COMPETITIVE ELECTRONICS ASSEMBLY NEARBY

GEERT WILLEMS – IMEC-ELECTRONIC ASSEMBLY
CENTER FOR ELECTRONICS DESIGN AND MANUFACTURING

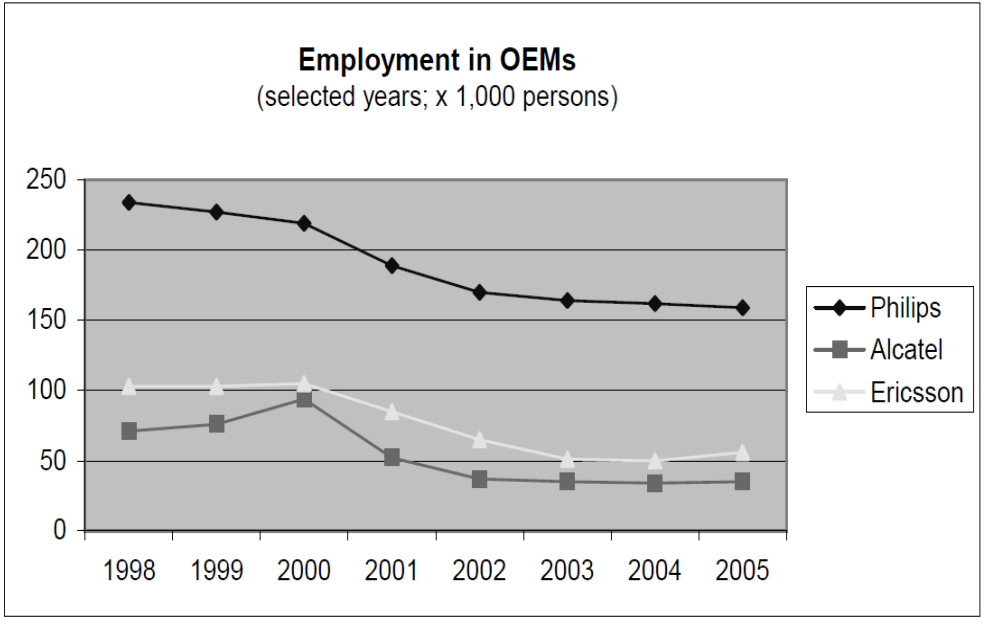
EDM
Electronics Design & Manufacturing

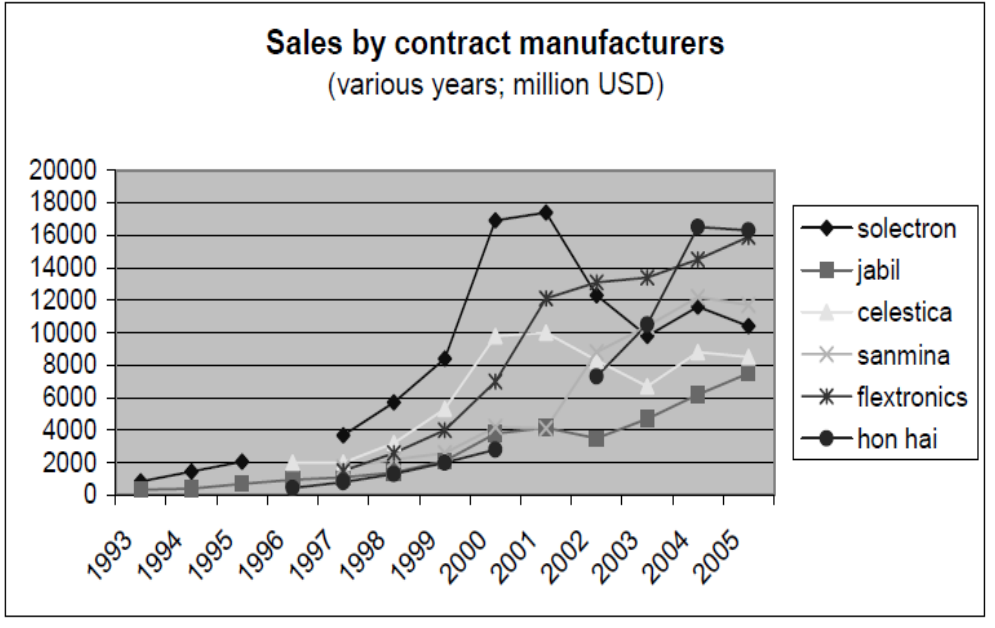
OUTLINE

- 20th Century Manufacturing Outsourcing
- Outlook 2016
- Re-shoring: bring manufacturing back
- What is needed?
- Quantification of Product Life Cycle Risks
- cEDM Tool Box

THE 20TH CENTURY MANUFACTURING OUTSOURCING

THE TREND





- Focus on the core business
- Low cost electronics manufacturing by EMS:

US → Mexico

West → East Europe

→ China

THE 20TH CENTURY MANUFACTURING OUTSOURCING

20 YEARS OF ELECTRONICS OUTSOURCING

The result

- Electronics is everywhere
- China: The world's factory
- US-Europe: major decline in manufacturing activity and know-how ...
  ... that is needed for cost effective, qualitative product development
- Highly complex and fragmented supply chain
- Declining quality and reliability
- Counterfeit: >10% of electronic components
- Copyright → "The right to copy"
- Slow response speed to customer driven changes.
- A lot of hidden costs: non-quality, communication, engineering changes, design iterations,...
- Transport: cost, environment

OUTLOOK 2016 - INDUSTRY

"THE TIMES THEY ARE A-CHANGIN' "?

EPS ELECTRONICS PURCHASING STRATEGIES NEWS+Plus

INFORMING, EMPOWERING & CONNECTING SUPPLY CHAIN DECISION MAKERS

Foxconn Is Coming to America: Has Offshoring Peaked?

Bolaji Ojo | January 28, 2014 | 1 Comment

Manufacturing Comes Back to United States *Terry Costlow, IPC online editor* *September 2, 2013*

HOW RESHORING DRIVES PROFITABILITY

This paper was originally published in the IPC APEX EXPO 2015 technical conference program.

Domestic Versus Offshore PCB Manufacturing

SUNSTONE

"Made in USA" ©2013

The Trend Away From Offshore PCB Manufacturing

Is Nearshoring Right for Your Product? JULY 2012

As China matures, a host of factors could rebalance the geographical supply chain.

Must manufacturing leave Europe?

Electronic Engineering Times Europe November 2013

"Raspberry Pi has shown that with the right product addressing a global market European manufacturing not only makes sense, but can show a lead to the world."

Is Reshoring A Viable Option?

Tue, 01/21/2014 - 9:58am

by Tia Nowack, Associate Editor, Industrial Maintenance & Plant Operation

More: http://reshoringmfg.com/

A NEW PARADIGM FOR DESIGN THROUGH MANUFACTURE

Presented at IPC Apex 2012

Why Printed Circuit Board Design Matters to the Executive:

How PCBs Are a Strategic Asset for Cost Reduction and Faster Time-to-Market

February 2010

OUTLOOK 2016 - GOVERNEMENT

"THE TIMES THEY ARE A-CHANGIN' "?

