Performance and cost optimization of the PCB through using intelligent PCB design

Fineline QPI BV

DESIGN AUTOMATION & EMBEDDED SYSTEMS

8 OKT ← D&E event 2019
VAN DER VALK HOTEL
EINDHOVEN

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EXCELLENCE IN PCB

ABOUT FINELINE QPI BV

Our History

Established in 1988 as QPI, quickly became one of the major suppliers of quick turn high end PCBs in NL and BE
In 1996 the PCB Design group was added
Since 2002 ISO 9001 certified, today ISO2001-2015
Opened in 2010 its own office in Shenzhen China, today integrated in the Fineline China office
2015 QPI has been acquired by Fineline Global

Our Profile

Dutch Subsidiary of Fineline Global.
A NL based company offering PCB supply,
PCB Design and PCB Laboratory supported
with the power of Fineline Global, one of the
world leading PCB suppliers

Locations

Helmond (Netherlands)
Sales, Engineering and Order Management
Logistics, Laboratory
Sales
Netherlands, Belgium, Luxemburg, Poland,
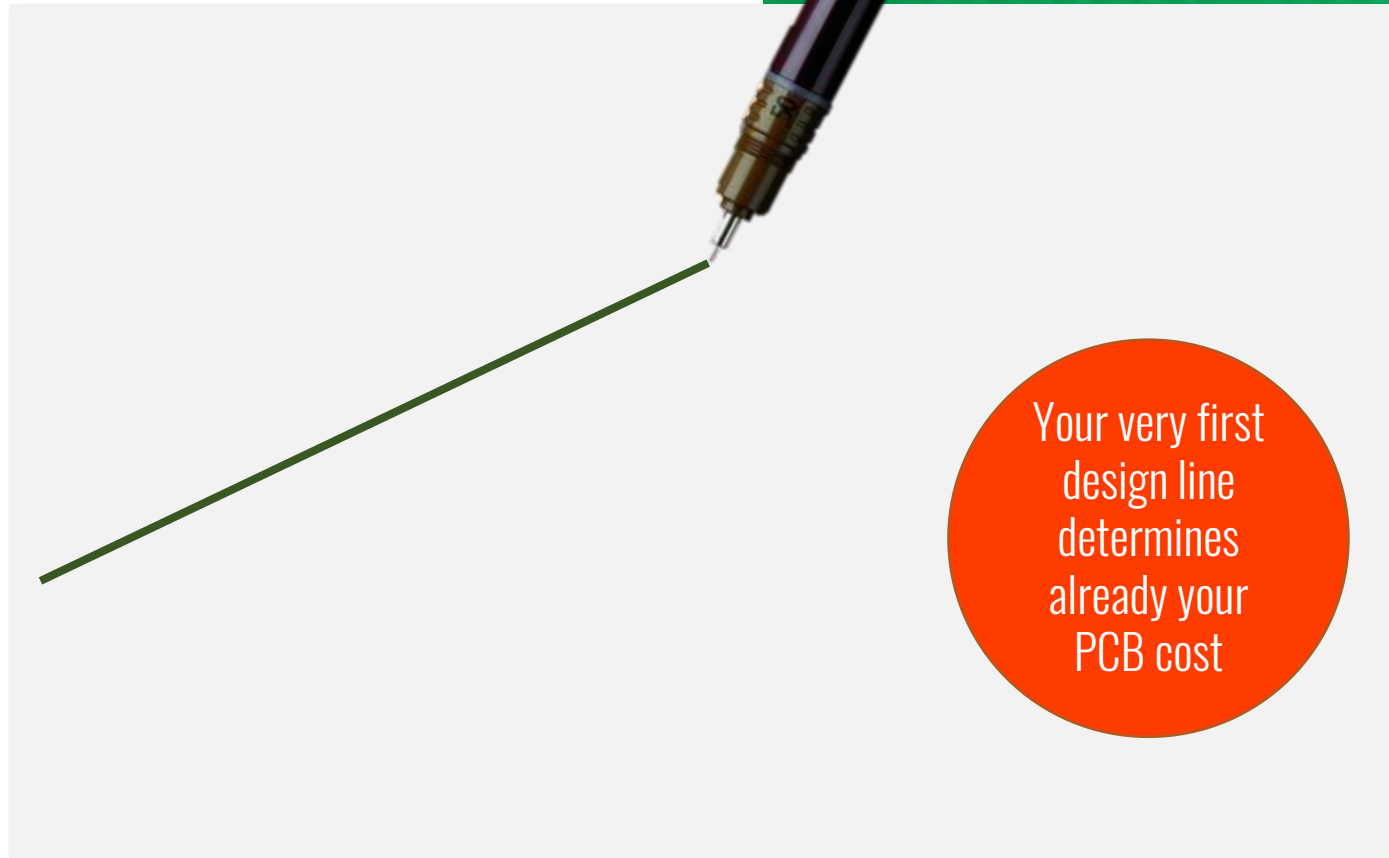Czech republic, Slovakia, Hungary, Romania

