



# mec

CENTER FOR DESIGN & MANUFACTURING 2016

GEERT WILLEMS



Met steun van:



# CONTENT

1. Some trends: industry & technology
2. How cEDM addresses the trends: R&D activities
3. Hardware service for research and industry

# I. SOME TRENDS

FROM MANUFACTURING  
OFF-SHORING  
*TO*  
NEAR- & RE-SHORING

# I.TRENDS: MANUFACTURING

## ELECTRONICS INDUSTRY OUTLOOK: “THE TIMES THEY ARE A-CHANGIN’ ”?



### 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

## Is Nearshoring Right for Your Product?

JULY 2012

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

## Is Reshoring A Viable Option?

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

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

More: <http://reshoringmfg.com/>

## HOW RESHORING DRIVES PROFITABILITY

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

## Domestic Versus Offshore PCB Manufacturing



The Trend Away From Offshore PCB Manufacturing

## 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.”

## 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

# I.TRENDS: MANUFACTURING

GOVERNMENT MANUFACTURING INITIATIVES: “THE TIMES THEY ARE A-CHANGIN’ ”?



✉ info@reshorennow.org

**Reshoring Initiative®**  
*Bringing Manufacturing Back Home*



 **EPRS**  
European Parliamentary  
Research Service

Briefing

21/03/2014

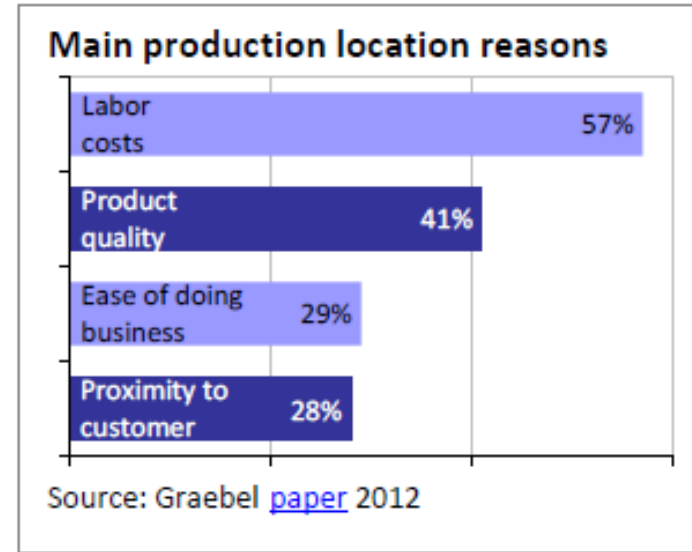
Reshoring of EU manufacturing

# I.TRENDS: 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

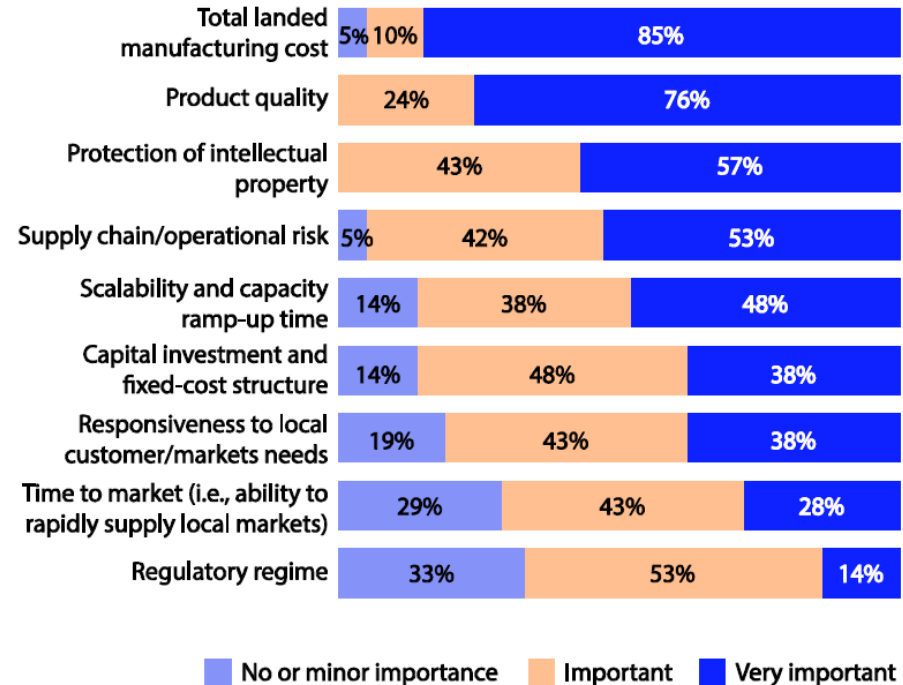
# I.TRENDS: MANUFACTURING

## 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

***Not everything will come back!***

Manufacturing sourcing strategy decision driver



Data source: Supply Chain Optimization Study, Hackett Group, 2012.



# I.TRENDS: MANUFACTURING

## WHAT IS NEEDED?

### Product:

- Dynamical
- High value
- Quality
- Safety → Reliable



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.

# THE ELECTRONICALLY CONNECTED WORLD



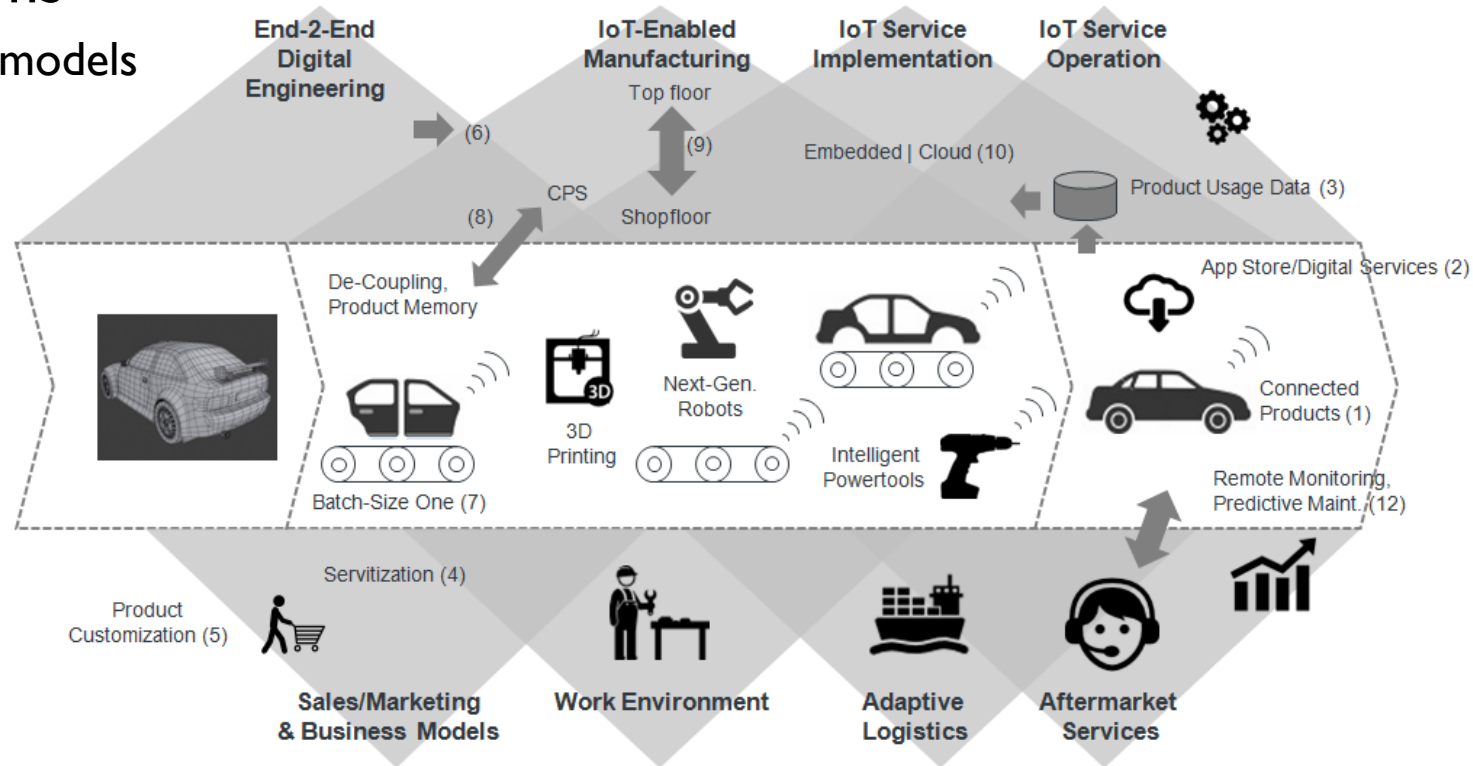
Article  
June 2015

# Manufacturing's next act

By Cornelius Baur and Dominik Wee

# I.TRENDS: INDUSTRY 4.0

- **Cyber-Physical Systems**  
HW – SW – connected – models
- **Internet-of-Things**
- **Cloud computing**







