# Excellent design for production

**Optimize your design for production**

Altium™

# Altium BV


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# Design For Excellence - DFx

- DFA (Assembly)
- DFM (Manufacturing)
- DFT (Test)
- DFC (Cost)
- DF….

# Quote

To be successful in today's increasingly time-sensitive and competitive markets, businesses need manufacturing processes that are fast, flexible, and adapt quickly to change.

Achieving this objective requires integrated solutions that **connect supply chains to factory processes, production equipment, and factory systems in a seamless, customer-centric network**.

SAP Manufacturing Strategy- An Adaptive Perspective

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# Design / Production Domains

- Designer world different than Producer world
  - **Expectation level** of designer does not always fit to available skills of producer
  - Designers know their design. Producers know their production processes
  - Producer cannot take responsibility for the design intent!!!
- Improvements
  - Early involvement of the producer (As early as possible)
  - Making right choices for PCB technology
  - **Awareness** of design aspects from the producer
  - **Awareness** of production aspects from the designer
  - **Awareness** of testing aspects from the designer

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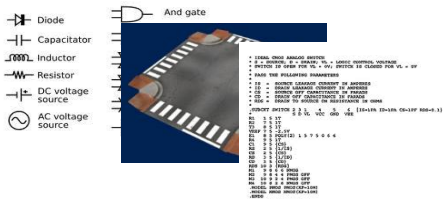
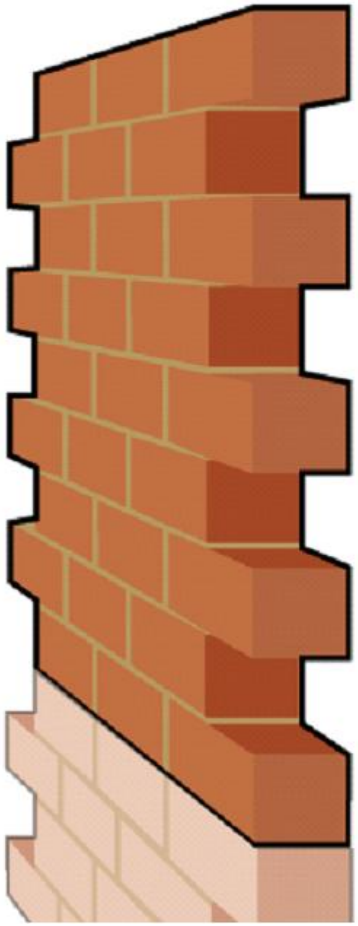
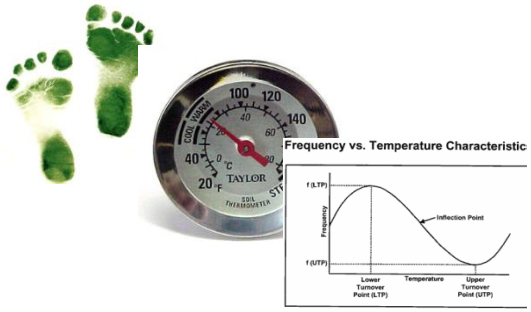
# Design / Production





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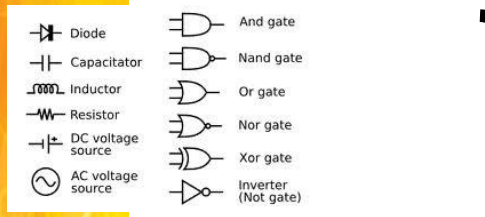
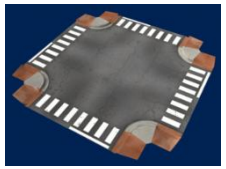
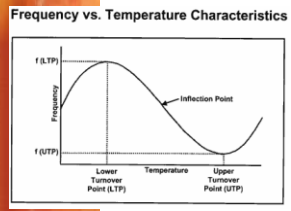
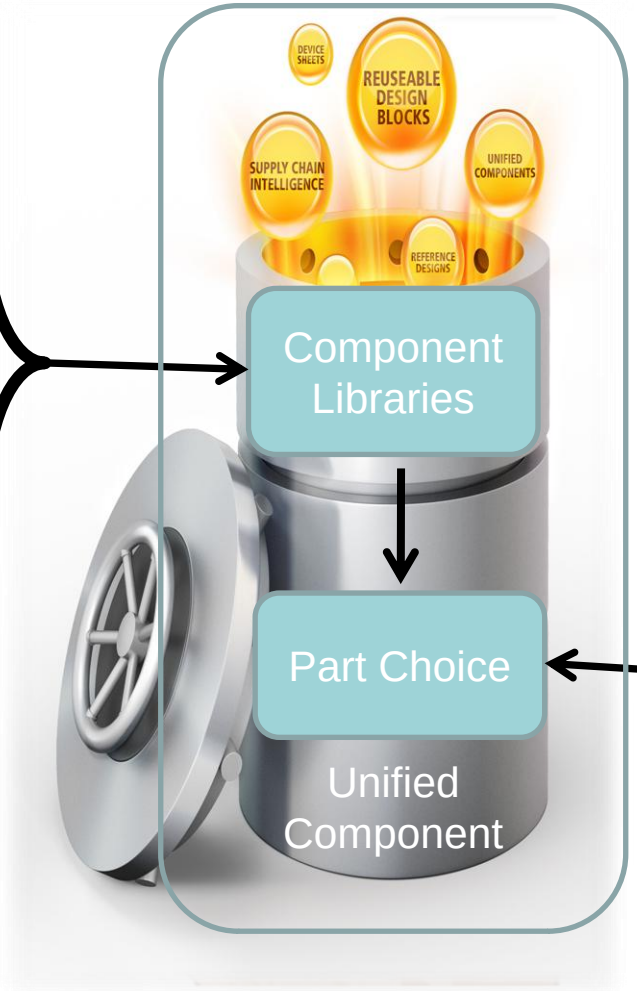
# Breaking the barrier…

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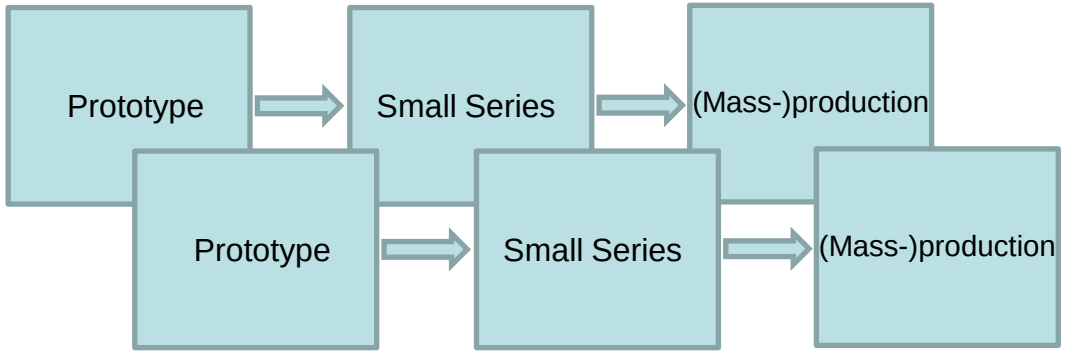
# PCB Design and Production process