Our Vision

To be market leaders in all aspects of
PCB supply and PCB Design from RFQ
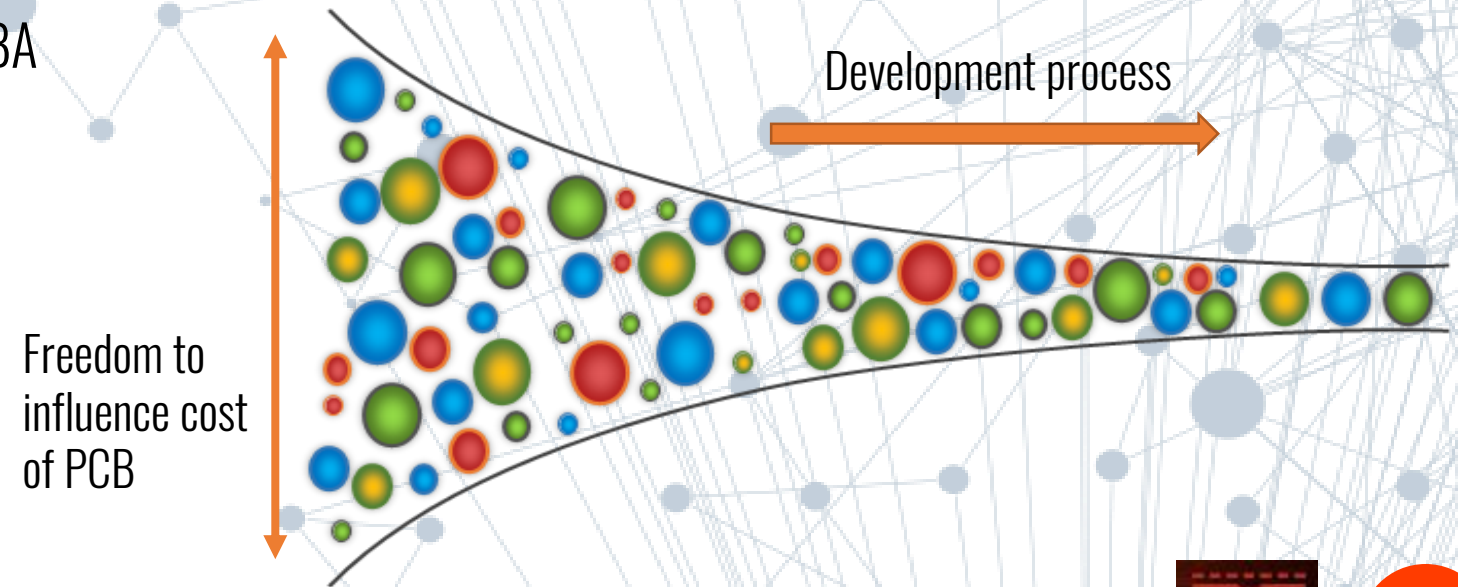through delivery and on going support.
Customer service is our priority

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CLEAN SHEET OF PAPER

Your very first design line determines already your PCB cost

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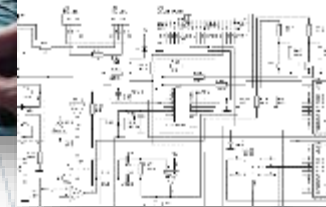EXCELLENCE IN PCB

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SUBJECTS

- PCB design flow
- Key factors which determine the costs and performance of the PCB/PCBA
- Layout PCB/PCBA
- Early supplier involvement
- Design For Manufactering (DFX) PCB/PCBA
- Production PCB/PCBA
- Conclusion

Development process

Freedom to influence cost of PCB

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PCB DESIGN FLOW

- Idea/new product, requirement or function
- Graphic/mechanical engineering (3D)
  - ➢ Determin the size and shape
- Hardware engineering
  - ➢ Determine the specifications required
  - ➢ Creation of electrical schematic
  - ➢ Choosing the required components
  - ➢ Choosing the required technolgy
- Software engineering
  - ➢ Start writing the software
- Design engineer
  - ➢ Layout of PCB/PCBA
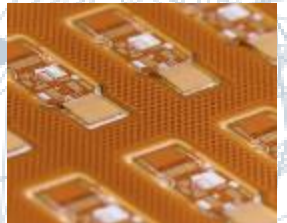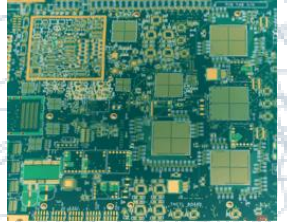

| Idea, new product | Graphic Mechanical engineering | Hardware engineering • Software engineering | PCB Design |

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SPECIFICATIONS

- Rigid, flex, flex-rigid
  - ➢ Dynamic behavior for flex and flex-rigid
- Power consumption (Current required)
  - ➢ Track width and thickness
- High Voltage requirement
  - ➢ Isolation between layers
- Impedance control
  - ➢ Accuracy of Cu pattern
  - ➢ Stack-up
  - ➢ Material
- High speed digital design
  - ➢ Material related

- Environment
  - ➢ Vacuum, temperature, moisture
- Qualification+reports
  - ➢ IPC 2/3, AS9100, MIL55110, TS16949 etc.