INTERNET of DATA

BROWSING  
ANTWERPEN.BE

SMARTPHONE  
CALLING  
Zimin 03sec

INTERNET of THINGS

SMARTWATCH

INTERNET of HUMANS



# City of Things

**15 min**  
BEFORE RAIN  
APPROACHES YOU



 05<sup>min</sup> 37<sup>sec</sup>  
BEFORE ARRIVAL



✈ 08 min 07 sec  
SINCE DEPARTURE




**1,214 KWH**  
**GAINED**



04 TABLES LEFT



 FULLY BOOKED



23 WATT USED



**ENERGY SAVING  
MEDAL UNLOCKED**



432 MILES TO THE CHEAPEST DIESEL



**04 RED LIGHTS ON YOUR WAY**



YOU WALKED 1894 METER  
SO FAR

235 METER UNTIL  
BIKE PARKING



YOUR PACKAGE WILL ARRIVE IN **15** MIN



17 HOURS  
PARKING LEFT

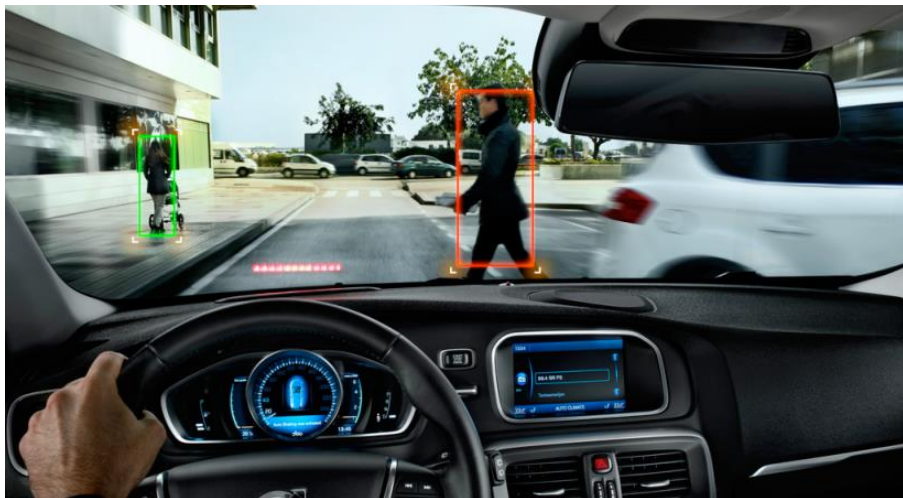


**124 PEOPLE FAVORISED** 



# I.TRENDS: CONNECTED CAR DIANNE TECHNOLOGY

Real-time execution by the  
AI-enabled point



Knowledge base & Deep  
learning in the Cloud

Push new samples  
to experience pool



Get optimized NN  
training results

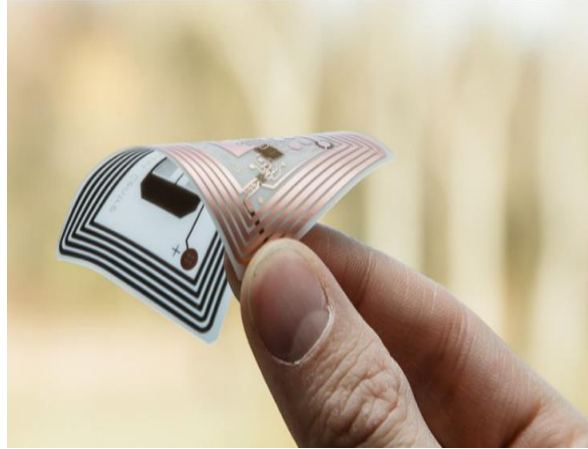
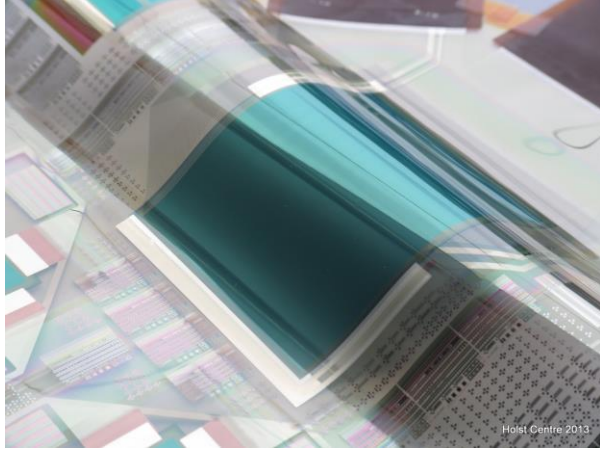