Design




PCB Manufacturing

PCB Assembly/Test

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# Life Cycle Cost

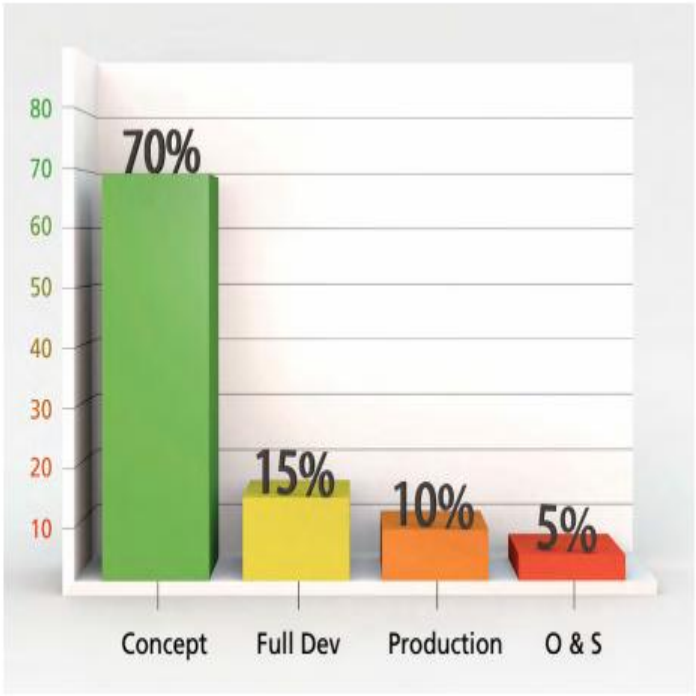
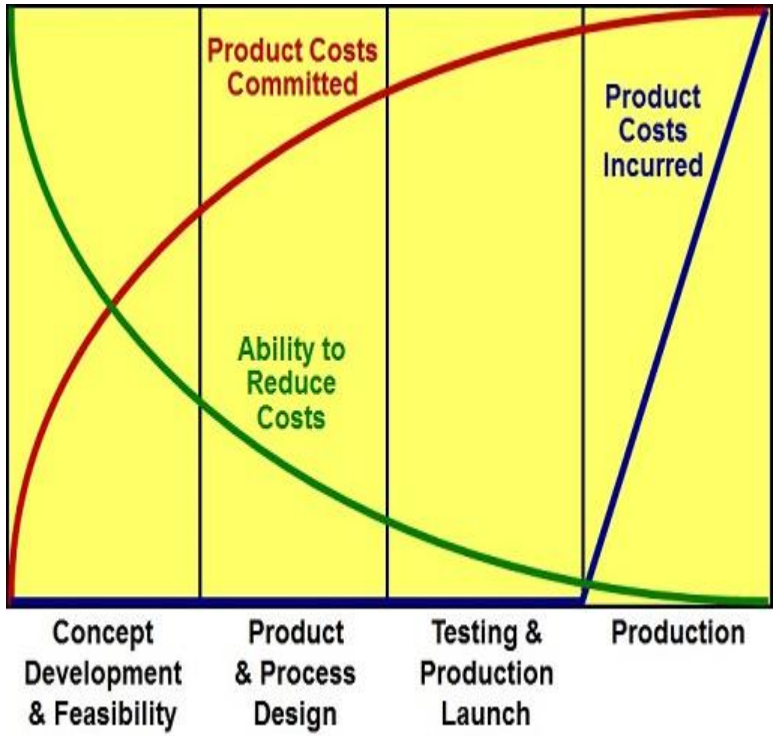



*Figure 1: Leveraged Effect of Design Phase on Life Cycle Costs*
*Source: Military Electronics/Countermeasures, August 1990.*

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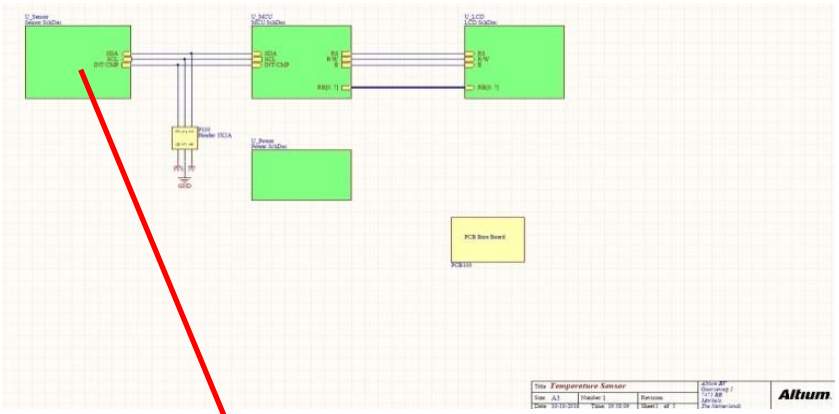
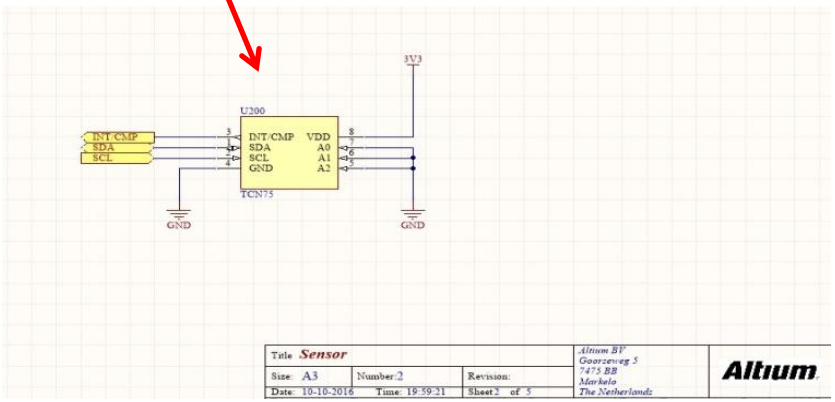
# Schematic Entry

- Functional decomposition (Block Diagram)
- Hierarchical Design
- Multi-Sheet
- Multi-Channel
- PCB Design Rules
- Variants
  - Alternative
  - (Un)Placed