COMPONENT CHOICE

- Hardware engineering decides the type of components
  - ➤ BGA, LGA, QFN, QFP, resistors, capacitors etc.
- Availabilty check is very important these days due to long-leadtime
  - ➤ Suitable alternative
- Pitch of these packages determine the design rules required
- The smaller the pitch the complexer the PCB/PCBA design
  - ➤ Pitch >0,8 mm means standard design rules
  - ➤ Pitch <0,8 mm means you will need blind and buried via's
  - ➤ Components >=0402 means relative easy solder proces
  - ➤ Components <=0402 means critical processing


BGAs and CSPs Save Board Space

Smaller chip packages allow products to become more compact and convenient, but complicate design efforts to place decoupling capacitors where they will be most effective for reducing EMI

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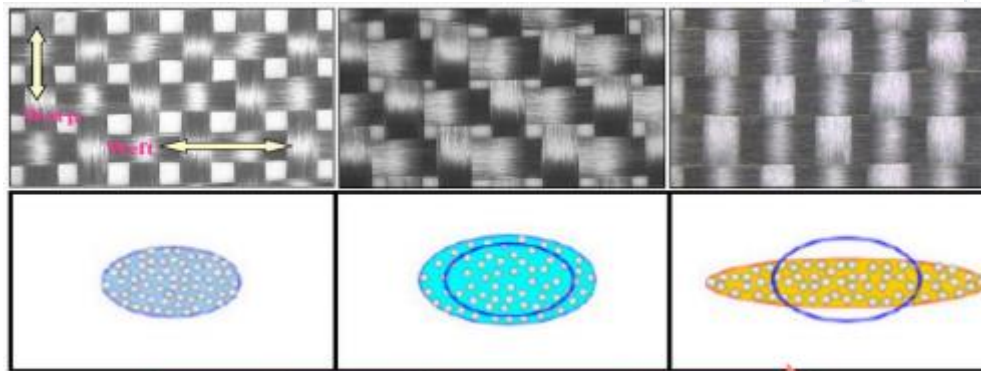EXCELLENCE IN PCB

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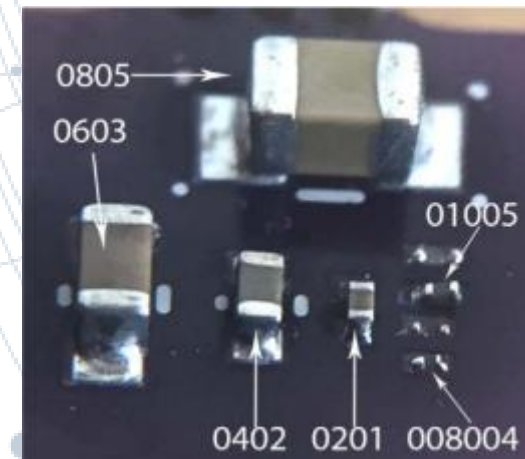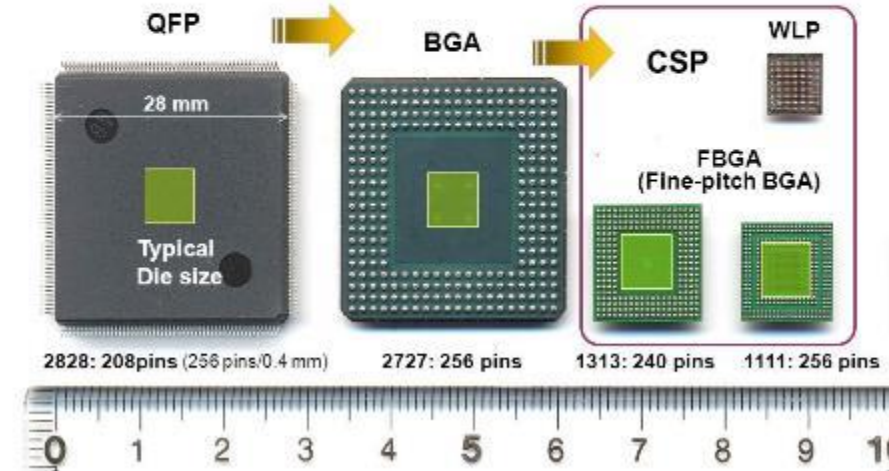
DESIGN RULES