ELECTRONICS EVERYWHERE  
FLEXIBLE – STRETCHABLE – ALL FORM FACTORS



# I.TRENDS: ELECTRONICS EVERYWHERE

## WEARABLE: FLEXIBLE - STRETCHABLE



non-contact sensing  
smart home/workplace/car



© Holst Centre

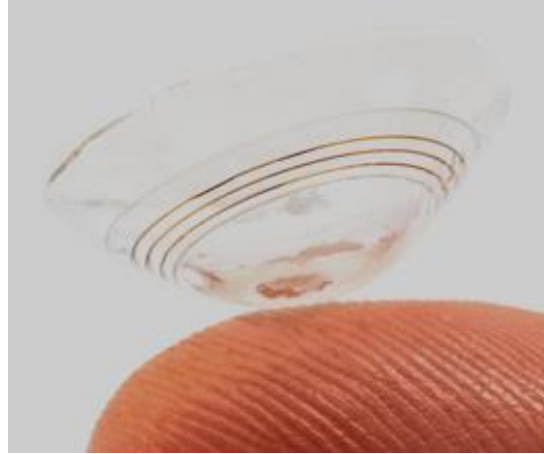
# I.TRENDS: ELECTRONICS EVERYWHERE

## ALL FORM FACTORS



# I.TRENDS: ELECTRONICS EVERYWHERE

## ...AND SO MUCH MORE

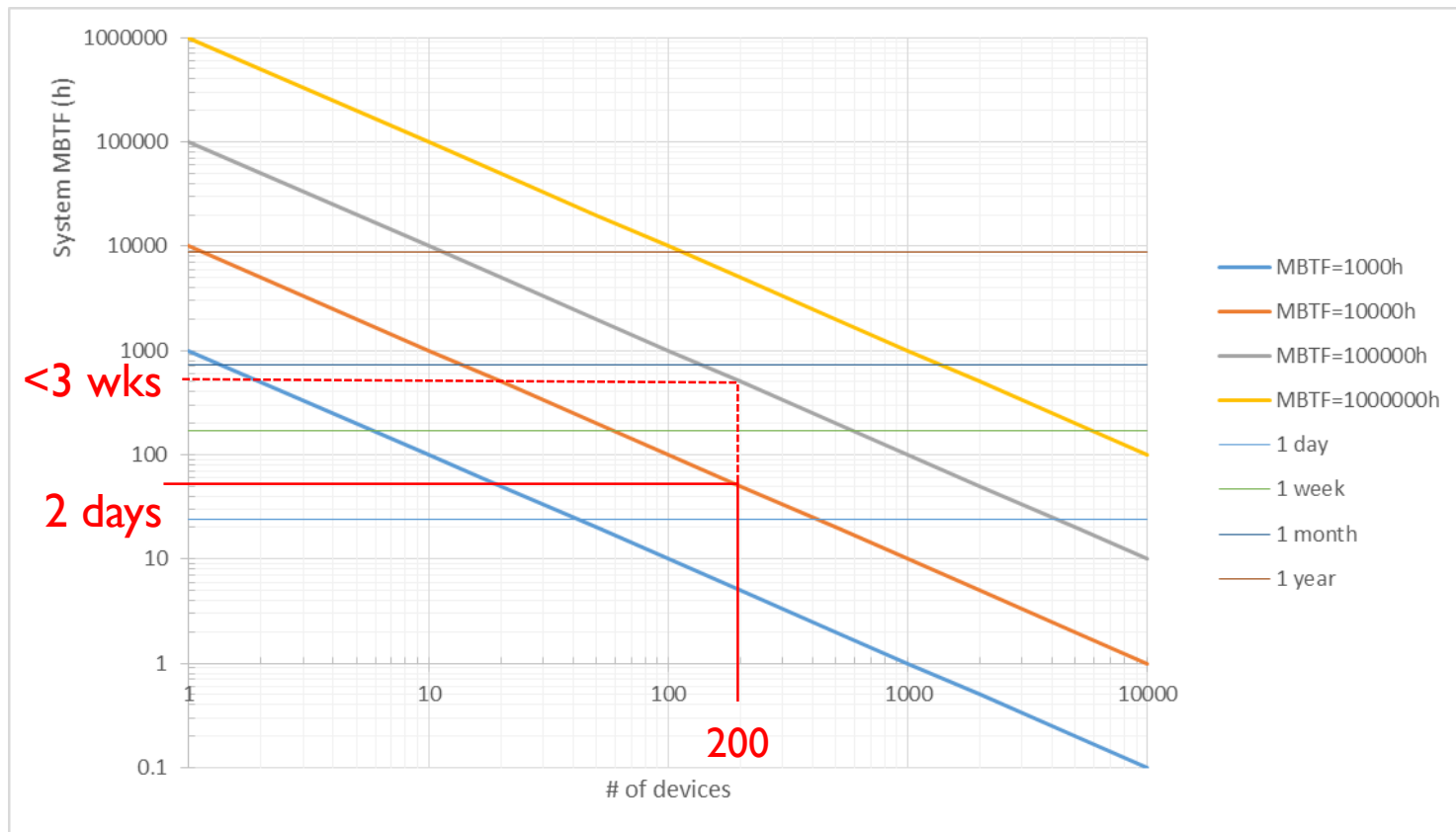




# I.TRENDS: EVERYWHERE CONNECTED ELECTRONICS

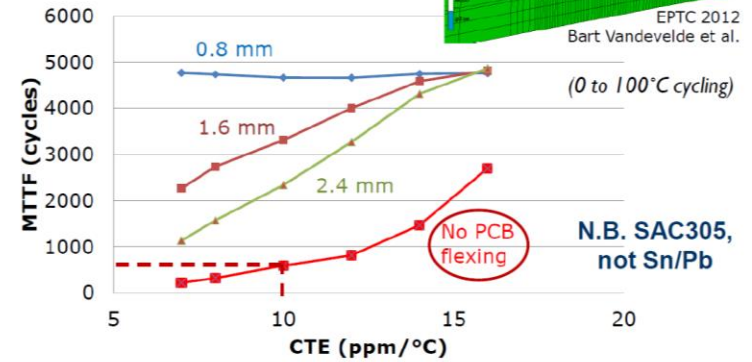
## TIME BETWEEN FAILURE

In the  
Connected  
world  
Reliability  
is  
Essential



## 6. Reliability of BGA Impact of board thickness

PBGA 27x27 area array  
1.27mm pitch



© Imec 2012 | www.edmp.be | 36

Willems, G., Thijs, S. & Vandeveld. 2012. Green IC Packaging: A threat to electronics reliability. Bits & Chips Hardware Conference.

4th European Expert Workshop on Reliability of Electronics and Smart Systems - 2016 EuWoRe  
Fraunhofer Forum, Berlin, Oct 18-19, 2016



## 2. HOW CEDM ADDRESSES THE TRENDS R&D ACTIVITIES

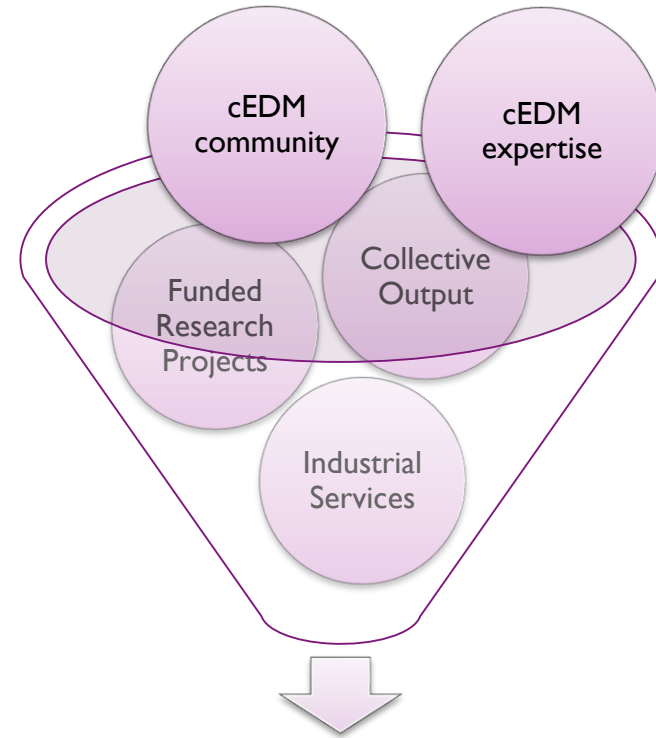
Riet Labie – Bart Vandeveld – Franco Zanon

Met steun van:



# 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**

## 2. R&D ACTIVITIES


### Industrial needs

- Reliability
- Quality
- Safety
- Design-for-X
- Predictability
- Fast development
- Virtualisation
- Mechanically adapt. electronics

### R&D activities

- O&O Rev-Up  
Reliability testing
  - ICON Compact  
Physics-of-Failure based Safety
- To be:
- Prog. Health Mon.
  - PoF based Maintenance
  - Electronics Everywhere

### Collective Knowledge Dissemination

- VIS InProVoL  
Reliability predict
- VIS SmartPro  
Elect. in textile
- Network 