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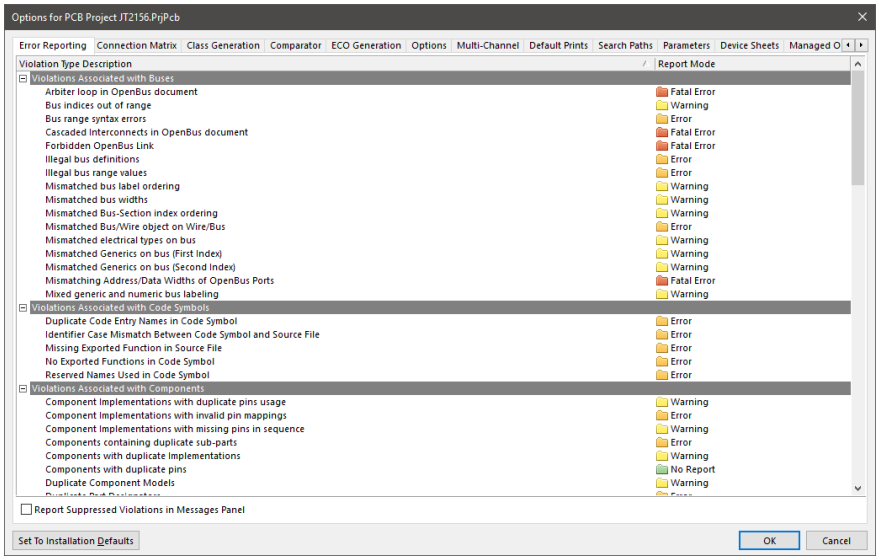
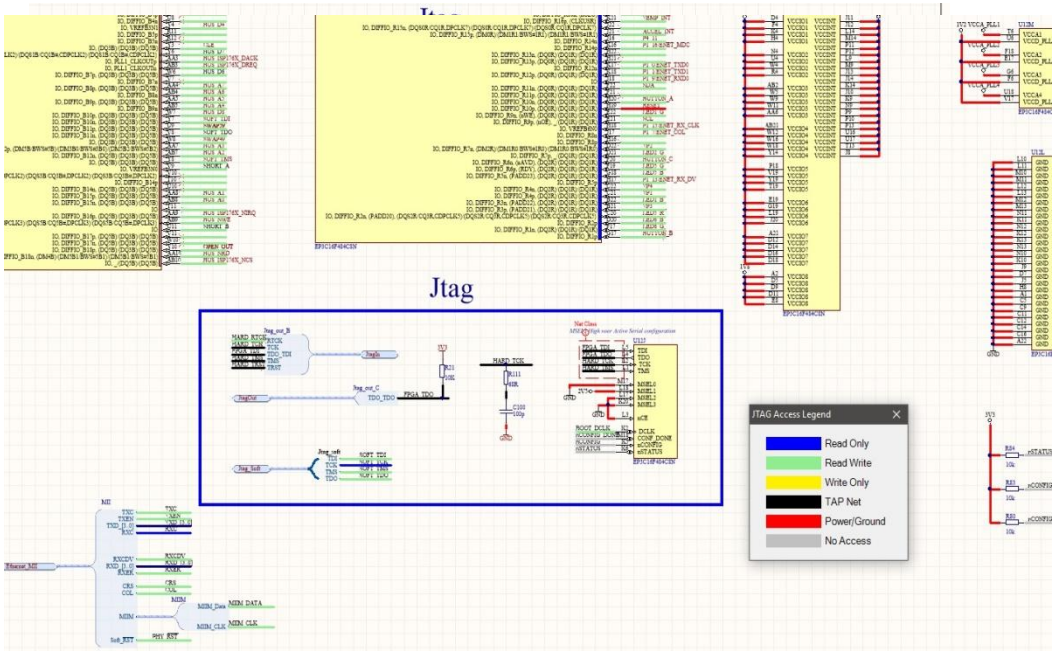
# Engineering Rule Checks - ERC

- Schematic diagrams can be checked:
  - Connectivity
    - Buses
    - Harnesses
    - Wires
    - Global power connections
  - Document
  - Net/Bus naming
  - Hierarchy
  - Component naming



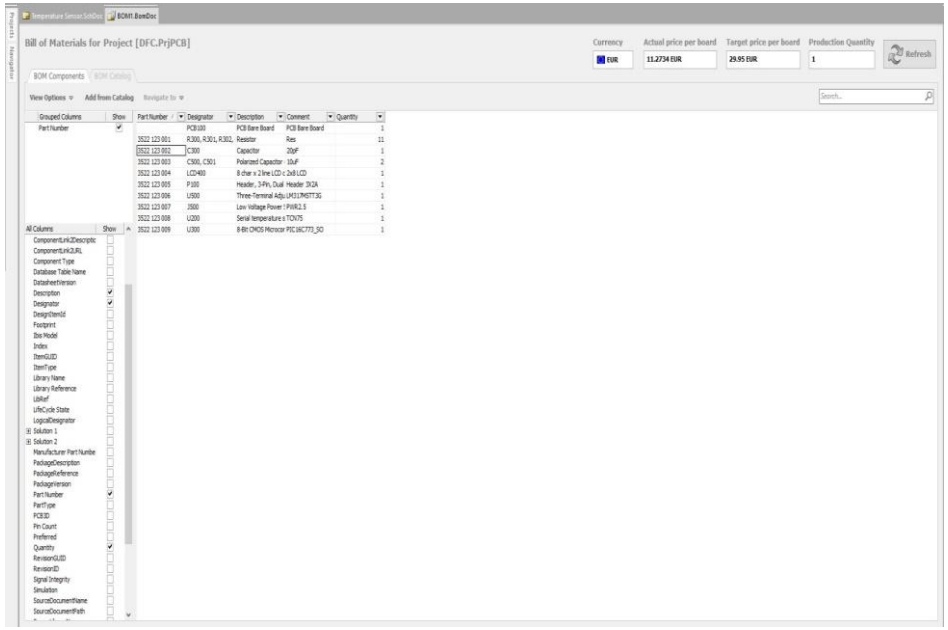
# Design For Test - DFT

- Accesability
  - Even before PCB Layout has started
- Test points
- Boundary Scan
  - Netlist
  - BS-Extensions



# Design For Cost - DFC

- Live Supplier Links
- Real time pricing using Active BOM
- Experiment with Quantity
  - Price
  - Availability
- 2 Views
  - BOM Components
  - BOM Catalog