EPRS
European Parliamentary Research Service

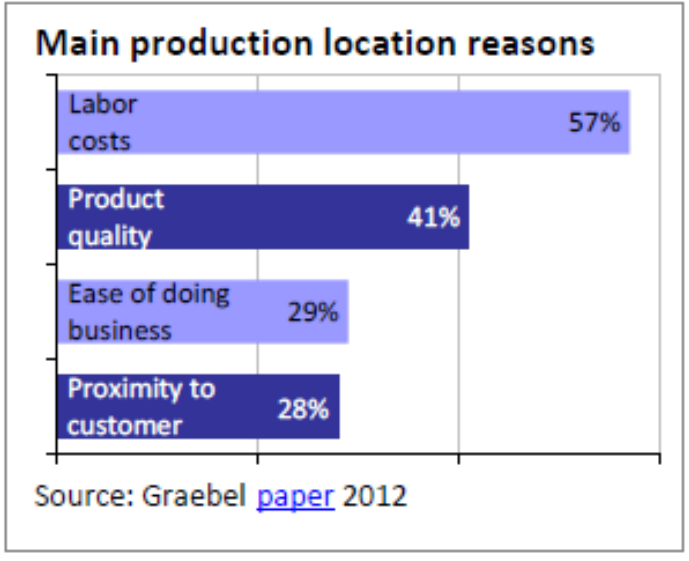
Briefing
21/03/2014

Reshoring of EU manufacturing

DRIVERS FOR RE-SHORING

Industry

- Rising total landed cost
  - Increasing labour cost
    China: +10%/y ('00-'05) +19%/y ('06-'10)
  - Increasing transport costs: oil x3 since '00
  - Cost of (larger) inventory
- Product quality
- Intellectual Property
- Ease of doing business
- Proximity to customers
- Mitigate supply risk



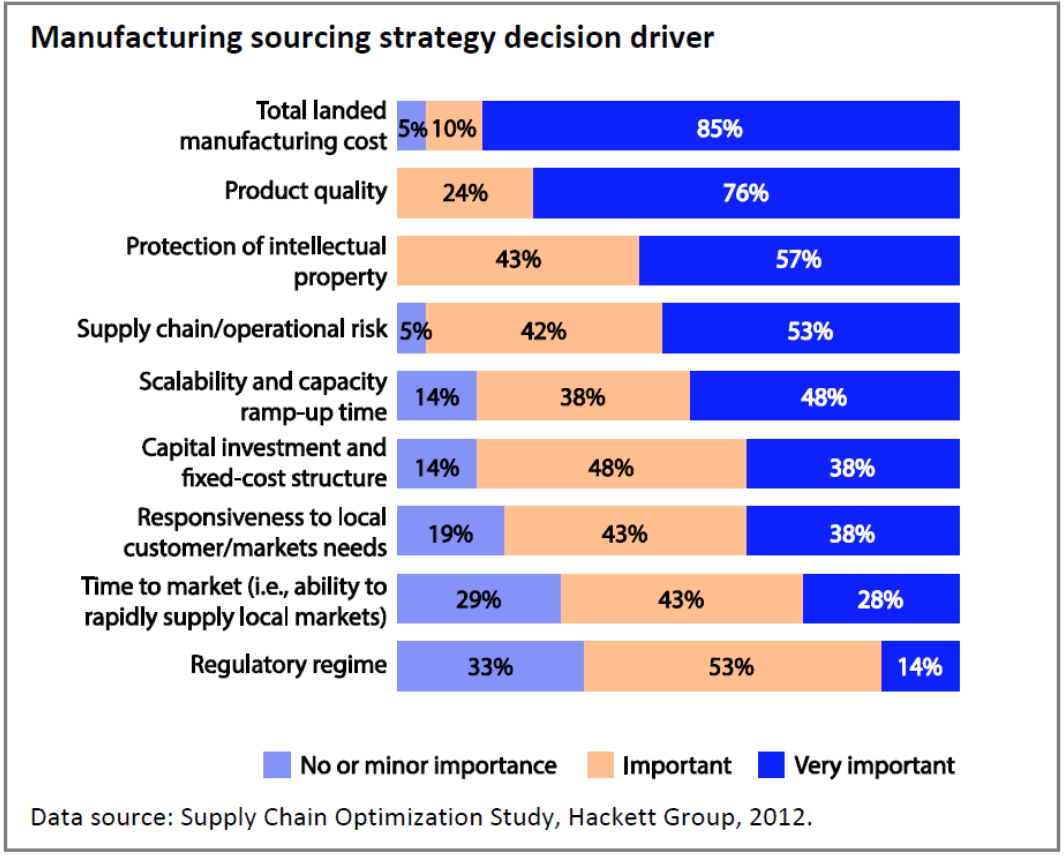
Governements

- Jobs: 1 manufacturing job + 2.5 support
- Higher pay than service sector
- More R&D → innovation, IP
- More export, less import

Ref: EPRS-study – Reshoring of EU manufacturing – 21/03/2014

MOST LIKELY PRODUCTS TO BE RE-SHORED

- Expensive to transport:
  ex. Heavy machinery
- "Dynamic" goods subject to frequent changes in consumer demand and short product life-cycles
- Products where safety concerns are important



OUTLOOK 2016 - EU

EU DRIVERS: TOWARDS 20% GDP BY 2020

- Factories of the Future – Industry 4.0
  Horizon 2020 "Industrial Leadership" category 2014-2020: **€17 billion**
- Skills 4.0 (Human-centered Manufacturing)
  Need for highly skilled, efficient workforce
- Nearshoring in Eastern Europe
  R&D support, skilled workforce, infrastructure
- Carbon Neutral Manufacturing
  Energy consumption, renewable energy
- Additive Manufacturing
  3D printing-as-a-service model
- Nanotechnology

Manufacturing in EU: 15% GDP
33 million employees

MANUFACTURING LEADERSHIP
FROST & SULLIVAN

The Future of Manufacturing in Europe

Posted By Muthukumar Viswanathan, April 05, 2016 at 12:29 PM, in Category: Factories of the Future

WHAT IS NEEDED?

Product:

- Dynamical
- Quality
- Safety → reliable
- High value

Trustworthy PREDICTION of all Product Life Cycle aspects

(without costly, long duration prototyping & testing)