### Consultancy & Engineering For & with Research & industry

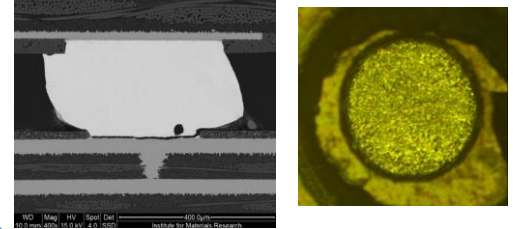


## 2. REVUP: REVISION AND UPGRADE OF RELIABILITY TESTS

### PROJECT SCOPE:

Revise/improve the reliability testing minimal cost

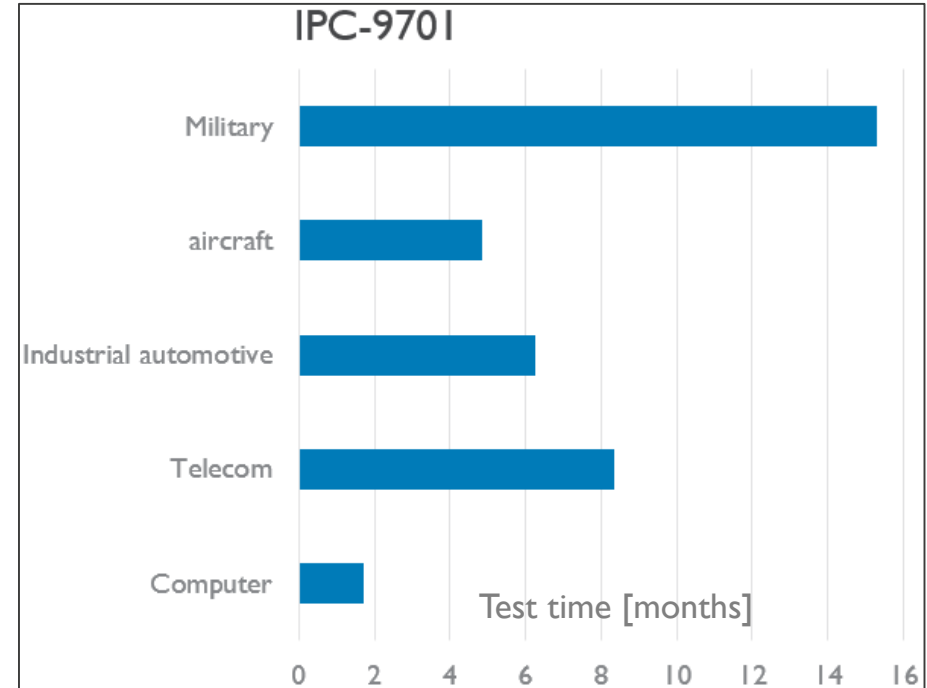
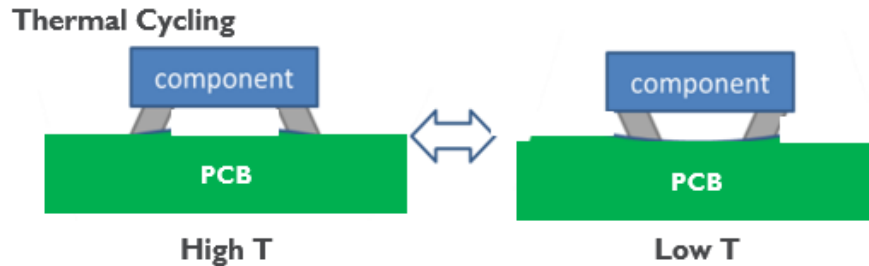
- Faster and more effective accelerated testing
  - Solder joint reliability
- Physics-of-Failure: Better understanding materials behavior
  - Brittle fracture solder joint interfaces
  - Surface Insulation Resistance: relationship with solder materials
- Mission profiling and field testing



## 2. REVUP: REVISION AND UPGRADE OF RELIABILITY TESTS

### THERMAL CYCLING TESTING OF SOLDER JOINTS

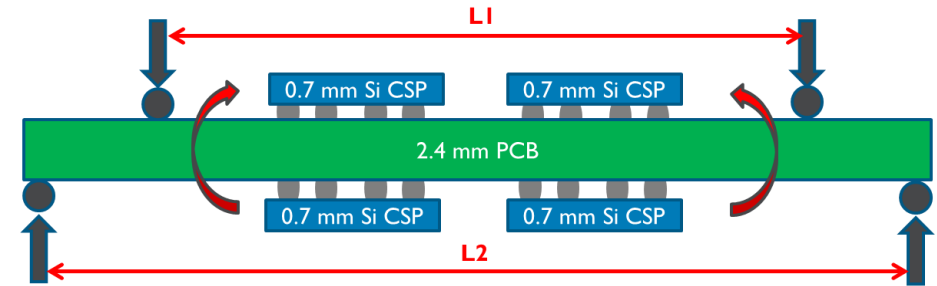
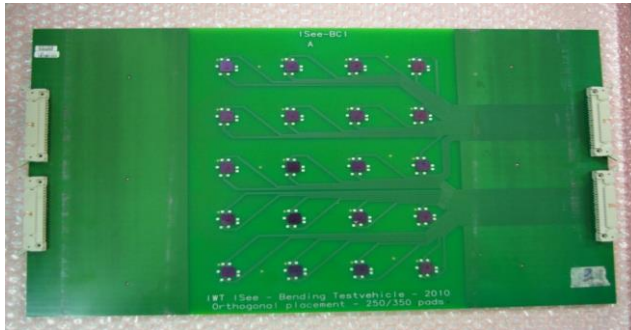
- Long duration: 2 → >12 months
- Temperature range is limited
- Minimal dwell time
- → 1 cycle/hour