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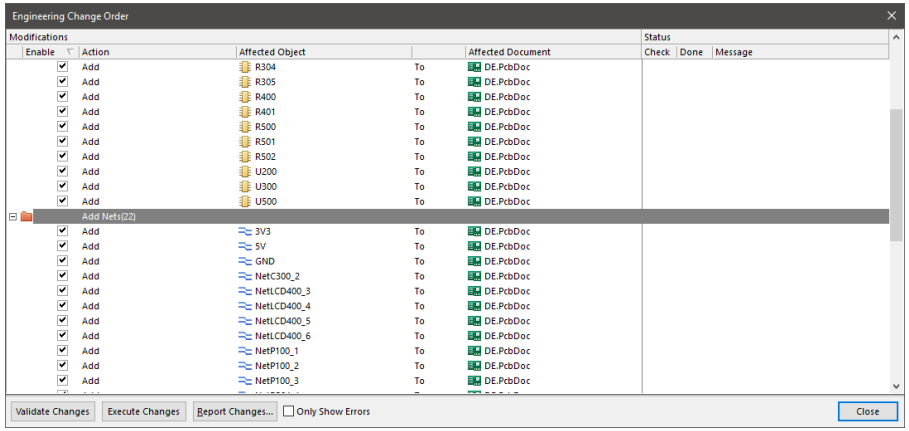
# Design Transfer to PCB

- Engineering Change Order
  - Differences between Schematic and PCB
    - Nets
    - Components
    - Multi-channel
    - Variant
  - Availability of footprints
    - Supplier libraries
    - Customer libraries
  - Footprint checks

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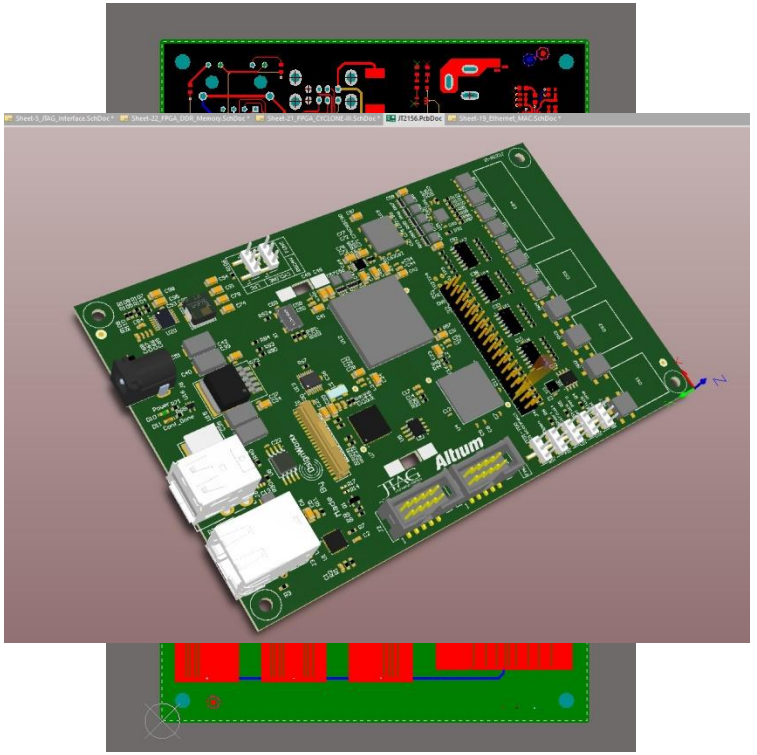
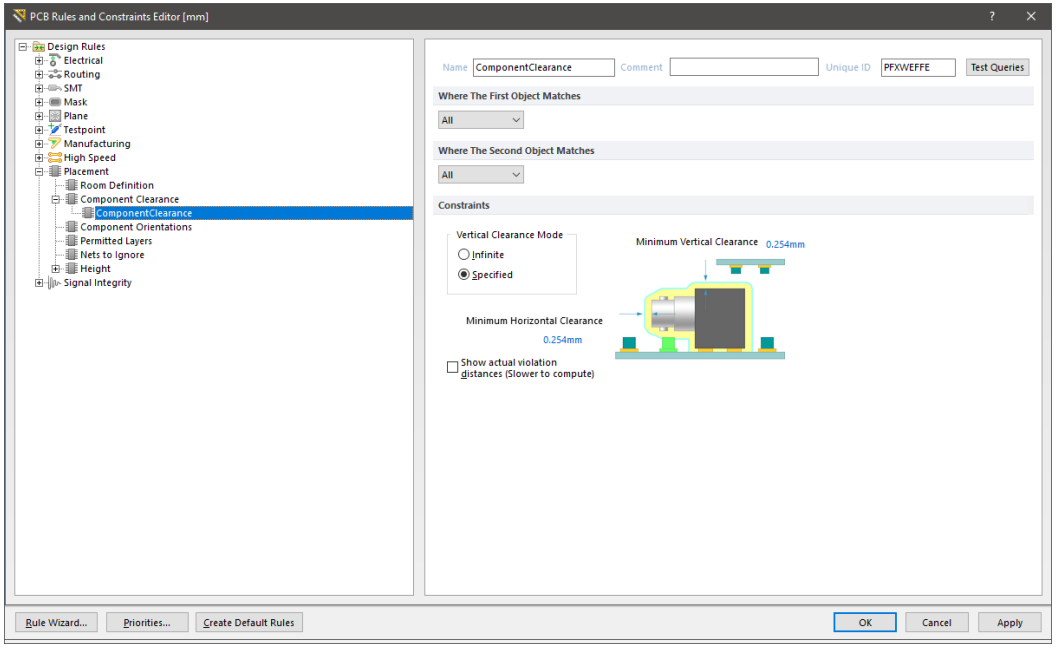
# PCB Design

- After Forward Annotation:
  - Netlist synchronization in PCB Editor
  - Design Rule creation
  - Component Placement
    - Floor planning
    - 2D/3D
  - Copper planes
  - Routing
    - Analog
    - RF
    - Digital
    - High-speed



# Design Rule Check - DRC

- Electrical
  - Trace and plane clearance
  - Short Circuits
  - Open Connections
- Routing
  - Trace widths
  - Permitted layers
  - Via sizes
  - Differential Pairs
  - Length Tuning
- Placement
  - Height
  - Component clearance

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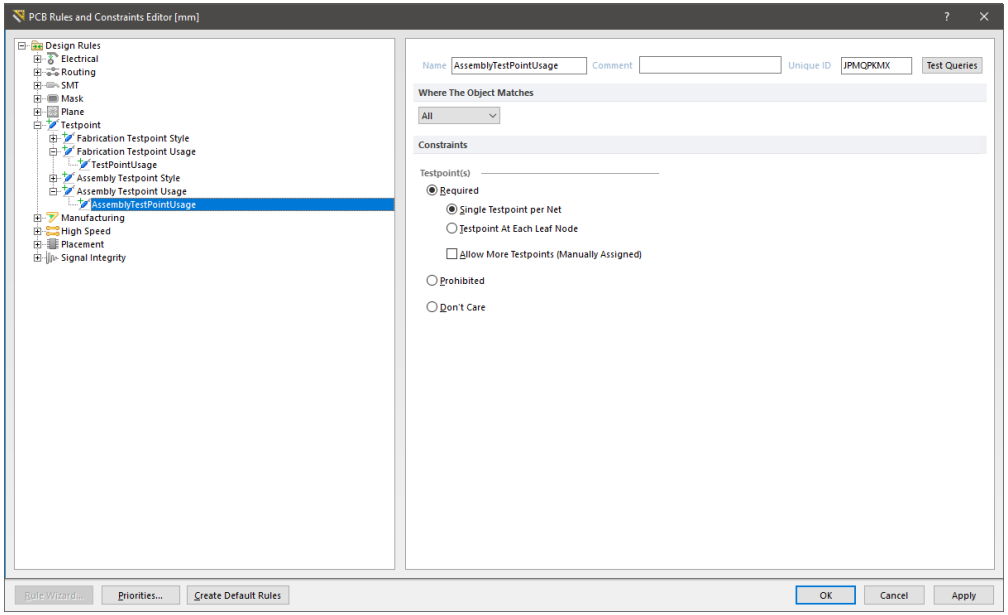
# Design Rule Check (cont.)