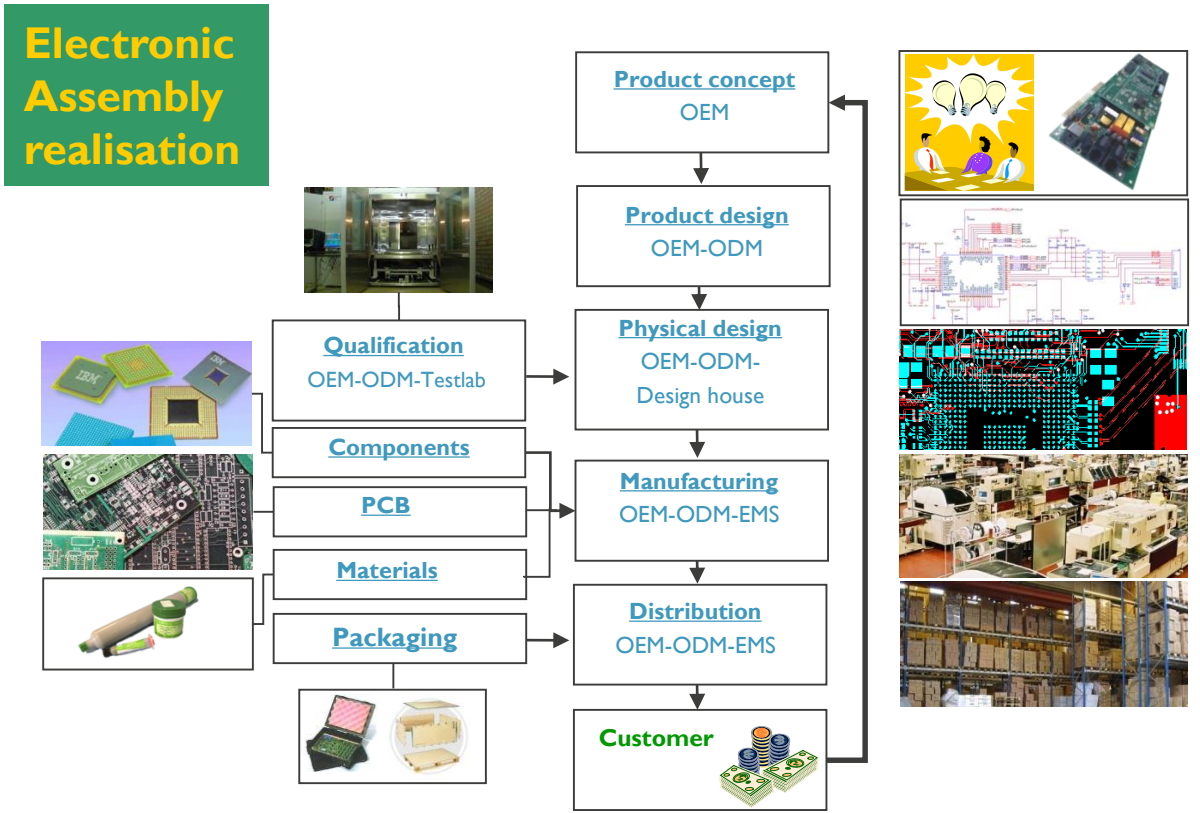
Design-for-eXcellence

Manufacturing, Reliability, Logistics, Cost,...

Challenge:

In the US – and in parts of Europe – there is difficulty in finding suitably skilled labour, reflecting the education system and a loss of specific manufacturing know-how, which has passed to new countries.

WHAT IS NEEDED?
PRODUCT LIFE CYCLE & SUPPLY CHAIN



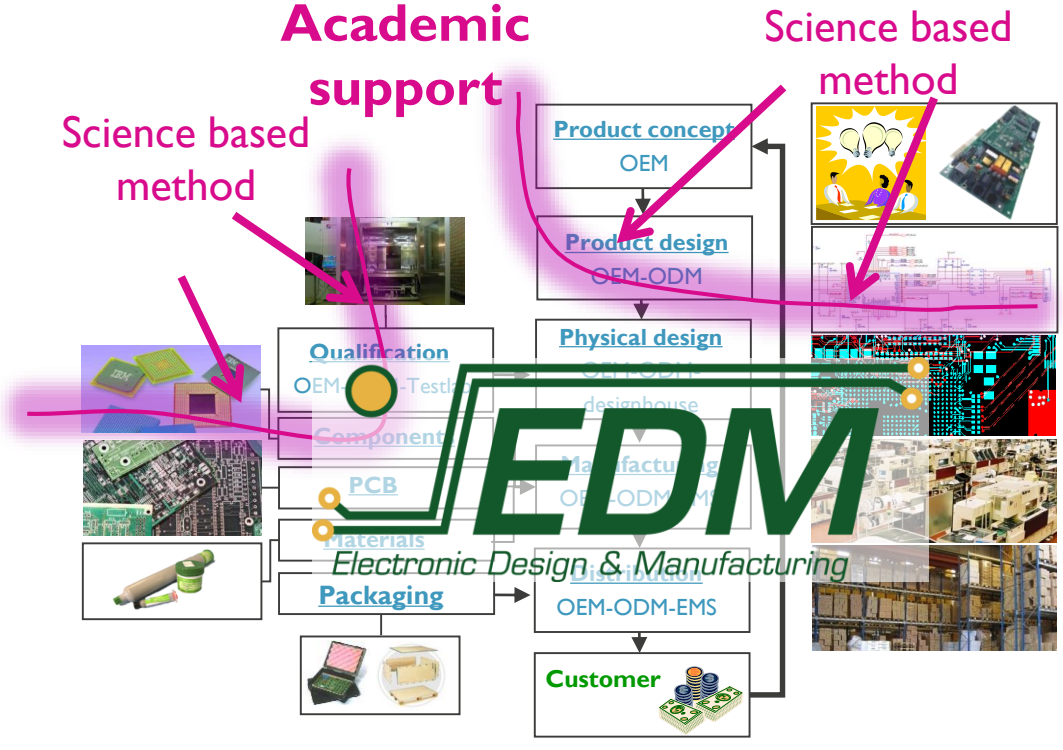
Status

- Many players.
- International.
- Very complex.
- Fragmented responsibility.
- Little academic support and education (esp. at master level)

Consequence

- Poor electronic product specification.
- Poor control of product and supply chain quality and performance.
- Development of design guidelines has stopped.

WHAT IS NEEDED?
SCIENTIFIC/ACADEMIC SUPPORT



Experience-based industrial approach

Insufficient scientific basis and possibilities for education :

- PCB/PBA technology
- Substrate manufacturing
- Electronics assembly
- Test coverage
- Failure-mechanisms
- Design-for-X
- Reliability tests
- etc.

to handle challenges of complexity, quality and reliability

WHAT IS NEEDED

- From experience to science based product development and manufacturing
- IC realisation as a source of inspiration:
  Each realisation element of an IC has a EA ‘sibling’.

IC realisation	EA realisation
• Materials semiconductors, metals, insulators, interfaces	• Materials polymers, metals, solder, interfaces
• Process-steps oxidation, implantation, deposition, lithography,…	• Process-steps lamination, drilling, plating, lithography, printing, assembly, soldering,…
• Production-flow IC process flow	• Production-flow substrate b… …, assembly flow
• Test and analysis	• Test and a… …is
• Design – layout - TAD	• Design – layo… …ufacturing
• Reliability	• Reliability

CEDM MISSION

To support industry

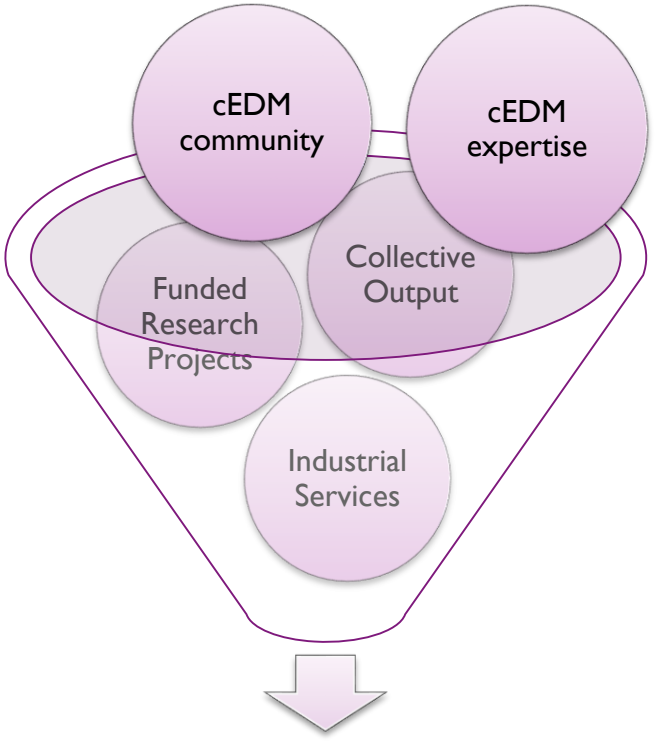
in the development and manufacturing of high quality, reliable and cost-effective electronic modules (PBA)

by means of

knowledge creation and sharing,

scientifically sound methodologies,

collaboration throughout the electronic supply chain.