## 2. REVUP: REVISION AND UPGRADE OF RELIABILITY TESTS

### BENDING TEST AT CONSTANT TEMPERATURE

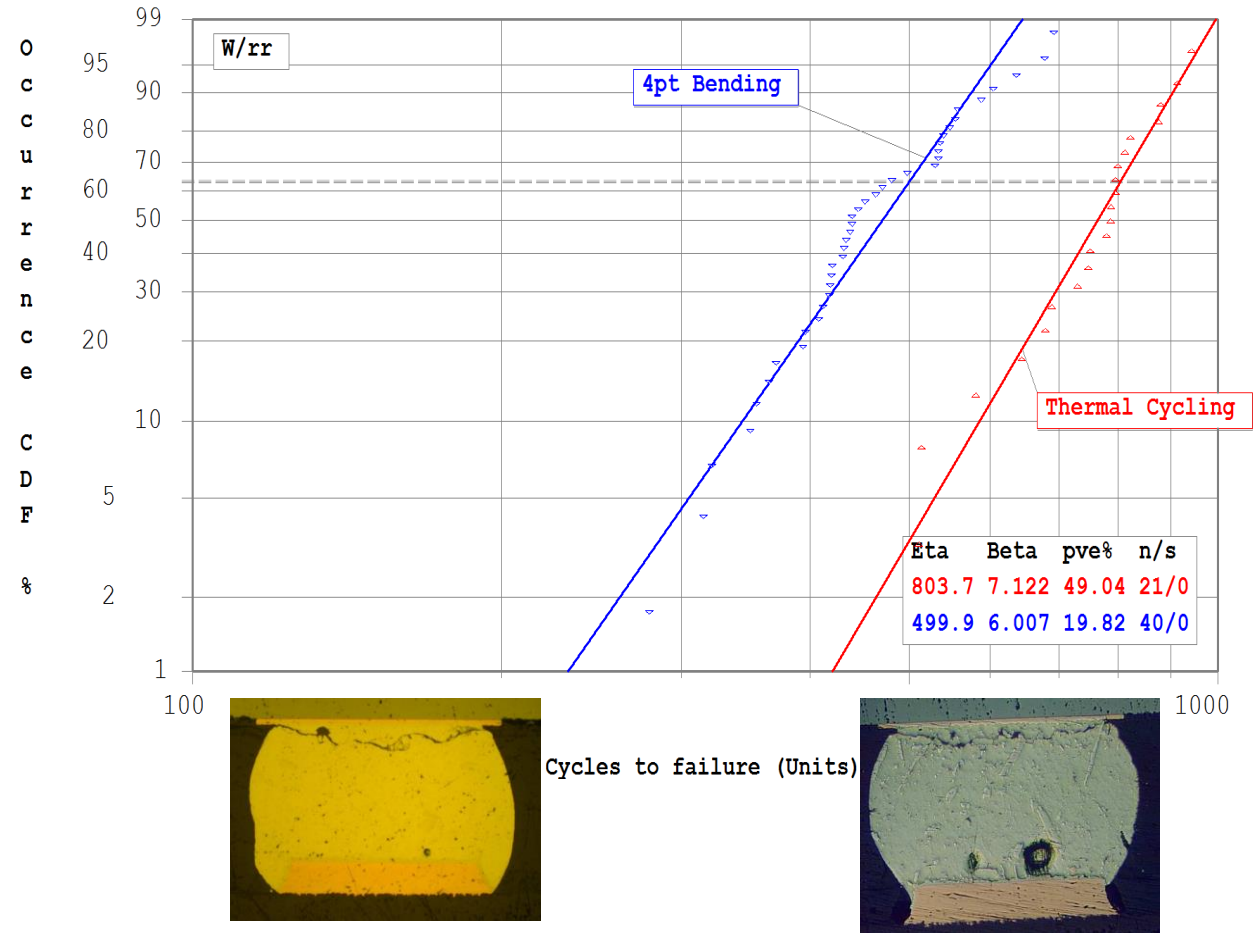
Bending Cycling



## 2. REVUP: REVISION AND UPGRADE OF RELIABILITY TESTS

### BENEFITS

- SIMILAR FAILURE MODE
- FASTER
  - High temperature
- DECOUPLING of mechanical load and temperature
  - Temperature dependency
  - Increase acceleration



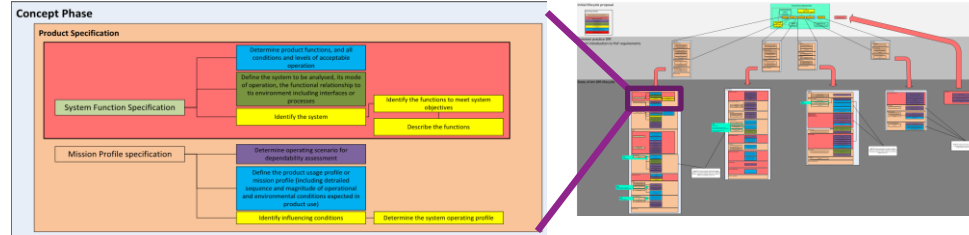
## 2. ICON COMPACT: PHYSICS-OF-FAILURE BASED SAFETY

PROJECT SCOPE: Development of **Physics-of-Failure** (PoF) based **Design for Reliability** (DfR) and **qualification methodology** integrated in the overall product development process

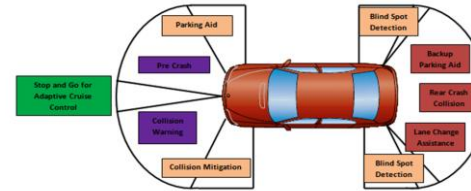
- Replace the traditional statistics and historical data-based reliability assessment by a **physics-based modeling** method with **strong prediction potential** for new products and applications
- **Integrate the methodology** in the overall system engineering lifecycle, that is more effective, at lower cost, faster and that has a better failure probability and lifetime prediction capability

## 2. ICON COMPACT: POF BASED SAFETY PROJECT ACTIVITIES

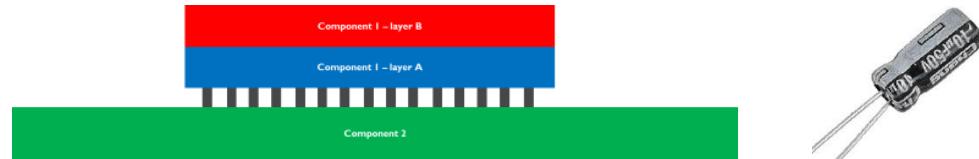
Process-level\*



System-level



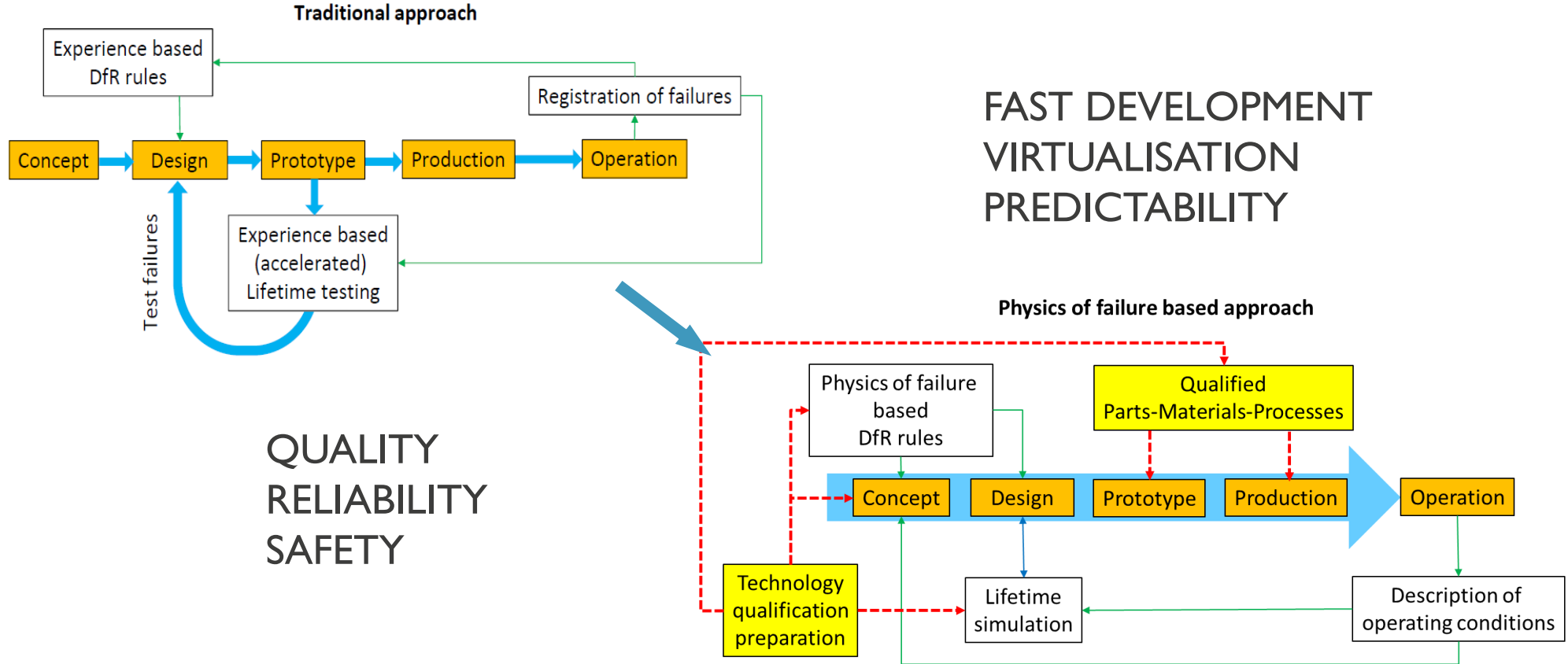
Component-level\*



\* imec cEDM contribution

## 2. ICON COMPACT: PHYSICS-OF-FAILURE BASED SAFETY

### PROCESS LEVEL: POF-BASED NEW PRODUCT INTRODUCTION (NPI) PROCESS



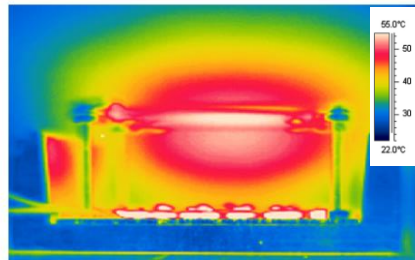
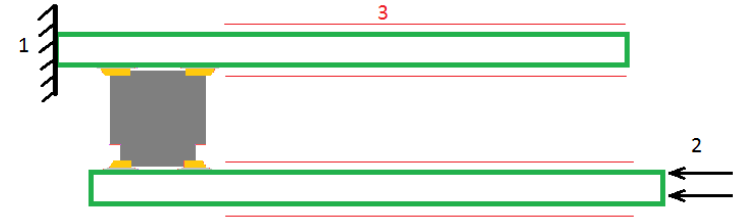