- Manufacturing
  - Bare Board
    - Solder mask
    - Annular ring
    - Hole size
  - Assembly
    - Solder paste
    - Silkscreen
- Test
  - Test points

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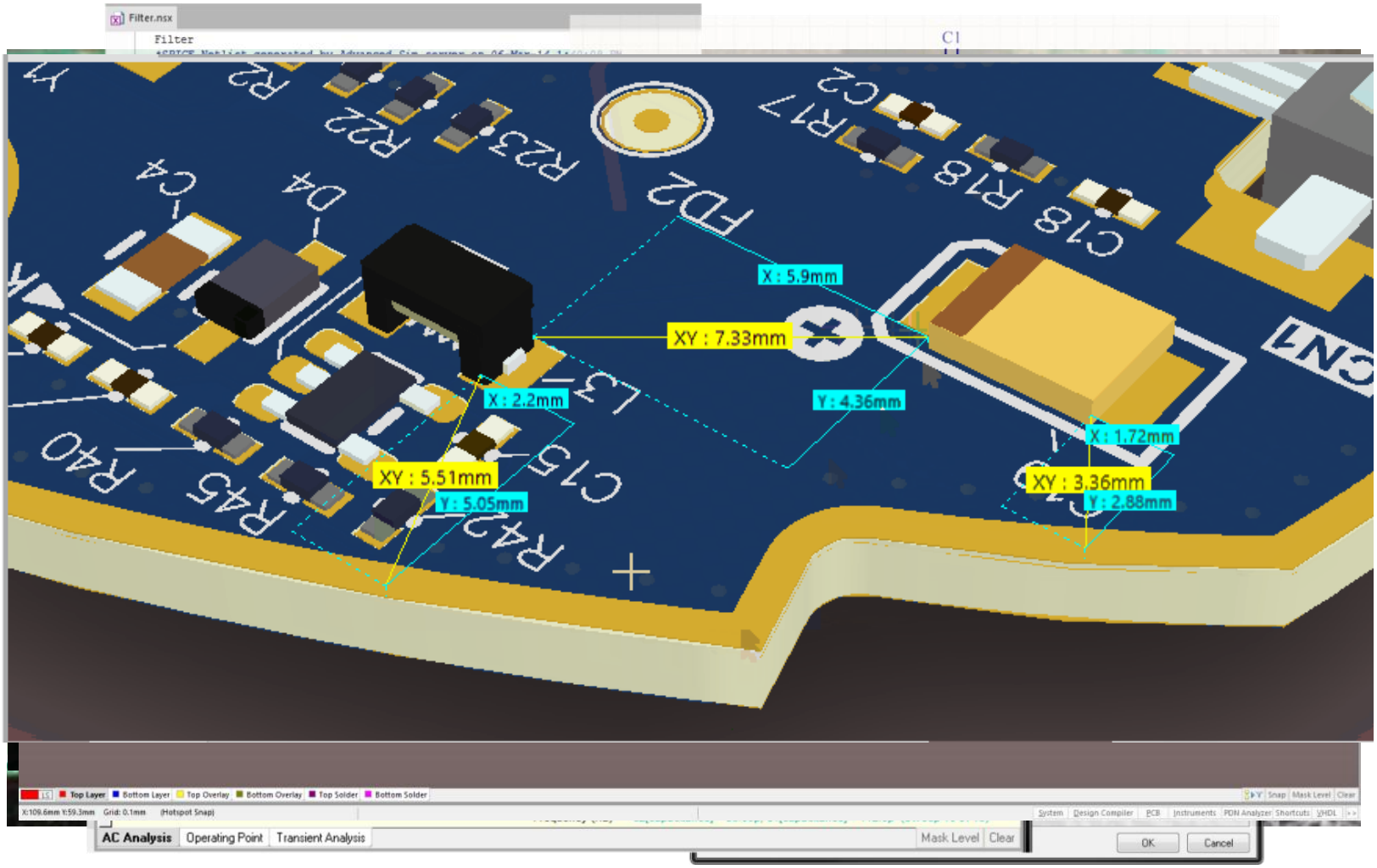
# Design Analysis

- Typically, most solutions will have you rely on a post process/design afterthought, which requires a physical prototype to verify.
- During design: Ability for upfront analysis
  - Simulation A/D
  - Signal Integrity
  - Power Distribution
  - Mechanical integration
  - ……

# Design Analysis

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# Technical Product Documentation

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- Tim
- Mai
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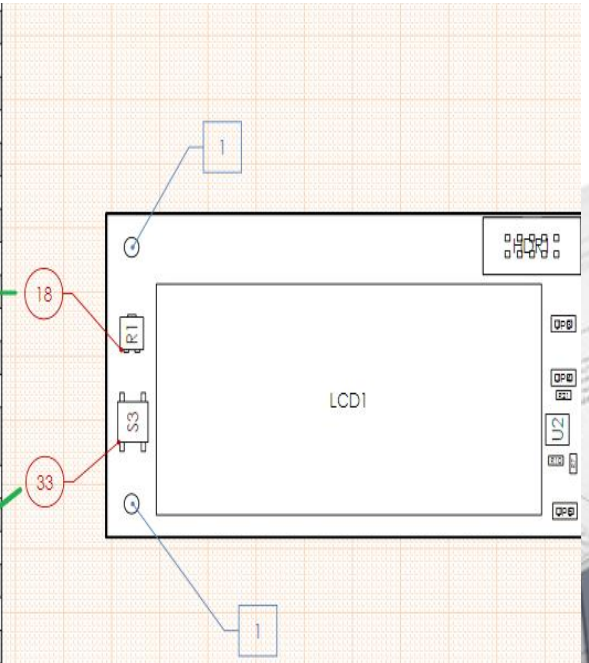
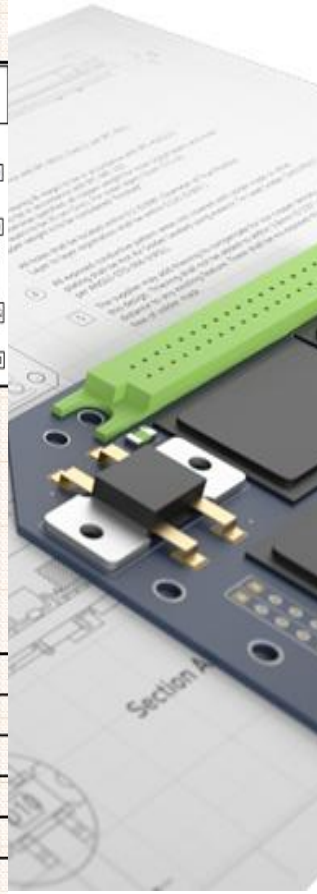
  -