Better electronics at reduced cost through science based design & production methodologies

QUANTIFIED ASSESSMENT OF PLC RISKS

Product Life Cycle of electronics

Development

Concept | Design | Prototyp… …lification

Manufacturing

Industriali… …oduction

Us…

Operation | Maintenance

End-of-Life

Decommissioning | Reuse – Recycle – Waste

Science based Quantification

cEDM Guidelines & Tools

CEDM GUIDELINES: NEW STRUCTURE

DESIGN/DfX	Qualification	Manufacturing	Operation	End-of-Life
EDM-D	EDM-Q	EDM-M	EDM-O	EDM-E

Product Life Cycle Management incl. New Product Introduction (NPI)

EDM-P

DfX Guideline	Title	Update/content
EDM-D-000	Good Design-for-X Practice (V1.0)	
EDM-D-001	PCB Specification (V2.5)	
EDM-D-002	Component Specification (V1.0)	
EDM-D-003	PBA Assembly Material Specification (V1.2)	V2: include reliability related lead-free solder selection
EDM-D-004	Design-for-Assembly (V1.0)	
EDM-D-005	Rigid PCB Build-Up and Density Classification (V1.3)	
EDM-D-006	Layout Solutions (V1.0)	
EDM-D-007	Quality and Test coverage quantification. Design-for-Test (V1.1)	
EDM-D-008	Technology and Manufacturing Capability Mapping of PBA designs (V1.1)	
EDM-D-009	Signal Integrity (V1.0)	
EDM-D-010	Power Integrity (V1.0)	
EDM-D-011	Electro-Magnetic Compatibility	V1.0: EDM-I-003 --> EDM-D-011
EDM-D-012	Mechanical integration	V1.0: EDM-I-001 --> EDM-D-012 V2.0 or V1.1: update of content
EDM-D-013	Thermal Design of Electronics	New. Instead of EDM-I-002

New guidelines:

- EDM-D-013: *Thermal Design of Electronics*
- EDM-M-007:
  Printed Board Assembly Defect Modeling.
  Extracting DPMO Values from Production Data.
- Available at www.cedm.be

QUANTIFIED ASSESSMENT OF PLC RISKS

Development: critical aspects

- Engineering cost
- Time-to-market

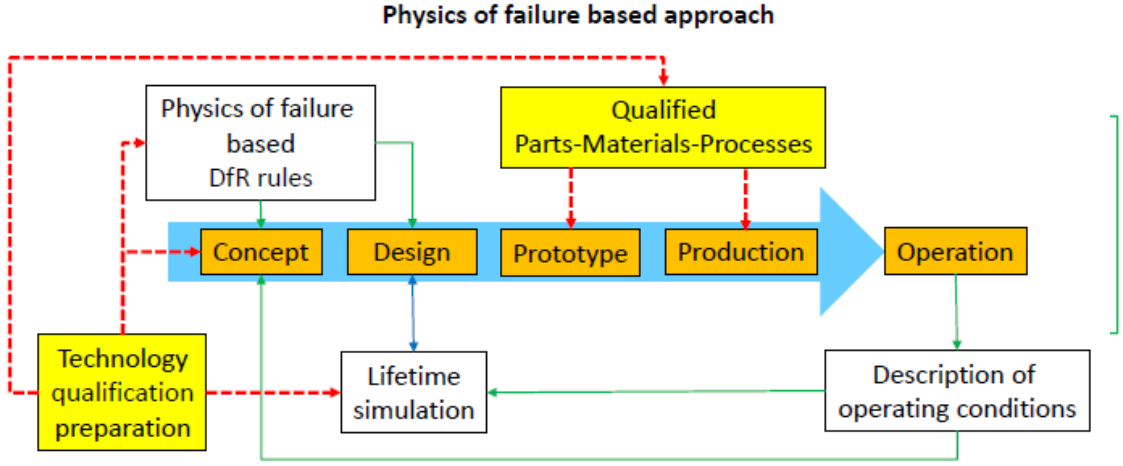
Minimize:

- Redesign
- Prototyping iterations: right first time
- Qualification failures

Maximize: PREDICTABILITY

Design-for-X guidelines & tools:

Manufacturing, test, reliability/robustness, logistics

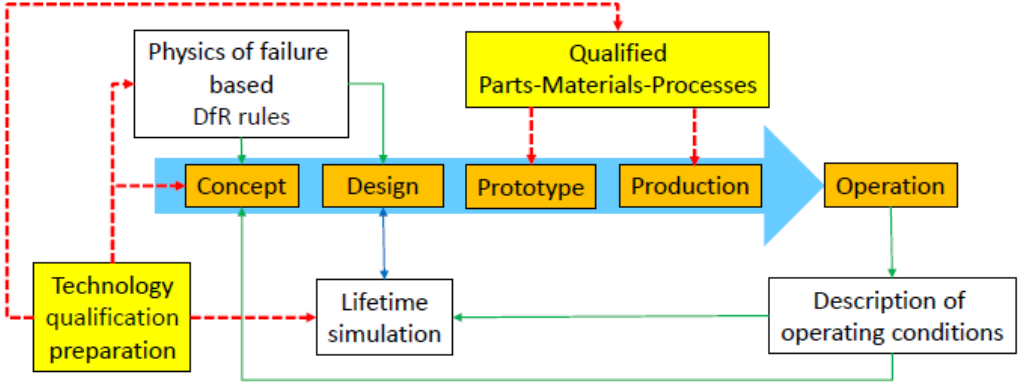


QUANTIFIED ASSESSMENT OF PLC RISKS

Pred-X

Manufacturing: critical aspects

- Cost
- Volume ramp-up
- Delivery performance



Maximize yield

Minimize labour

Minimize Work-in-Progress (test & repair)

Design-for-Manufacturing, Test, Cost, Logistics,...