- Size of the PCB
- Number of layers
- Cu Thickness
- Track and gap
- Annularing
- Smallest holes size
- Blind/buried/stacked via

- Via in pad
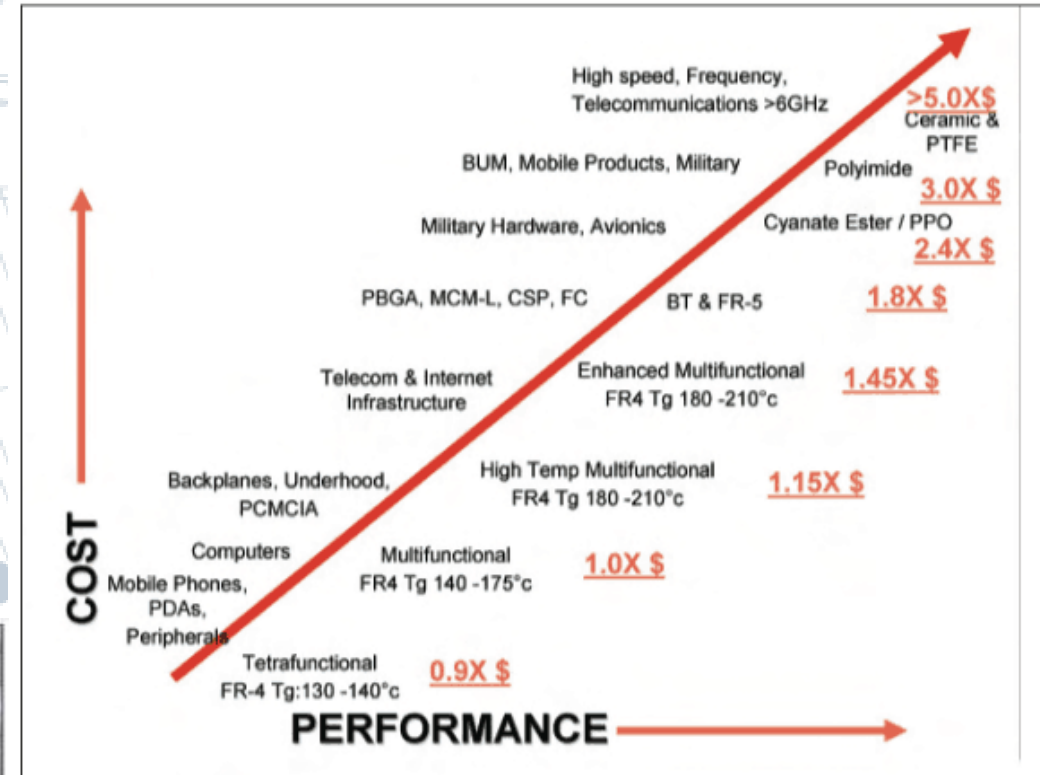 - Resin or Cu filled
- Finish
- Tolerances