| | | | |
|---|---|---|---|
| 10 | J1 | KLD-0202-B | 1 |
| 11 | JP3 | X axis | 1 |
| 12 | JP4 | Y axis | 1 |
| 13 | JP5 | CONFIG | 1 |
| 14 | JP2, JP6 | GND | 2 |
| 15 | LCD1 | 162A | 1 |
| 16 | LED0-LED9 | HSMH-C170 | 10 |
| 17 | Q1 | 2N7002 | 1 |
| 18 | R1 | 20K | 1 |
| 19 | R10 | 680R | 1 |
| 20 | R11 | 0R | 1 |
| 21 | R12, R14, R21, R22 | 100R | 4 |
| 22 | R15, R20, RA1-RA3, RA9, RA10 | 270R | 7 |
| 23 | R17 | 47R | 1 |
| 24 | R13, R18 | 120R | 2 |
| 25 | R19 | 5R6 | 1 |
| 26 | R2 | 560R | 1 |
| 27 | R3 | 10K | 1 |
| 28 | R7 | 1K | 1 |
| 29 | R8, R9 | 68R | 2 |
| 30 | RA4-RA8, R4-R6, R16 | 4K7 | 9 |
| 31 | S1 | TL36WW050 | 1 |
| 32 | S2 | A6ER-8104 | 1 |
| 33 | S3 | DTSM-61-NR | 1 |
| 34 | U1 | XC2S300E-6PQ208C | 1 |
| 35 | U2 | ADXL202E | 1 |
| 36 | U3, U4 | LM1084IS-ADJ | 2 |
| 37 | U5 | XCF02SVO20C | 1 |
| 38 | U6 | SN74LVC1G04DBV | 1 |
| 39 | Y1 | 25MHz | 1 |



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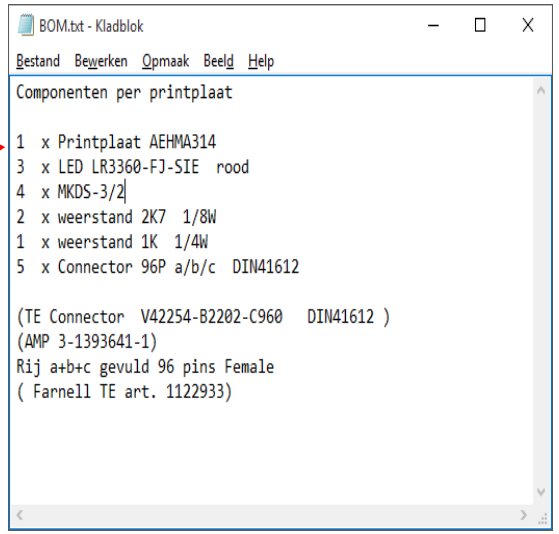
# Production data

- Design data -> Production data
  - Production data is just a subset of design data
    - Gerber, NC-drill, netlist, …
  - Bill of Materials:
    - Excel, Text, CSV, PDF, …
    - Formatted by the designer
    - Not always complete or not always clear enough (e.g. missing MPN)
    - Preliminary BOM
    - Variants
  - Improvements:
    - Use templates from Producer
    - Use ODB++ (or IPC-2581)
    - Always deliver MPN
    - Indicator for alternative components
    - Revision control (PDM/PLM) is more than sending a ‘versioned’ .zip file
    - 3D visualization or even 3D printed mockup

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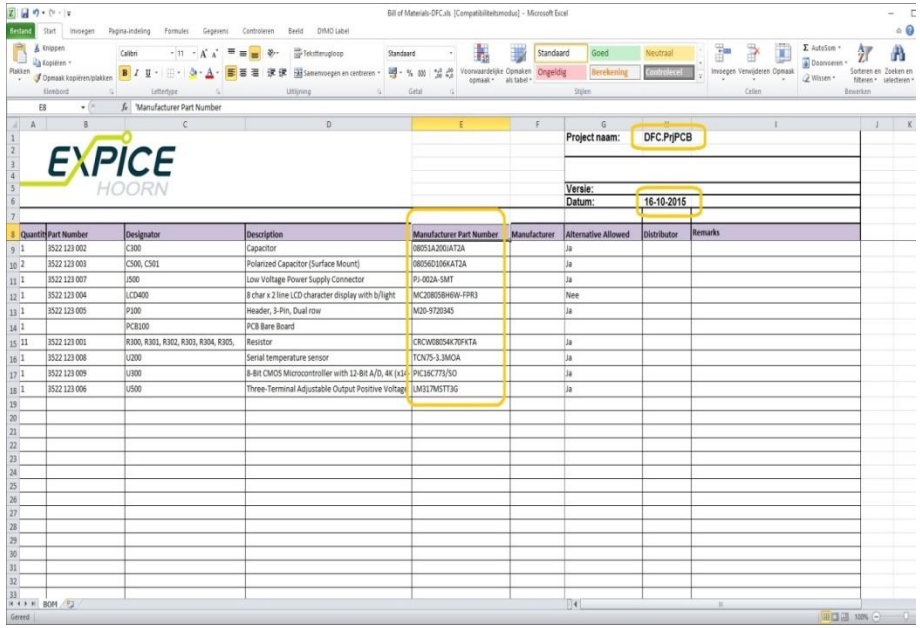
# Bill of Materials Template