## 2. ICON COMPACT: POF BASED SAFETY

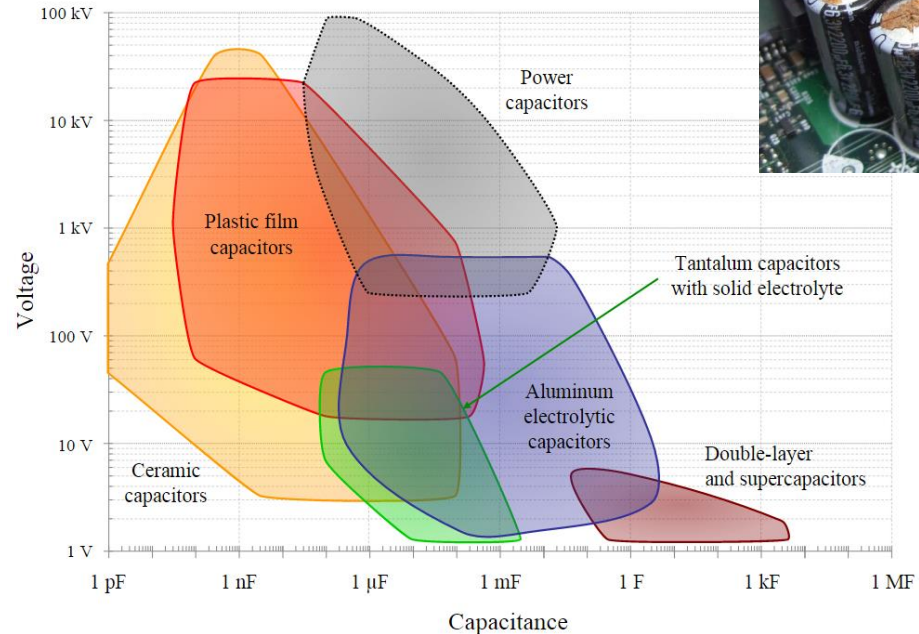
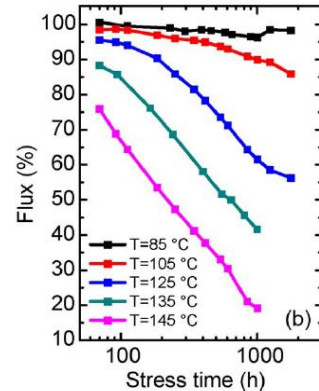
### COMPONENT LEVEL: PHYSICS-OF-FAILURE MODELS

cEDM FMEA expanded with PoF-based models for:

- Board-to-Board connectors
- Capacitors (Aluminum, Tantalum, MLCC, Supercapacitors)
- Remote phosphors degradation



Remote Phosphors (RP)





## 2. SMARTPRO: SMART TEXTILE AND PORTABLE INTELLIGENCE

### VIS-TRAJECT: DISSEMINATION

PROJECT SCOPE: From lab-scale prototypes to industrial solutions

PROJECT CONSORTIUM:   
CENTEXBEL – UGENT – HOGENT – KULEUVEN – imec – iMinds – SIRRIS  
*TEXTILE* *ELECTRONICS* *DATA*

User committee:

Textile (weaving, yarn, ready-made clothes, ...), materials. EMS, ICT (Data analysis) industry.

Activities:

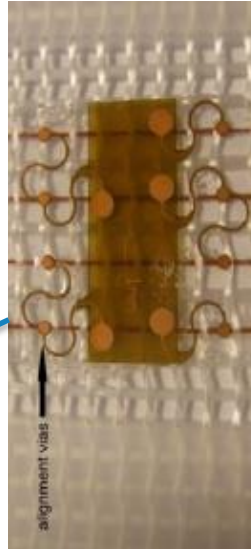
- Supporting cross-collaborations between different industries
- Solutions for interconnecting electronics and textile
- Demonstrator cases

# 2. SMARTPRO: SMART TEXTILE AND PORTABLE INTELLIGENCE

## INTERCONNECTING ELECTRONICS

### AND TEXTILE

- Textile integrated interconnect: conductive yarns versus printed interconnect
- Connecting electronics to textile integrated interconnect:
  - State-of-the-Art
  - Strechable interconnect (imec patent)
- Technology selection guideline



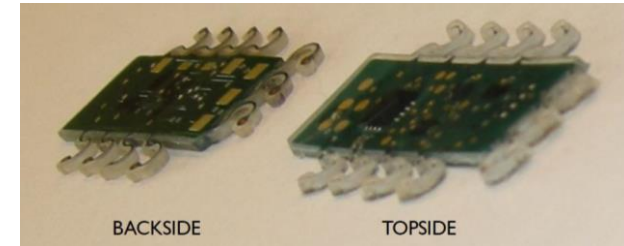
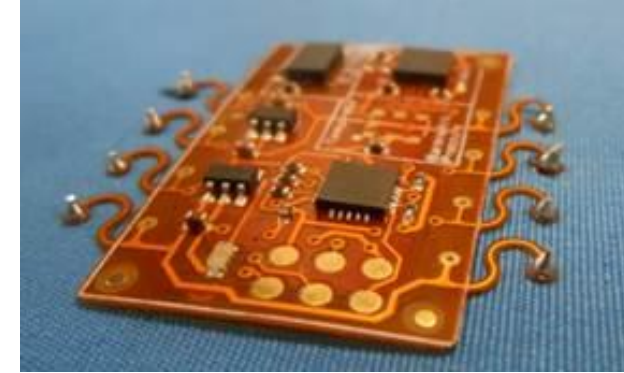
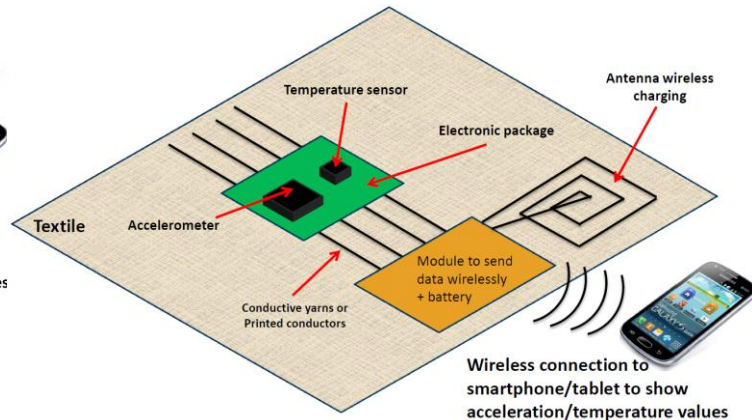
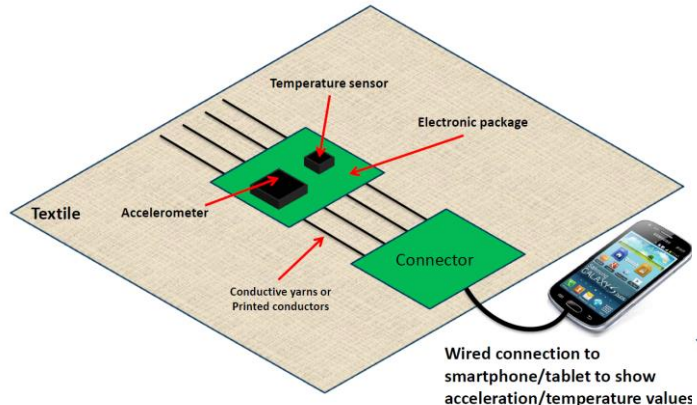
## MECHANICALLY ADAPTABLE ELECTRONICS FLEX & STRETCH