All dimensions in µm
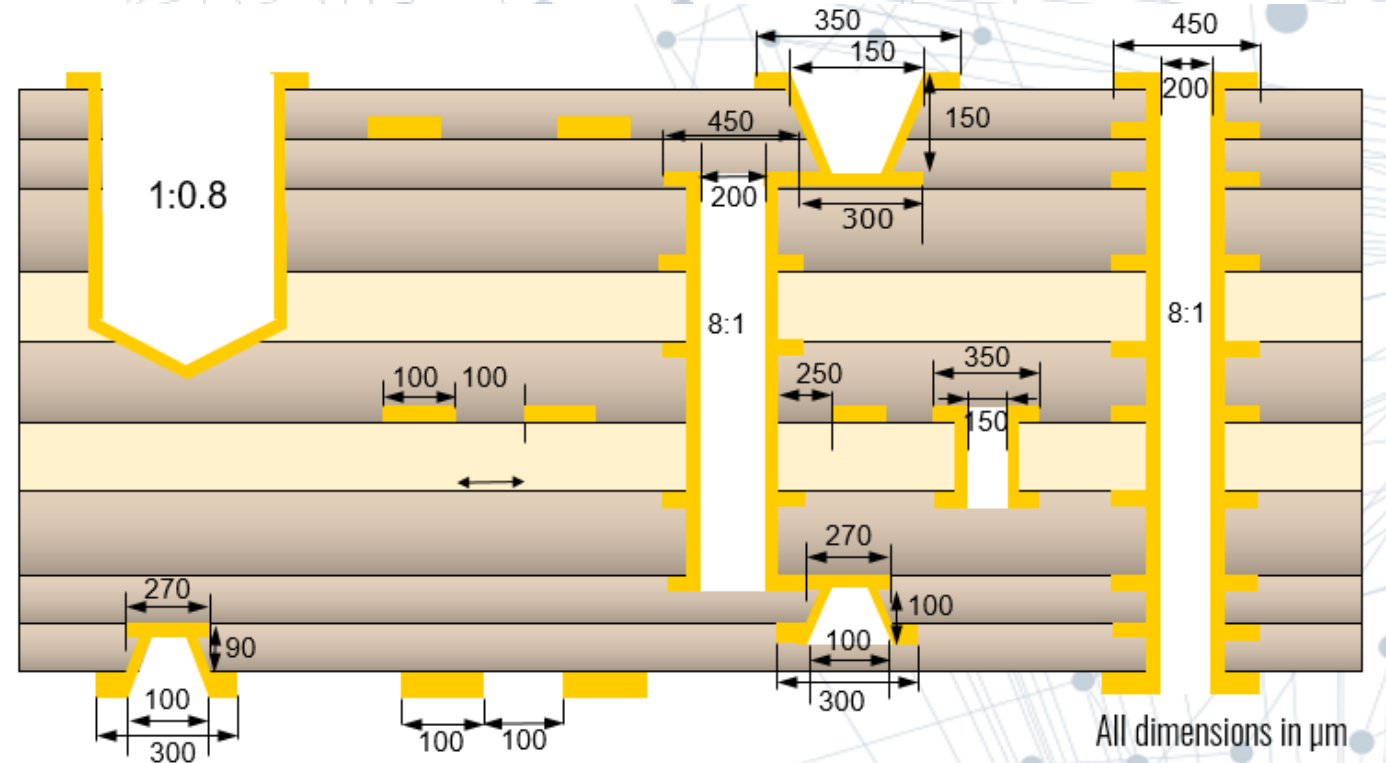
MATERIAL CHOICE

- Try to use as much standard materials as possible
  - ➤ Specify it according to IPC4101/...
  - ➤ Try to avoid to specifiy a brand or type if not really necessary
- If you need to use special material
  - ➤ Option: order upfront when stack-up is fixed ➡ reduces leadtime
- Stack-up of PCB
  - ➤ Core thicknesses and prepreg type



Less Skew or Fiber Weave Effect

High speed, Frequency, Telecommunications >6GHz — >5.0X$ — Ceramic & PTFE

BUM, Mobile Products, Military — Polyimide — 3.0X $

Military Hardware, Avionics — Cyanate Ester / PPO — 2.4X $

PBGA, MCM-L, CSP, FC — BT & FR-5 — 1.8X $

Telecom & Internet Infrastructure — Enhanced Multifunctional FR4 Tg 180 -210°c — 1.45X $

Backplanes, Underhood, PCMCIA — High Temp Multifunctional FR4 Tg 180 -210°c — 1.15X $

Computers — Multifunctional FR4 Tg 140 -175°c — 1.0X $

Mobile Phones, PDAs, Peripherals

Tetrafunctional FR-4 Tg:130 -140°c — 0.9X $

COST

PERFORMANCE

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QUANTITY & LEAD-TIME

- Production is done is panels
  - ➢ Be aware when creating sub-panels
- Min. Production batch is one panel
- Quick turn around service costs extra (QTA)

Regular sheet (Raw FR-4 copper clad)				
Cut	mm	inch	mm	inch
1	1220	48	915	36
4	610	24	457	18
6	457	18	406	16
6	610	24	305	12
8	610	24	228	9
8	457	18	305	12
9	406	16	305	12
10	457	18	244	10
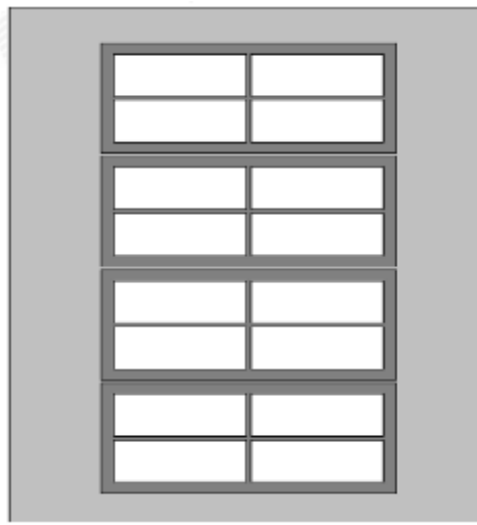
Size:
Panel: 18.0 x 24.0
Array: 11.125 x 5.125
Part: 5.0 x 2.0
Panel Yield:
4 Arrays of 4 Parts
16 Parts Total
62.6% Material Utilization
Matrix:
On Panel: 1 x 4, Origin: X3.4375 Y1.6
On Array: 2 x 2
Spacing:
On Panel: NA x 0.1
On Array: 0.125 x 0.125
Panel Borders:
Left: 3.4375 Right: 3.4375
Top: 1.6 Bottom: 1.6
Array Borders:
Left: 0.5 Right: 0.5
Top: 0.5 Bottom: 0.5

Poor utilization !

