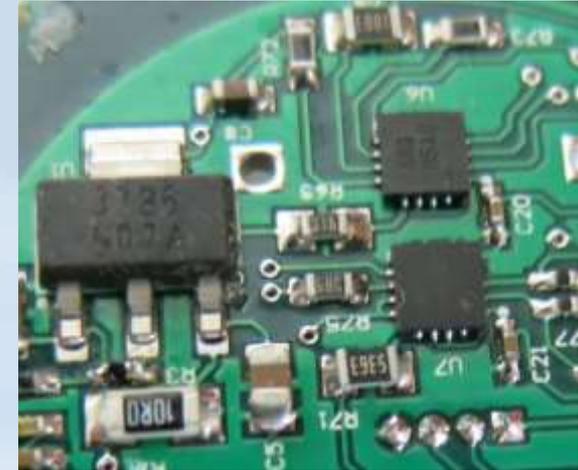


# Successful Application Examples

- Product Development
  - Existing sensor design consists of 2 PCBA's. Product refresh reduced to 1 PCBA for savings of 12%. (Not to mention a better DFA index)
- Should Cost Activity
  - High volume sensor PCBA DFM used to renegotiate price for an 8% savings yielding \$13K a year.
- Benchmarking
  - DFM utilized to fully cost 5 competitors units in comprehensive benchmark study.

# Cost Components of a PCB Assembly

- As with any fabricated product the components of cost are similar:
  - Material
    - The board itself (different materials, number of layers, copper weight)
    - The components (through hole or surface mount)
    - Any coatings etc...
  - Setup
    - Automated placement equipment including the reels for components
    - Auto solder paste machine, solder ovens etc..



Cost results, \$	Previous	Current
<input type="button" value="Calculate"/> material	5.54	5.54
setup	3.71	3.71
process	2.51	2.51
rejects	0.77	0.77
piece part	12.53	12.53
tooling	0.12	0.12
total	12.65	12.65
Tooling investment	2,460	2,460

# Cost Components of a PCB Assembly

## – Process

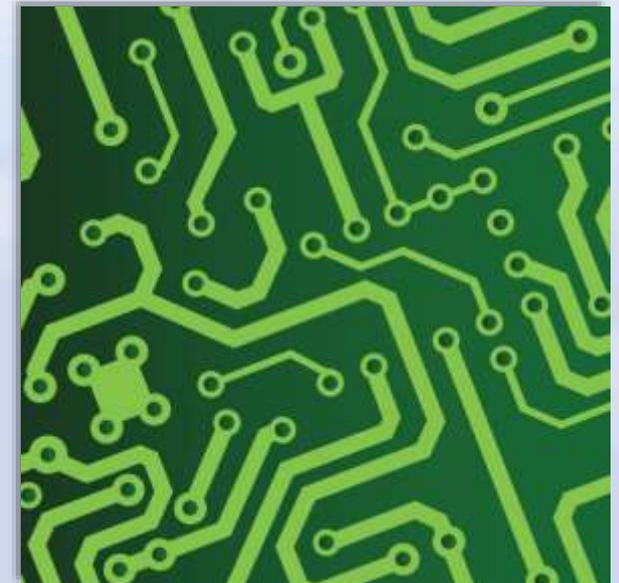
- Process time for the automated placement equipment
- Solder paste application and solder ovens
- Any hand solder operations

## – Rejects

- Bare board process yield and reject rate after assembly have separate inputs

## – Tooling

- If you wish to have the tooling amortized across the parts
- Includes programming labor for various machines.



# Sample PCB DFM

- Typical PCBA DFM

Bare board process →

Component placement and other processes →

Secondary processes →

You can structure to match a PCBA BOM with reference designations.

DFM Concurrent Costing 2.4 [C:\Program Files\Dfma\data\working directory\DFMA WHITE PAPER PCB EXAMPLE.DFM]

File Edit Analysis View Reports Graphs Tools Help

FR-4 printed circuit board

- Bare board process
  - Printed wiring board fabrication
  - Hole drilling
  - Solder mask
  - Legend printing
  - Testing
- Pcb Assembly
  - Solder paste-auto
  - MELF placement
  - SOT placement
  - SOT placement
  - R1 - chip placement**
  - MELF placement
  - IC1 - SOT placement
  - SOT placement
  - Chip placement
  - PTH connector insertion
  - Reflow solder
  - Cleaning
- Plastic bag part
- Profit

Part

Part name: Forum Example  
Part number: NA  
Life volume: 20,000

Envelope shape

Approximate envelope dimensions, in.