Contact method		Conductive yarn		Printed conductivity	Electronic module
Solder		Metallic core	Metallic coating	Printed electronic circuitry are often/mostly combined with conductive adhesives for interconnection purposes.	Solderable finish easily obtained. Bonding on rigid and flexible substrates possible
MECH	ELEC	Solderability has to be ensured: combinations with a Ag/Au finish and Cu bulk are ideally used. Special flux materials will be needed to directly contact steel wires or bare Cu. Soldering is not compatible with Al wires.	At least an equivalent of 5µm of Cu / 2µm Ni has to be present in order to form a reliable solder interconnection.		
Usually not sufficient, depending on contact size. Needs additional mechanical fixture (underfill-like).	Good				
Adhesive		Full metal thickness not needed due to absence of chemical reaction, full metal thickness only advantageous for conductivity.	Feasible	Feasible	Bonding on rigid and flexible substrates possible
MECH	ELEC				
With ACA: simultaneous electrical and mechanical bonding when applying ACA film. For local connection points: not sufficient.	OK				
E-broidery		Sewing-ability of fully metallic yarns is considered as difficult.	Limited reliability due to long term contact resistance increase due to 'creep' of core wire material without additional support	Unlikely, since wiring/yarn is used as interconnection material, it would be most suited to use it for the textile conductivity fabrication as well.	Bonding on rigid and flexible substrates possible. Flexible substrate needed for piercing
MECH	ELEC				
Additional reinforcement may be needed	Risk for contact loss in time				
Lamination		Feasible	Feasible	No demonstration found	Metal topography needed
MECH	MECH				
Good	Accessibility of metal pad and conductive fabric has to be ensured				
Crimp		Preferred. Single metallic wires should be avoided in favour of stranded wires.	Cracking of coating layer observed for high contact pressure force. Risk for low contact resistance	Unlikely, since yarns are needed for crimp contact.	Mechanical force needed from clamping substrate onto fabric: rigid substrate probably needed
MECH	ELEC				
Additional reinforcement may be needed	Low contact resistance at low contact forces only obtained for metallic strands				
Force-fit				No demonstration found of force-fit connection with printed conductive tracks	Mechanical force needed from clamping substrate onto fabric: rigid substrate probably needed
MECH	ELEC				
OK					

## 2. SMARTPRO: SMART TEXTILE AND PORTABLE INTELLIGENCE DEMONSTRATOR BUILDING

Demo: textile integrated sensor/accelerometer module

- Different fabrics with different conductivity (yarns, printed)
- Development of electronic module: design and fabrication
- Integration by **CONNECT GROUP**  
INTEGRATED SUBCONTRACTORS



Silicone encapsulation for protection/"washability"

## 2. INPROVOL: INTELLIGENTE PRODUCTEN MET VOORSPELBARE LEVENSDUUR

### VIS-TRAJECT: DISSEMINATION

#### PROJECT SCOPE

- Realising electronics “with predictable life time” under known loading conditions.
- Reliability-by-Design concept based on Physics of Failure

Activities: towards industrial implementation

- Analytical model based software tools: PREDICTABILITY - VIRTUALIZATION
- Design & Qualification Guidelines: DfX - QUALITY – RELIABILITY
- Reliability-by-Design: FAST DEVELOPMENT



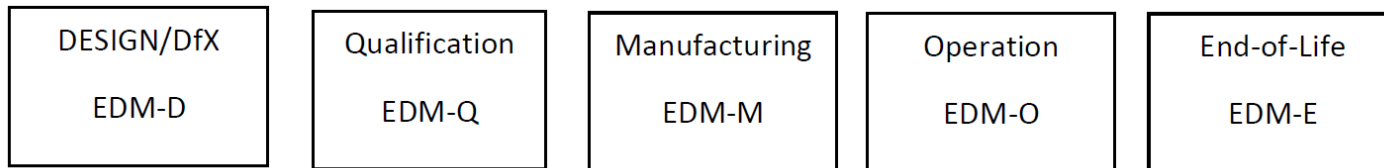
## CALCULATION TOOLS FOR LIFE TIME PREDICTION

Tool	Format	DfR relevance	Status Sept 2016
PTH via fatigue tool	cEDM calculator Sherlock (DfR Solutions)	Predicting the life time of Plated Through hole via's in PCB's	Available: upgrade
Vibration tool	cEDM calculator	Calculating Eigenfrequencies of PCB with specified support	Available
Delamination tool	cEDM calculator	PCB delamination, degradation at high T	Available: upgrade
Solder fatigue prediction	cEDM calculator	Predicting the life time of solder joint fatigue life for soldered components	Under development Model for two terminal components by end 2016
Quantified FMEA	Excel	Quality and Failure Risk assessment	Available: FMEA regularly updated

More info @ [www.cedm.be](http://www.cedm.be)



# CEDM GUIDELINES: NEW STRUCTURE



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

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

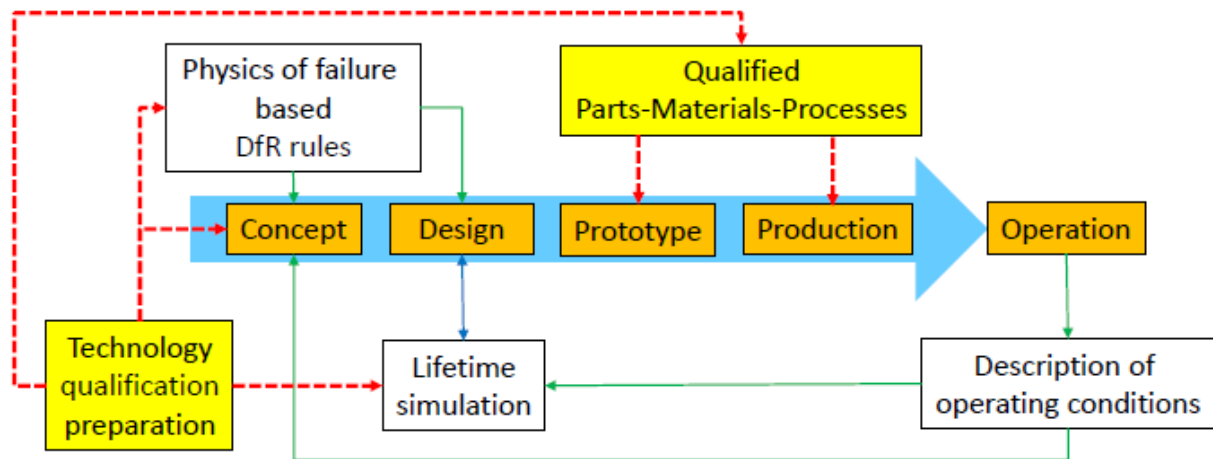
EDM-P

## 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](http://www.cedm.be)



# INTEGRATED RELIABILITY-BY-DESIGN METHODOLOGY

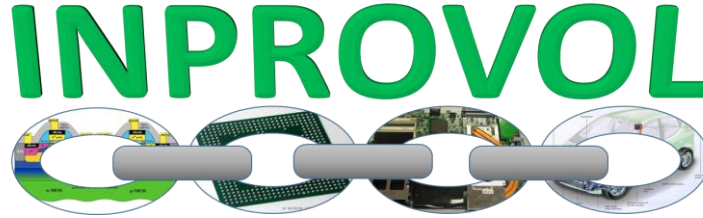


Supporting industrial implementation of PoF based Reliability-by-Design:

- Workshops, webinars (to be)
- Individual consultancy
- Implementation support: simulation
- Projects on DfR / FMEA

## 2. INPROVOL: INTELLIGENTE PRODUCTEN MET VOORSPELBARE LEVENSDUUR

### VIS-TRAJECT: DISSEMINATION



Is InProVoL of interest to you?