Increase cost of 33%
(16 circuits per panel verse
24 circuits per panel)
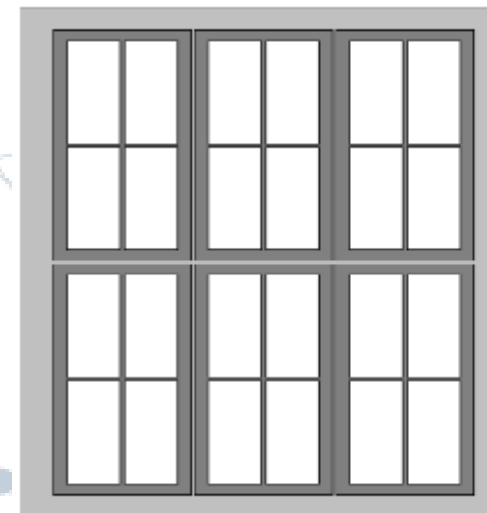
Size:
Panel: 18.0 x 24.0
Array: 5.125 x 10.925
Part: 2.0 x 4.9
Panel Yield:
6 Arrays of 4 Parts
24 Parts Total
77.8% Material Utilization
Matrix:
On Panel: 3 x 2, Origin: X1.2125 Y1.025
On Array: 2 x 2
**Spacing:**
On Panel: 0.1 x 0.1
On Array: 0.125 x 0.125
Panel Borders:
Left: 1.2125 Right: 1.2125
Top: 1.025 Bottom: 1.025
Array Borders:
Left: 0.5 Right: 0.5
Top: 0.5 Bottom: 0.5

Good utilization !

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LAYOUT PCB/PCBA

- Set-up Libary
  - ➢ Foot print according to specification or IPC2
- Mechanical outline
- Schematic entry
- Set-up fixed component placements
  - ➢ USB, Ethernet, Power etc.
- Component placement
- Height restriction

- Routing of critical signals
  - ➢ High current
  - ➢ High speed
  - ➢ Impedance traces
  - ➢ Length matching
  - ➢ Skew groups
- Full and split planes
- Set-up output files
  - ➢ ODB++, gerber, design file
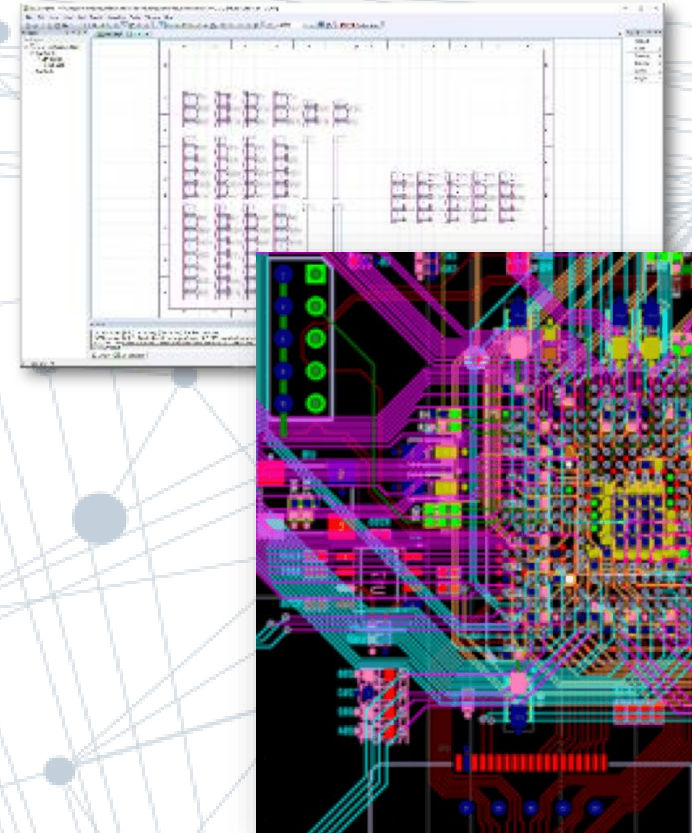
EARLY SUPPLIER INVOLVEMENT

- Think about who would be capable of manufacturing your design
  - ➢ Low volume, high volume
  - ➢ Quick turn around
  - ➢ Complexity

- Be aware of the capabilities of your partner
  - ➢ Determine their sweet spot

- Get them involved with your design
  - ➢ No suprises during RFQ or order stage

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DESIGN FOR MANUFACTURING (DfX)

- With special software the layout can be checked for manufacturability
    - ➤ Reccomended (not standard)
    - ➤ Extra cost and time
- Goal of DfM is "first time right"