- Use BOM template from producer
  - Can be used during output generation
  - Streamlines dataflow
  - Prevents incomplete BOM
  - Less work for producer
    - Lower the labor costs
    - More competitive
  - Prevents errors
  - Communicate with supplier about the preferred format
  - **<u>Need for structured libraries</u>**




| Quantity | Part Number | Designator | Description | Manufacturer Part Number | Manufacturer | Alternative Allowed | Distributor | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1 | 3522 123 002 | C300 | Capacitor | 08051A200JAT2A | | Ja | | |
| 2 | 3522 123 003 | C500, C501 | Polarized Capacitor (Surface Mount) | 08056D106KAT2A | | Ja | | |
| 1 | 3522 123 007 | J500 | Low Voltage Power Supply Connector | PJ-002A-SMT | | Ja | | |
| 1 | 3522 123 004 | LCD400 | 8 char x 2 line LCD character display with b/light | MC20805BH6W-FPR3 | | Nee | | |
| 1 | 3522 123 005 | P100 | Header, 3-Pin, Dual row | M20-9720345 | | Ja | | |
| 1 | | PCB100 | PCB Bare Board | | | | | |
| 11 | 3522 123 001 | R300, R301, R302, R303, R304, R305, | Resistor | CRCW08054K70FKTA | | Ja | | |
| 1 | 3522 123 008 | U200 | Serial temperature sensor | TCN75-3.3MOA | | Ja | | |
| 1 | 3522 123 009 | U300 | 8-Bit CMOS Microcontroller with 12-Bit A/D, 4K (x1 | PIC16C771/SO | | Ja | | |
| 1 | 3522 123 006 | U500 | Three-Terminal Adjustable Output Positive Voltag | LM317MSTT3G | | Ja | | |

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# Transfer DSW


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# DFM/DFA - Vayo

- CAD DRC
- CAM DFM/DFA
- Component Libraries

| Difference | DRC in EDA | DRC+ | DFM Expert (Comprehensive DFM analysis) |
|---|---|---|---|
| 1. Total check rules | appr. 100 | appr. 1000 | appr. 1200 |
| a. fabrication | 50~80 | 300 | 300 |
| b. assembly | <10 | 700 | 900 |
| c. test points | <10 | 30 | 30 |
| 2. Customization | | value added service | value added service |
| 3.1 Component entity library | | | YES |
| 3.2 Component checking rules | | | + >100 rules |
| 4. BOM import, comparison, export | | | YES |
| 5. 3D assembly boards, and export | | | YES |
| 6. Support Gerber data source | | | YES |
| 7. Job comparison, layer comparison | | | YES |

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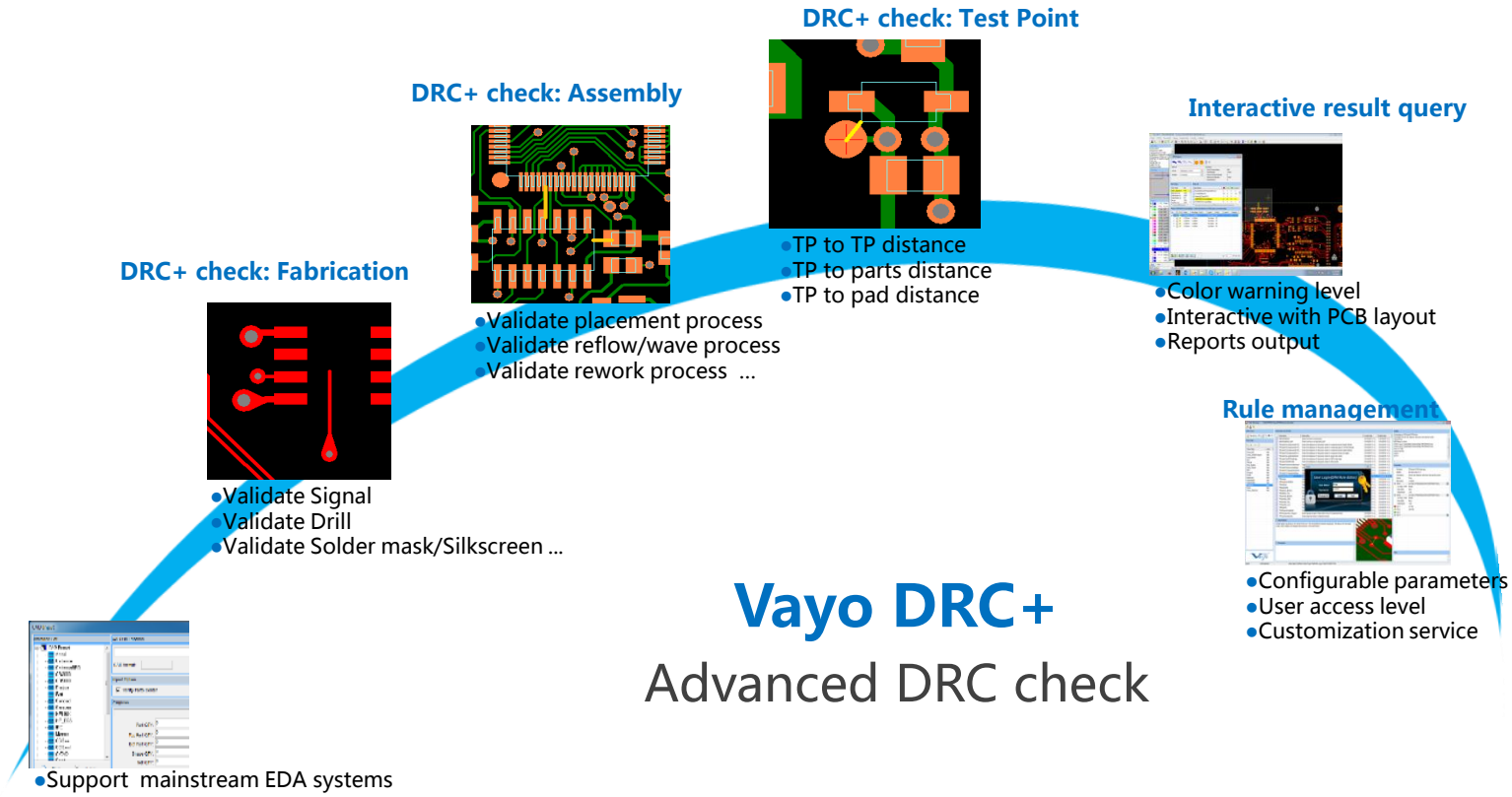
# DRC+




## Vayo DRC+

Advanced DRC check

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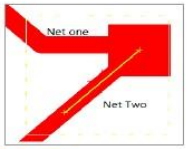
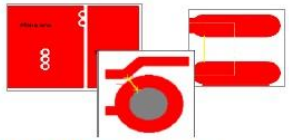
# Examples of PCB Fabrication Defects




**Shorts**

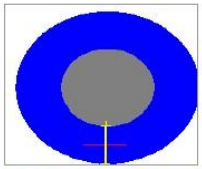
Risk: PCBA malfunction



**Safe distance check**

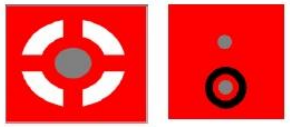
(Check distance among trace, pad & hole)

Risk: shorts, difficult to repair



**Annular ring, Gasket analysis**

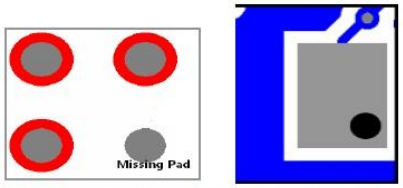
Risk: Difficult to solder or poor solder joint quality