0.06 0.06 average thickness

0.435 2.05

Forming direction

Select process and material...

Picture

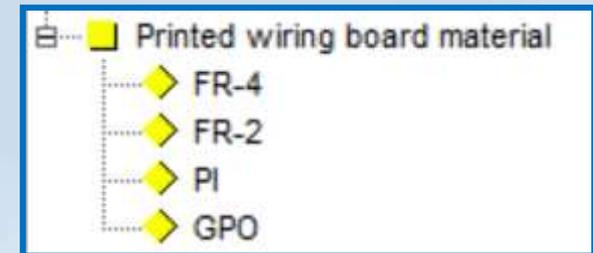
Load Clear Scale to fit Transparent

Notes

Example PCB 50 pcs		
Cost results, \$	Previous	Current
material	5.54	5.54
setup	3.82	3.71
process	2.52	2.51
rejects	0.77	0.77
piece part	12.64	12.53
tooling	0.12	0.12
total	12.76	12.65
Tooling investment	2,476	2,460

# Key Inputs for Accuracy

- PCB material.
  - 4 materials to choose from.
- The bare board process inputs
  - The board type, correct number of layers and copper weight.
  - The DFM module defaults to a high value for the number of holes. Example a 2" X 1" board defaults to 400 holes which even for through hole is quite high.
  - Selections for gold plated edge connectors, solder mask and screen printing.



Board processing data	
Board type	Double sided
Board thickness, in.	0.062
Number of holes	33
Copper weight, oz/sq ft	1
Minimum trace width, in.	0.006
Minimum conductor spacing, in.	0.006
Gold plated edge connectors	<input type="checkbox"/>
Solder mask required	<input checked="" type="checkbox"/>
Legend screen printing	<input checked="" type="checkbox"/>
Circuit overlays, \$	971

# Key Inputs for Accuracy

- Through hole and surface mount component selections.
- Selecting on a component shows you the general shape, description and available inputs.

Printed circuit board assembly

- Through hole insertion
  - Axial insertion
  - Post insertion
  - Radial insertion
  - Can insertion
  - SIP insertion
  - SIP socket insertion
  - DIP insertion
  - DIP socket insertion
  - PTH connector insertion
  - Pin grid array insertion
- Surface mount placement
  - Chip placement
  - MELF placement
  - LCCC placement
  - LDCC placement
  - PLCC placement
  - SOIC placement
  - SSOP placement
  - SOJ placement
  - SOT placement**
  - Flat pack placement
  - Quad flat pack placement
  - SMD connector placement
  - Ball grid array placement

Placement method: Auto

Fault rate: 0.002

Number of leads: 5

Number of components placed: 1

Average component cost, \$: 0.1

Setup cost per part type, \$: 1.6

Component rework time, s: 37.9

Replacement component required?

Picture

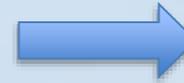
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Notes

A small outline transistor (SOT) is a SMD package for discrete components with three to five leads in a gull-wing shape along two sides..

# Key Inputs for Accuracy

- If there is a large mix of similar components you can enter them in one dialog by averaging the price and knowing the number of different components.



Placement method	Auto with adhesive
Fault rate	0.002
Number of components placed	10
Number of component types	2
Average component cost, \$	0.1
Setup cost per part type, \$	3
Component rework time, s	33.9
Replacement component required?	<input type="checkbox"/>