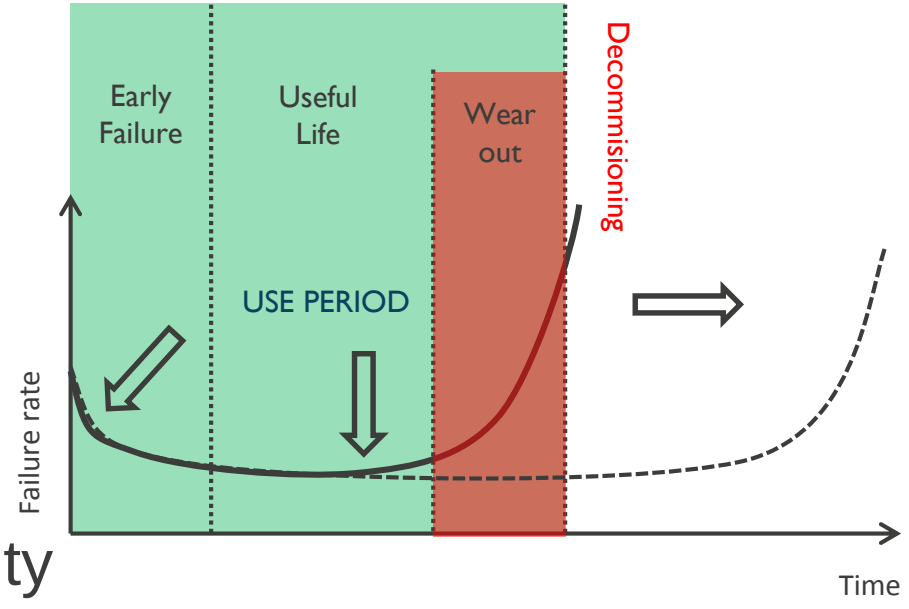
QUANTIFIED ASSESSMENT OF PLC RISKS

Use: critical aspects

- Quality
- Reliability
- Performance
- Availability
- Low maintenance cost

Design-for-Quality and Reliability

Quality and Reliability quantification



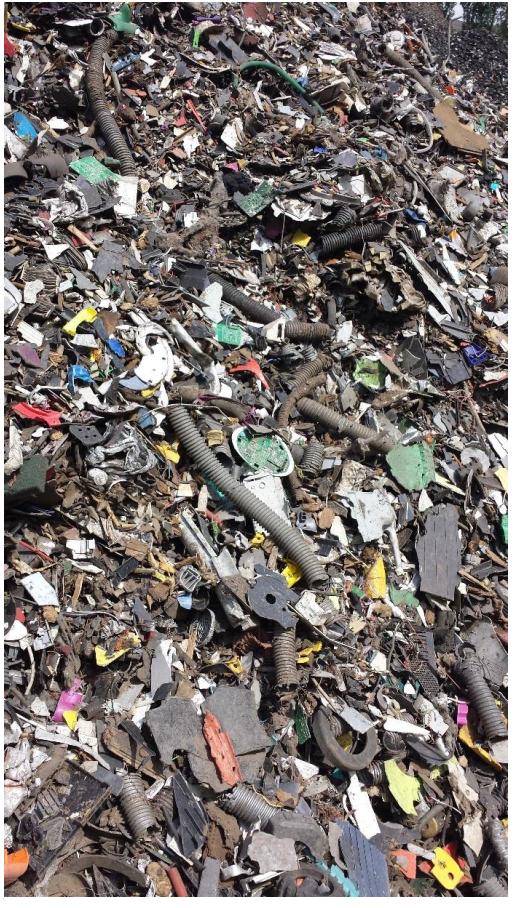
QUANTIFIED ASSESSMENT OF PLC RISKS

End-of-Life: critical aspects

- Replacement
- RoHS/WEEE
- Toxicity
- Waste treatment cost
- Recycling revenue

Design-for-RoHS/WEEE, disassembly, recycling

BOM based material identification



imec

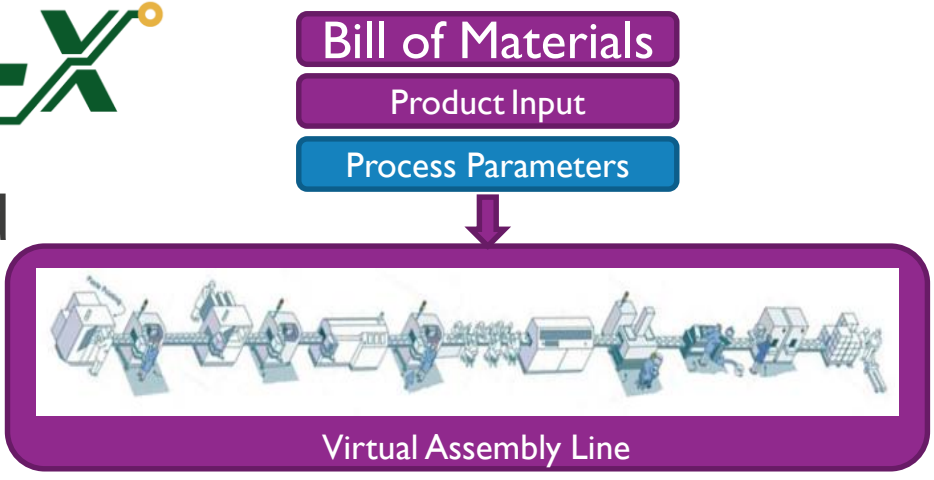
CEDM TOOL BOX

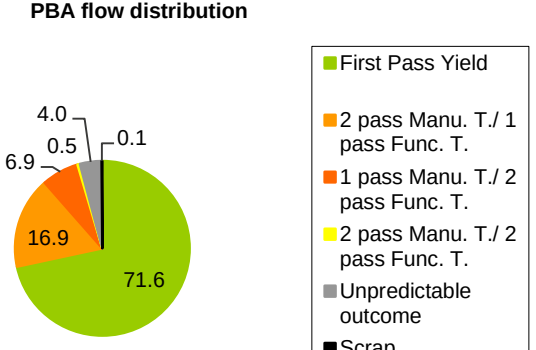
EDM
Electronics Design & Manufacturing

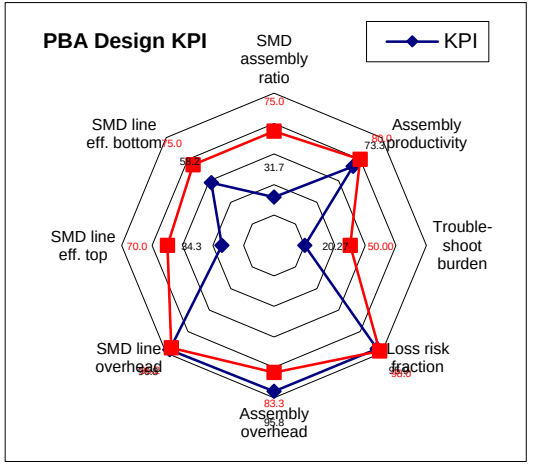
CEDM TOOL BOX

Pred-X

- Design-for-Assembly: BOM based
- Quantified Quality
  - DPMO/yield
  - Test coverage
  - Assembly flow & time
- Assembly model and DfA evaluator
  - Design impact on assembly flow and efficiency





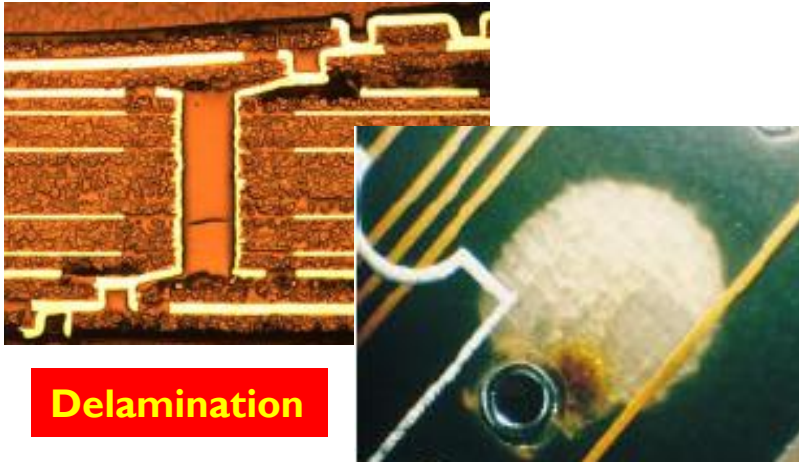


CEDM TOOL BOX

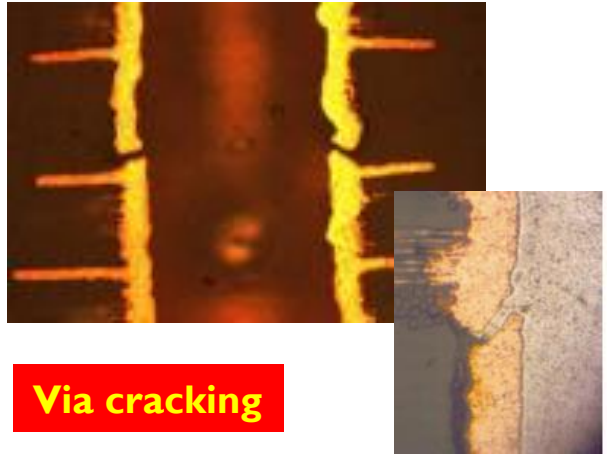
Pred-X

PCB laminate specification: specify FR4 type

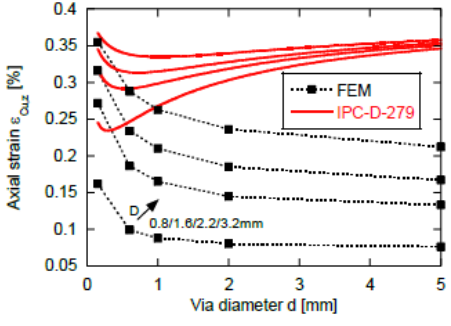
- (Cohesive) delamination
- **Via failure: new analytical model**
- Prediction of failure probability: production & operation
- >200 laminates: ***PCB Laminate Overview*** on www.cedm.