**Thermal pad check**

(Thermal connection & thermal spoke width)

Risk: Fast heat distribution cause cold soldering

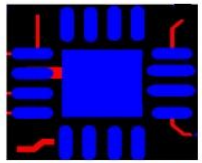



**Pad issue (Missing, via on pad)**

Risk: Assembly problem, insufficient solder

**Solder mask check**

Risk: Sold problem



**Trace output from long edge**

Risk: Standardize design

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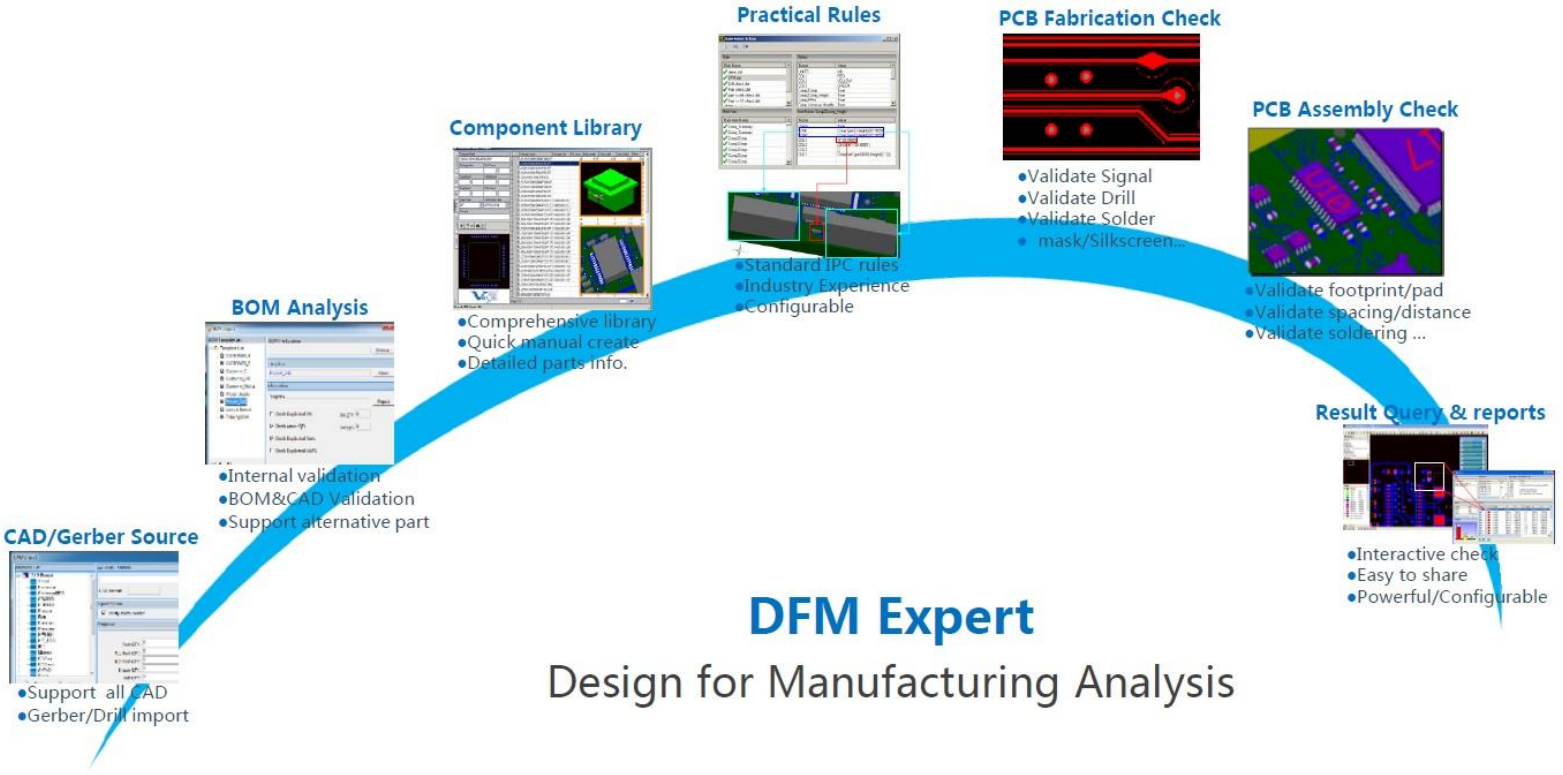
# DFM Expert




## DFM Expert

Design for Manufacturing Analysis

Comprehensive, Automatic, Easy

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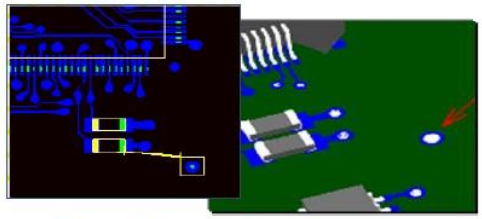
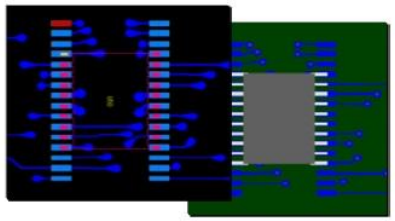
# Examples of Assembly Defects



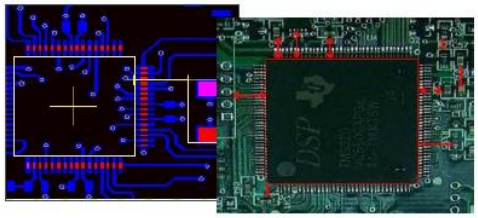
**Fiducial mark check**

Risk: identification problem



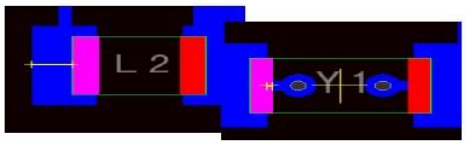
**Package Vs. pad validation**

Risk: Placement error, poor soldering



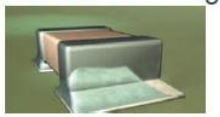
**Component safe distance check**

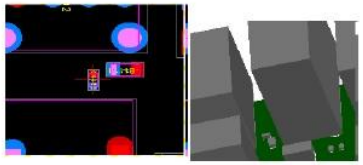
Risk: Poor Soldering, difficult to rework




**Pin .Vs. pad Analysis**

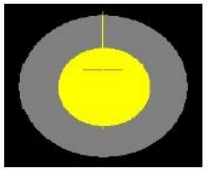
Risk: Poor soldering





**Low SMD comp. between high SMD comp. analysis**

Risk: Component damage, difficult to rework



**PTH lead to drill safe distance check**

Risk: problem for manual insert process or poor reliability

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# Q & A

Any questions?

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