Picture

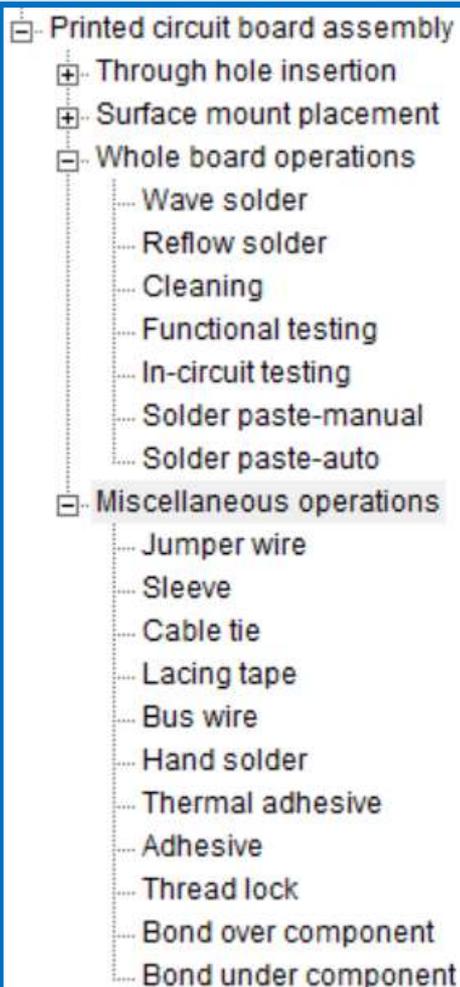


Load Clear  Scale to fit  
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Notes

Chips are small passive SMD packages rectangular in shape with pads at both ends for mounting to the board. Most commonly these are chip resistor and chip capacitor packages.

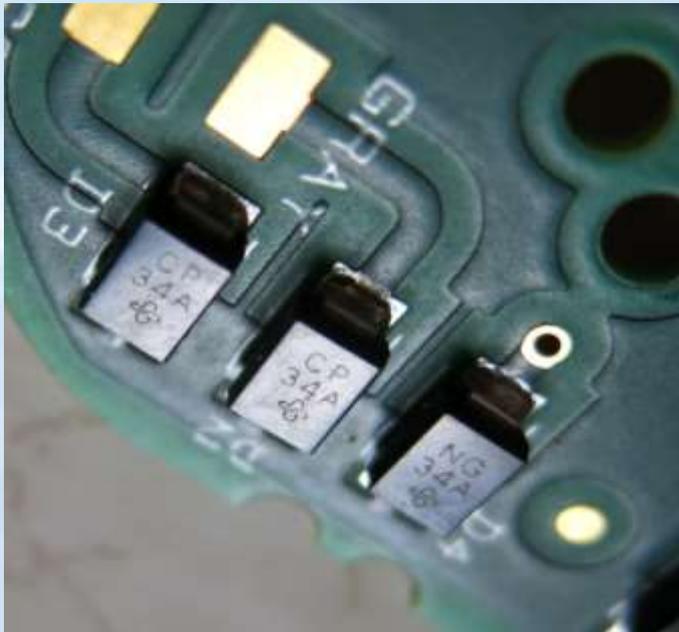
# Key Inputs for Accuracy



- Whole board ops
  - Wave or reflow solder
  - Functional and in circuit testing if specified.
- Miscellaneous operations
  - Manual operations to circuit board assemblies.

# Key Inputs for Accuracy

- Component identification for benchmarking



- Entering the component markings and component type, determined from the reference designation (D for diode in this case), into a search engine will often yield results.
- Costs can be estimated from sites such as Digikey, Mouser and Newark.

# Integrating PCB's into DFA

- If multiple boards are utilized, DFM and DFA can be used to determine the best cost and DFA index for your design.

 PCB SUB ASM 2
 PCB 1
 WIRE
 WIRE
 Wire/cable preparation
 Soldering
 PCB SUB ASM 1
 PCB 2
 Hand solder leads
 PCB 3
 Hand solder leads
 PCB 4

# DFM and PCB assemblies



DFM Concurrent Costing 2.4 [C:\Program Files\Dfma\data\working directory\DFMA WHITE PAPER PCB EXA...

File Edit Analysis View Reports Graphs Tools Help

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- Pcb Assembly
  - Solder paste-auto
  - MELF placement
  - SOT placement
  - SOC placement
  - R1 - Chip placement
  - MELF placement
  - IC1 - SOT placement
  - SOT placement
  - Chip placement
  - PTH connector insertion
  - Reflow solder
  - Cleaning

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**Include PCB's in the DFM process for product development, should-costing, and benchmarking**

# Questions?