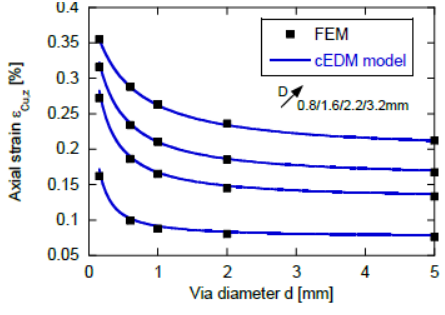


Delamination



Via cracking

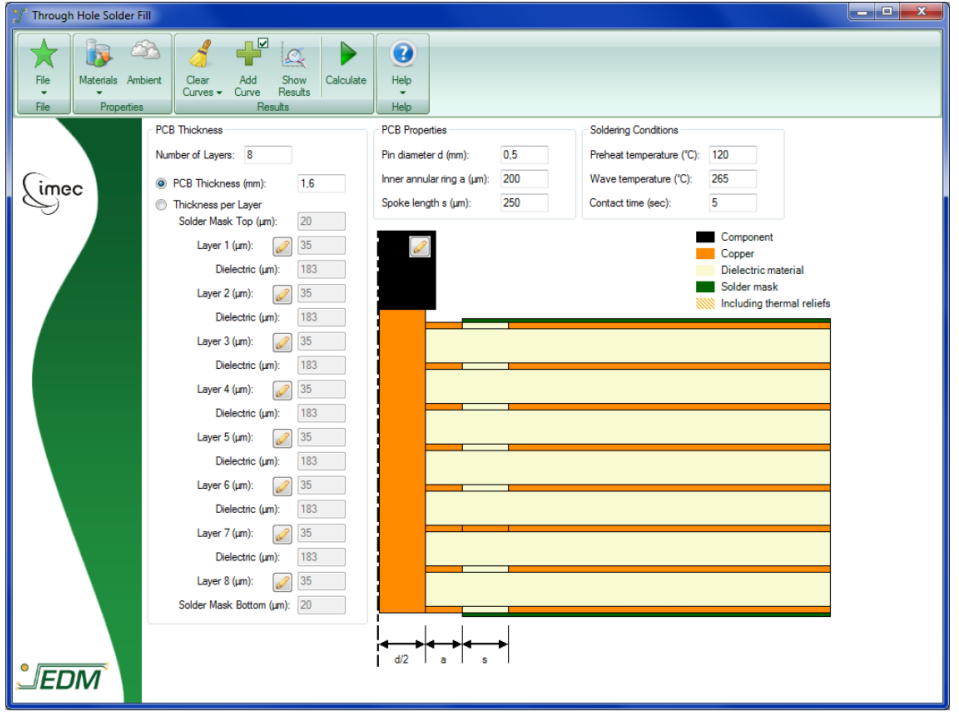


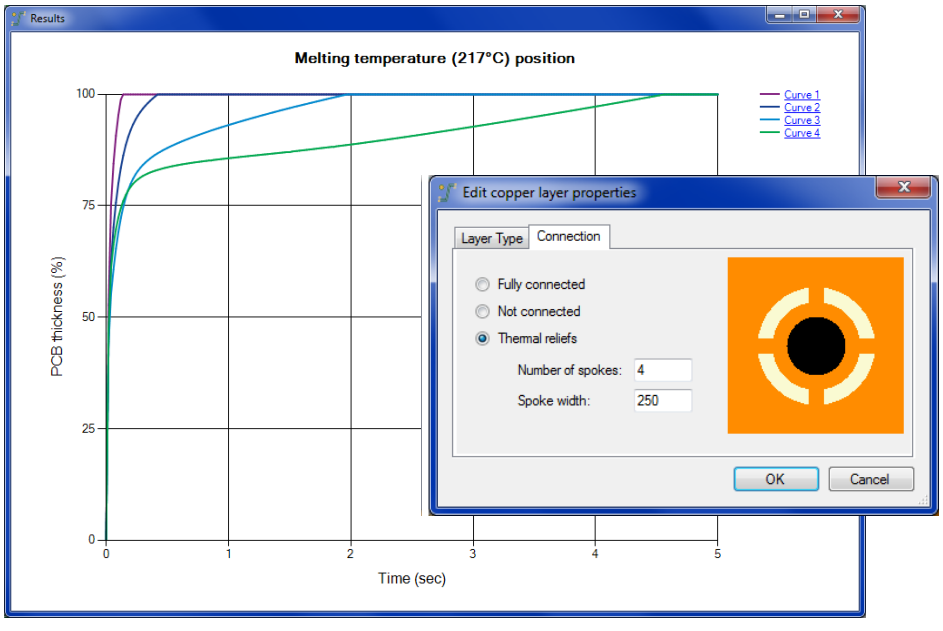


3. CEDM TOOL BOX

Assembly:
wave soldering

NEW:
% through hole fill





CEDM TOOL BOX

PCB layout:
DfA & thermal design

NEW:
Thermal via for bottom terminated SMD

CEDM TOOL BOX

PBA design:
D-f-Reliability

Guidelines | Tools | Calculators | Projects | Agenda | Library | Membership | RoHS Service

TOOLS

- IPC Standards Guide
- PCB Laminate Overview
- NPI Questionnaire
- PBA Checklist
- BOM DfM Checklist

Failure Risk Assessment FMEA

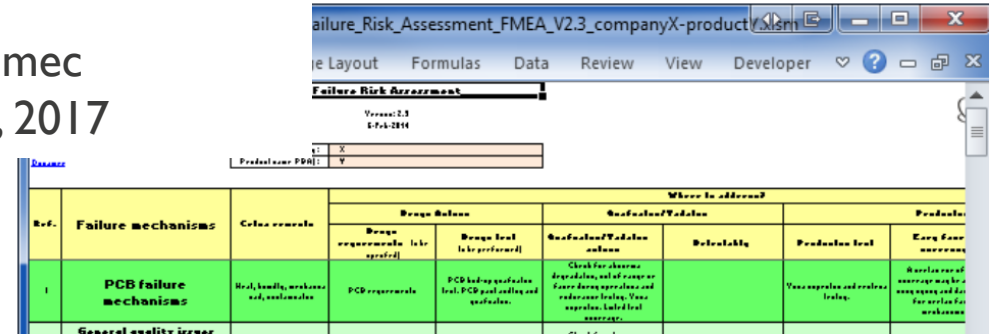
The PBA Failure Risk Assessment FMEA provides a comprehensive overview of potential Printed Board Assembly quality and reliability issues together with the major risk factors. Where and how to address these issues in the product development cycle is indicated. This tool can be used as a pro-active FMEA tool in PBA development. FMEA: Failure Mode and Effects Analysis

Failure Risk Assessment (Members / Partners only)

"How **FMEA** can improve the reliability of your product"

Presented by: **Riet Labie**, imec
10h00 - Thursday 12 January, 2017

p / partnership



News

cEDM is hiring
Check out our new job openings
More

New calculator
Through Hole Solder Fill Calculator
More

September 18, 2015
cEDM WORKSHOP # 23
More

New guideline
Signal Integrity
More

New calculator
Thermal Via Design Calculator
More

October 7-14-21-28, 2015
KULeuven Course EMC
More

CEDM TOOLBOX

Under development

PBA design:
D-f-Reliability

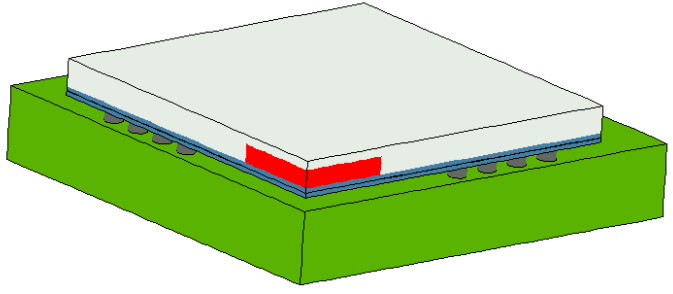
- Reliability extension to Pred-X
- Analytical solder joint lifetime model
  - 2 & 3D models for assemblies with flexible component on flexible substrates calculating forces and moments on solder joints
  - PCB and package flexibility taken into account