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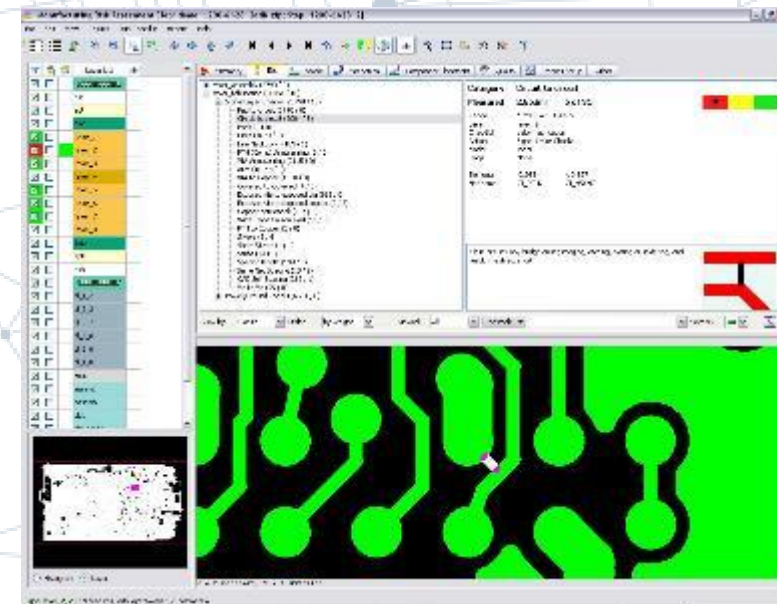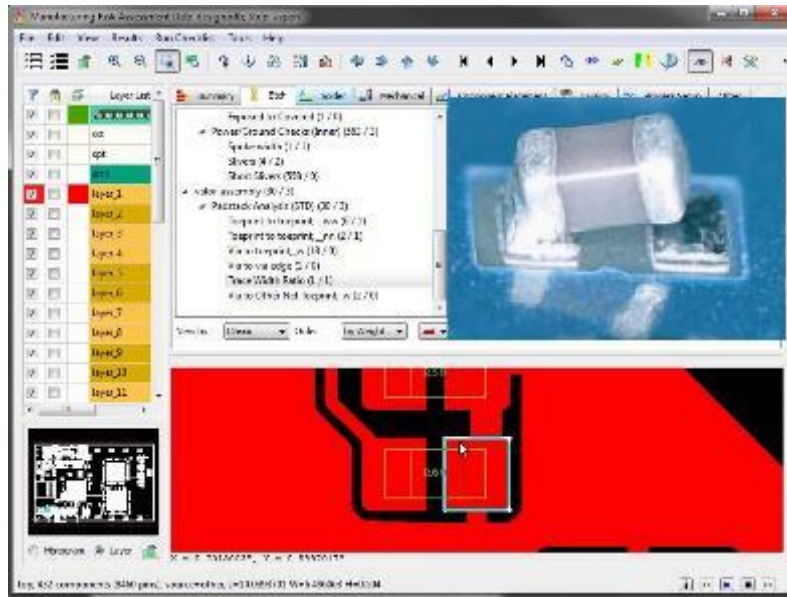
DESIGN FOR MANUFACTURING (DfM)

- DFM PCB (e.g. Genesis 2000)
  - ➤ Determine overall PCB technology
  - ➤ Design rule check
    - Pattern, holes, mechanical checks
  - ➤ Netlist check
    - Compare cad netlist with gerber net list
  - ➤ Impedance check
    - Calculte required impedance
    - Check stack-up manufacturabilty
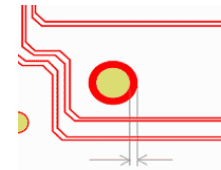
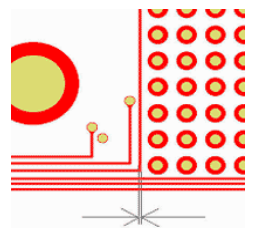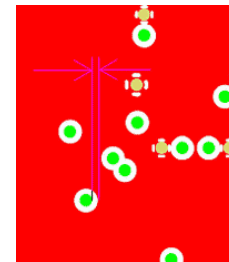Via Annular Ring - PTH Annular Ring   Pad to Pad   Track to Pad
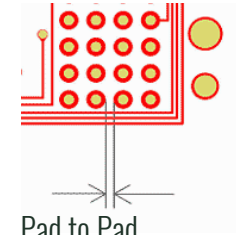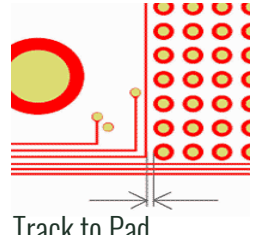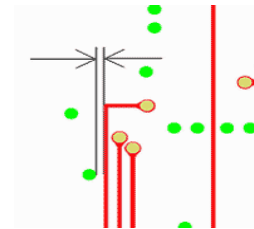
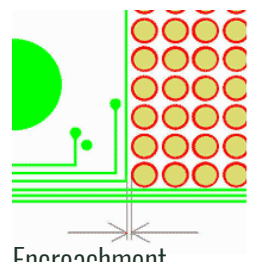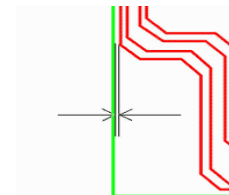PTH to Copper - NPTH to Copper   Track to Track   Track Width
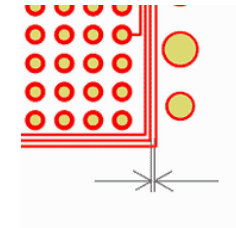
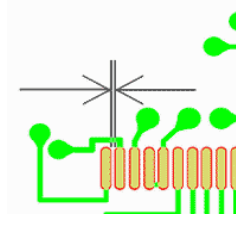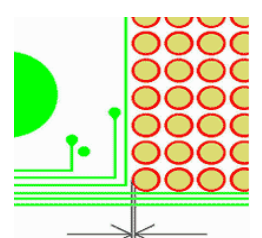PTH to Cu Plane   Text Width   Encroachment