To replace IPC-D-279's:

The cyclic fatigue damage term for leadless SM solder attachments, for which the stresses in the solder joints exceed the solder yield strength and cause plastic yielding of the solder, is

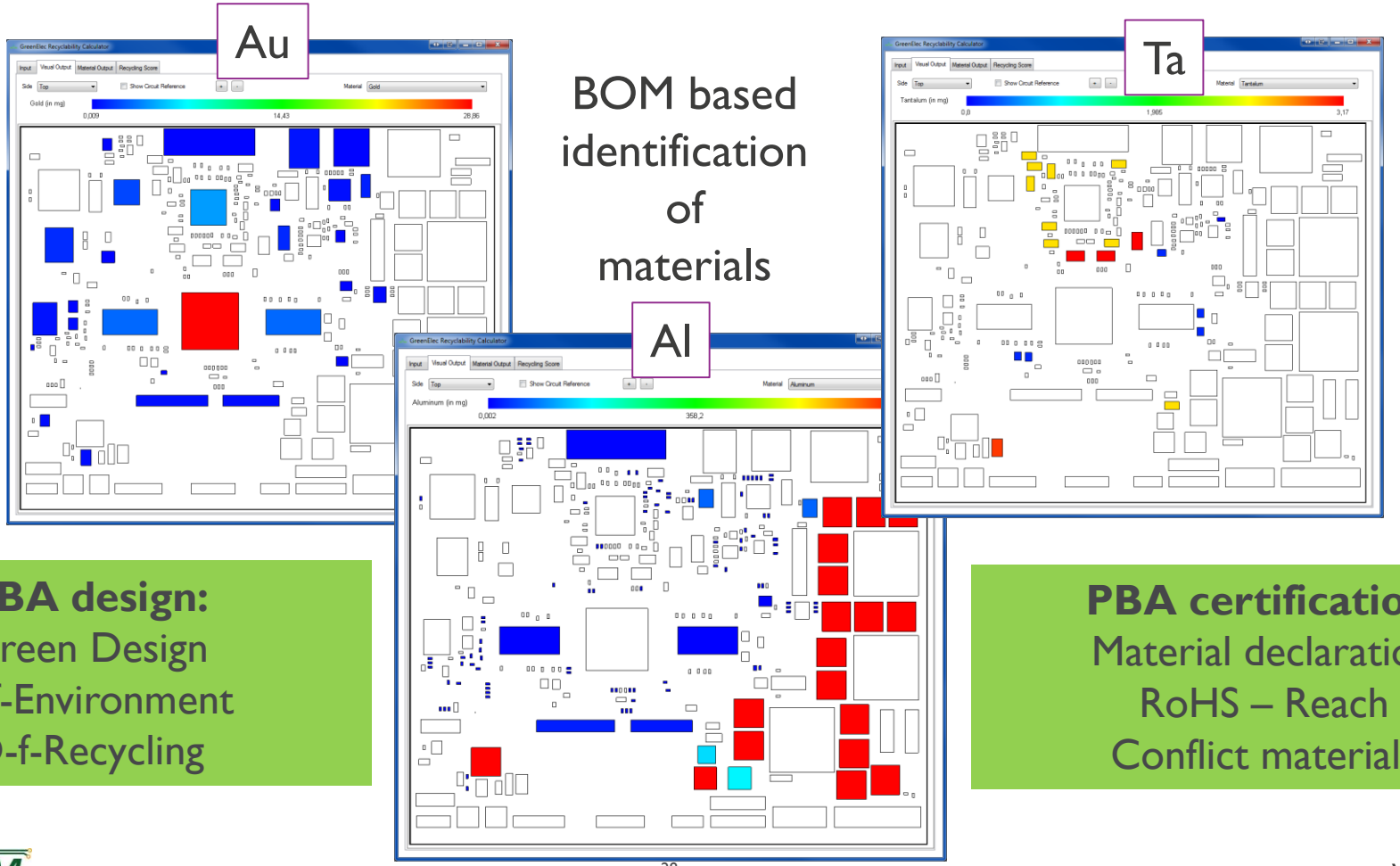
$$\Delta D(\text{leadless}) = \left[\frac{FL_D\,\Delta(\alpha\Delta T)}{h}\right]$$

[Eq. A-3]



CEDM TOOL BOX

greenelec



BOM based identification of materials

PBA design:
Green Design
D-f-Environment
D-f-Recycling

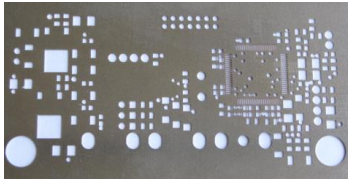
PBA certification:
Material declaration
RoHS – Reach
Conflict materials

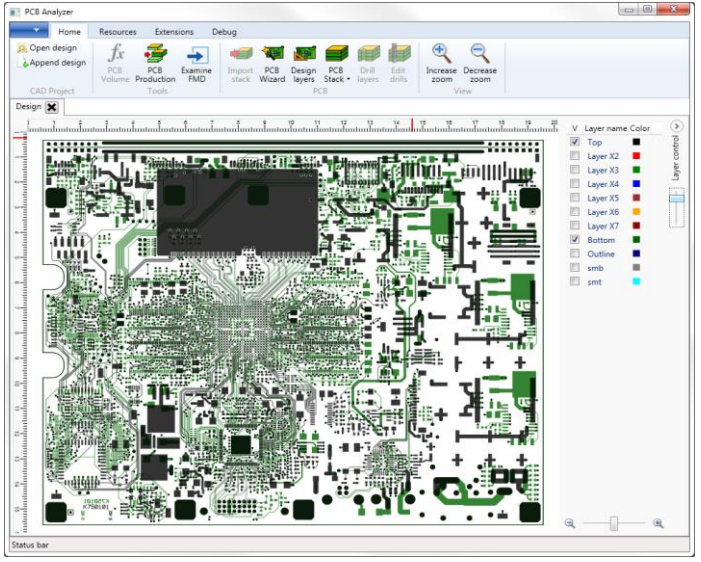
CEDM TOOL BOX

greenelec

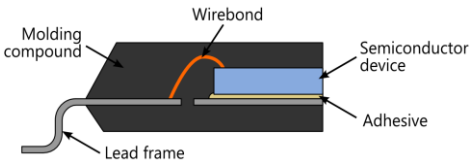
Full Material Declaration
Material Composition Models

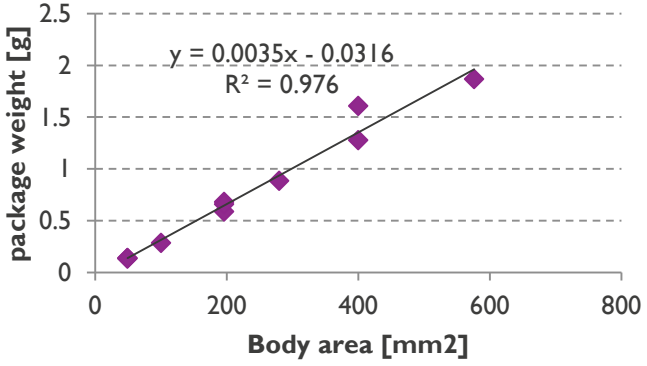
Solder: pad & stencil data





Component





Estimate material content based on the physical characteristics and build-up

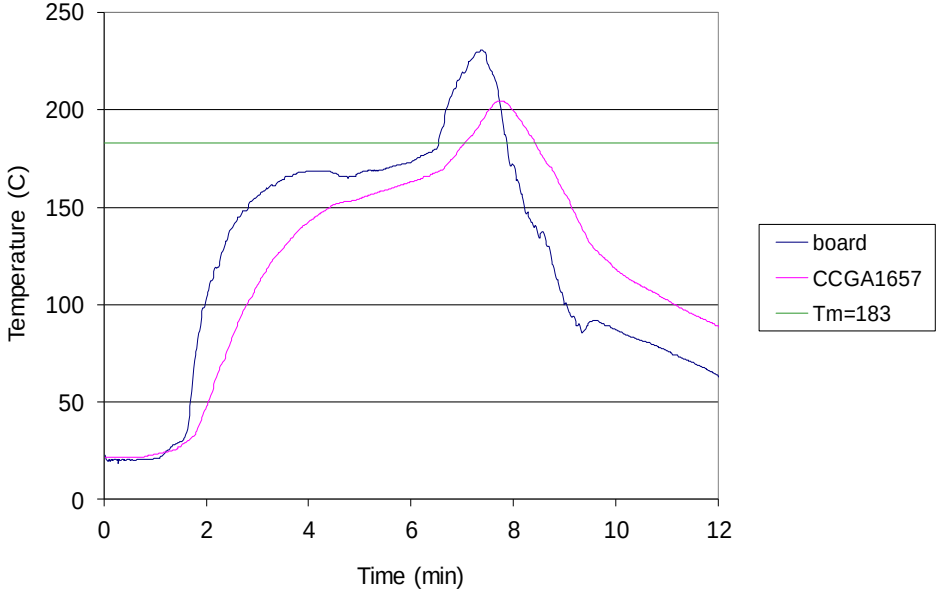
PCB

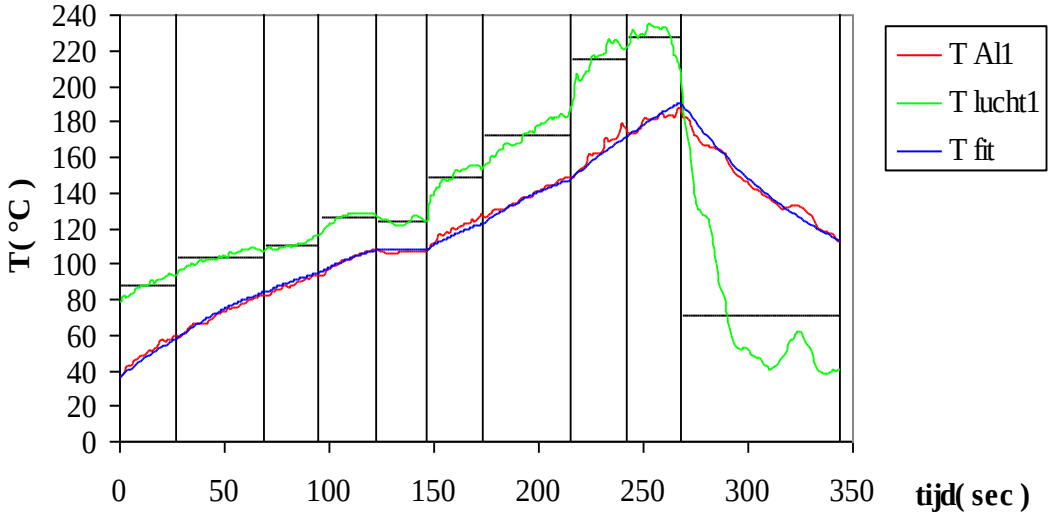
8 LAYER STACKUP
Basic material

		PLATING	17 um
Cu_top		COPPER	18 um
		PREPREG	2x63 um
Cu_lay2		COPPER	35 um
		INNER	300 um
Cu_lay3		COPPER	35 um
		PREPREG	2x63 um
Cu_lay4		COPPER	35 um
		INNER	300 um
Cu_lay5		COPPER	35 um
		PREPREG	2x63 um
Cu_lay6		COPPER	35 um
		INNER	300 um
Cu_lay7		COPPER	35 um
		PREPREG	2x63 um
Cu_bot		COPPER	18 um
		PLATING	17 um
		TOTAL	1684 um

Assembly:
reflow soldering

Under development:
BOM based prediction reflow soldering temperature differences across the PBA





FUNDED PROJECTS

Cooporative projects

IWT O&O Rev-Up

- Reliability testing
- Physics-of-Failure based
- Interconnection
- Surface Insulation Resistance
- "health monitoring"

ICON Compact

- Physics-of-Failure based reliability modeling
- Interconnection
- Selected components
- Time-dependent failure in product development.

Collective project

Start: 1/10/2015

VIS-traject InProVoL

- DfR Guidelines
- DfR Tools
- Industrial implementation
- Consultancy

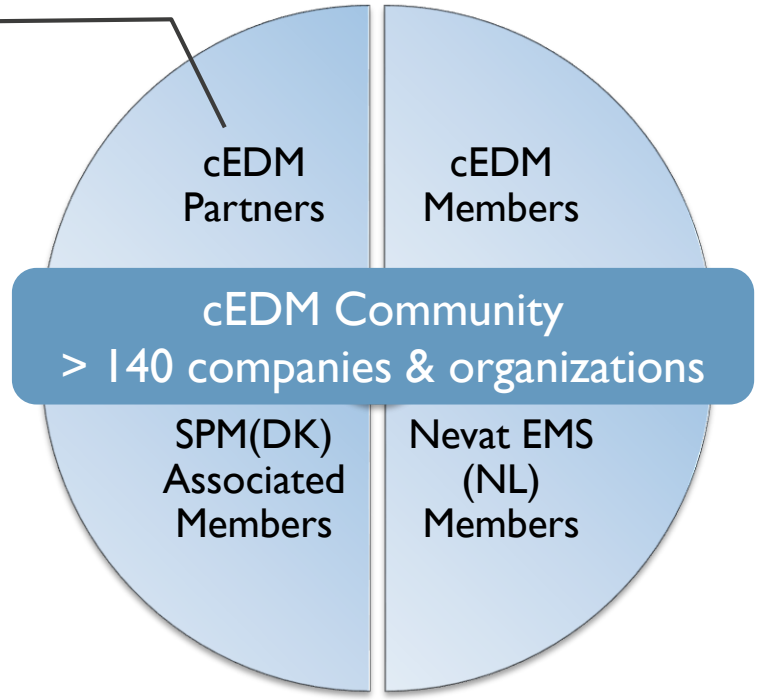
You can join the consortium and get early access to the results!

THE CEDM COMMUNITY

2016: +15

Founding Partners

sirris imec



AC3 ADVANCED CIRCUIT BOARDS · AQC · ASML · BARCO Visibly yours · CONNECT GROUP INTEGRATED SUBCONTRACTORS

DfR Solutions reliability designed, reliability delivered · ed&a the power to control · EURO CIRCUITS · FLANDERS MAKE · NEVAT EMS TECHNOLOGY GROUP

Newtec MANUFACTURING COMPETENCE CENTER · ON Semiconductor · page.be electronica · PsiControl mechatronics · ReMI Reliability in Mechatronics and ICT · KU LEUVEN

sirris · SPM Reliability Management · tbp · televic · VERHAERT MASTERS IN INNOVATION

THANK YOU

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embracing a better life