Profile to Copper   Web (Dam)   Annular Ring

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DESIGN FOR MANUFACTURING (DfA)

- DFM PCBA (e.g. Valor NPI)
  - General check
    - Panel, Fiducials, transport edge, tooling holes
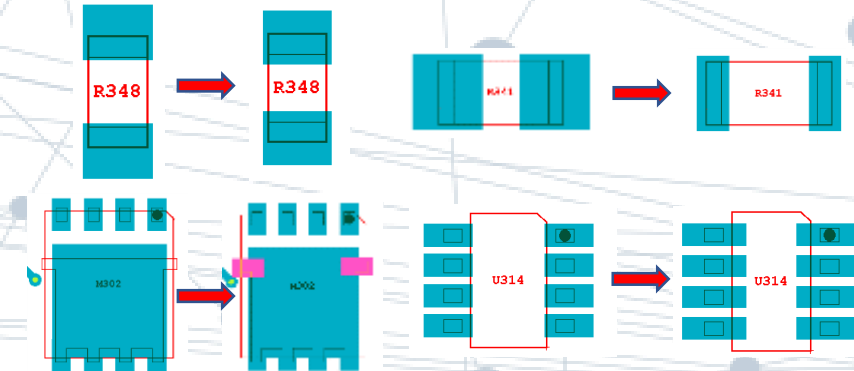 - BOM issues
    - Wrong codes, availability
  - Solderability check
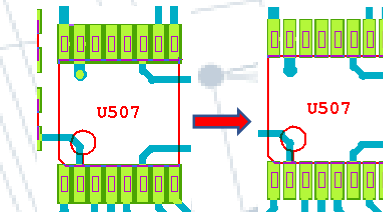   - Reflow, wave, paste
  - Design rule check
    - Component overlap, orientation, tombstoning, footprint, test, repair
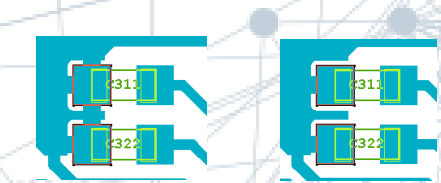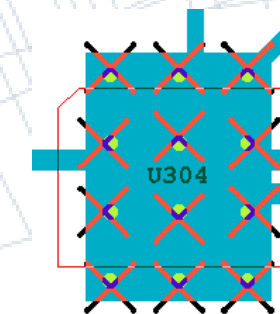
Footprint check

Solder mask dam check   Thermal unbalance
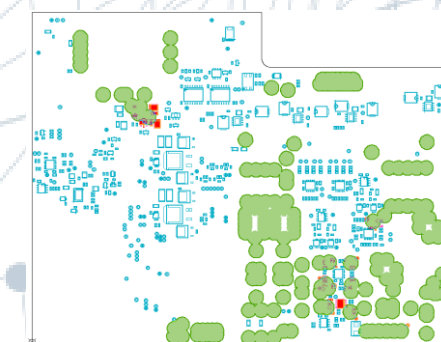
Holes not filled   Selective wave clearance

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PRODUCTION PCB/PCBA

- When the design is finished RFQ stage starts
  - ➤ Don't expect a full DfM in RFQ stage
  - ➤ During RFQ process only a ligth DfM will take place
- After placing the order production will start tooling and EQ's will follow
  - ➤ Only when EQ's are finished the quoted lead-time starts

PCB Technology	Single sided	Double sided	Multi-layer	Flex-rigid	H.D.I.
PCB production steps	22	30	40	60	>60

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CONCLUSION

- It is very easy to over or under specify your design
  - ➢ Be aware of the technology you really need
  - ➢ Your choice will determine the complexity of your PCB
- Talk to your production partner don't make assumption
  - ➢ Be aware of their capabilities
  - ➢ Make sure that what you design fits their production
- Respect the extra time and costs of DFx
  - ➢ Best way to achieve the "First time right goal"

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