Join the 22 companies/organisations in the VIS-traject InProVoL community

- Join user committee
- Join the InProVoL consortium as cEDM partner or member  
(InProVoL consortium member fee is covered by cEDM partner/membership)
- Contact [Bart.Cox@imec.be](mailto:Bart.Cox@imec.be) - +32 16 283108 - +32 478 252316
- Project leader [Bart.Vandeveldede@imec.be](mailto:Bart.Vandeveldede@imec.be) - +32 16 281513 - +32 473 694157

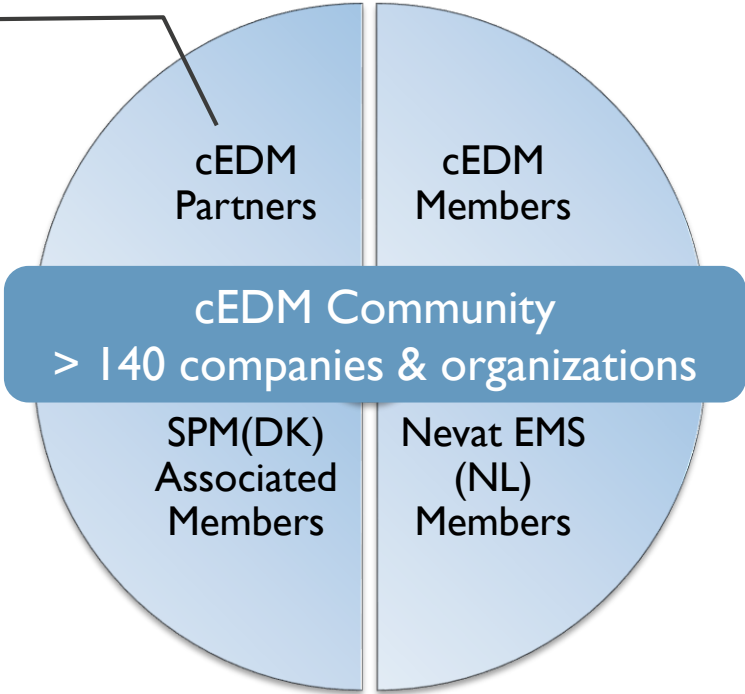


# THE CEDM COMMUNITY

2016: +15 companies



Founding Partners



### 3. HARDWARE SERVICE FOR RESEARCH AND INDUSTRY

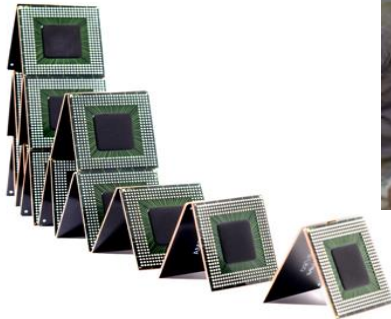
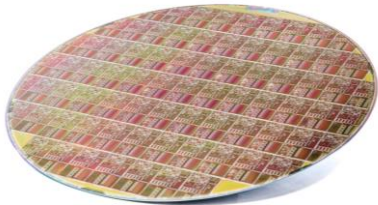
### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

■ **imec** <sup>IC link</sup> : COMMITTED TO MAKING GREAT PRODUCTS HAPPEN

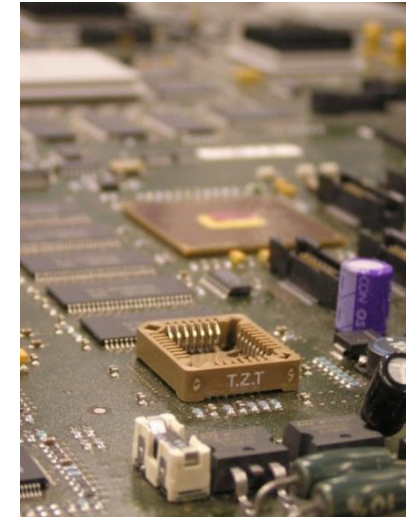
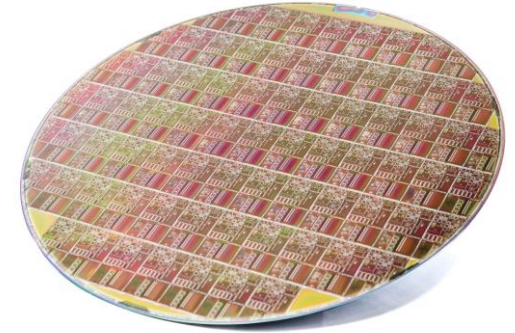
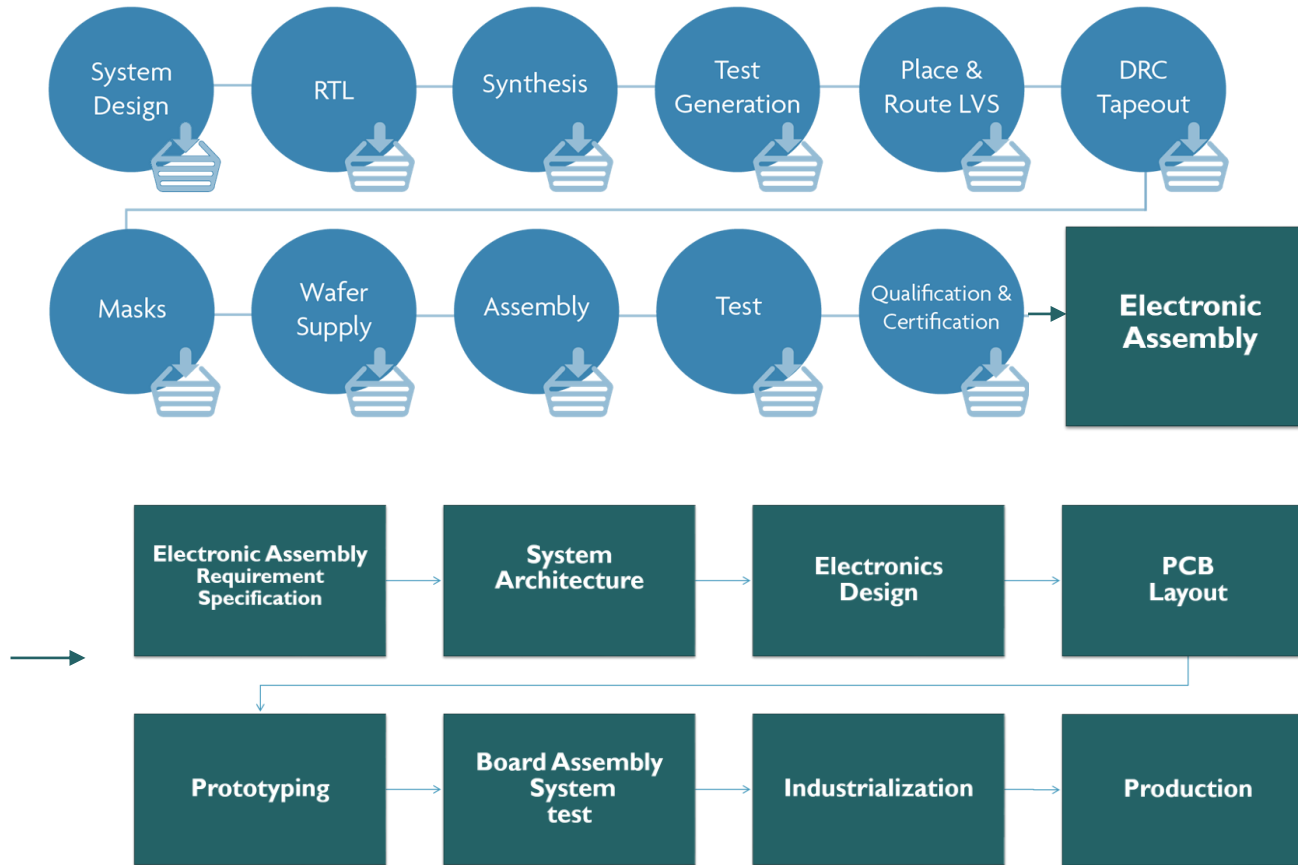
Imec's electronic hardware partner for academia and industry committed to making great products happen.

Supporting electronic product design:

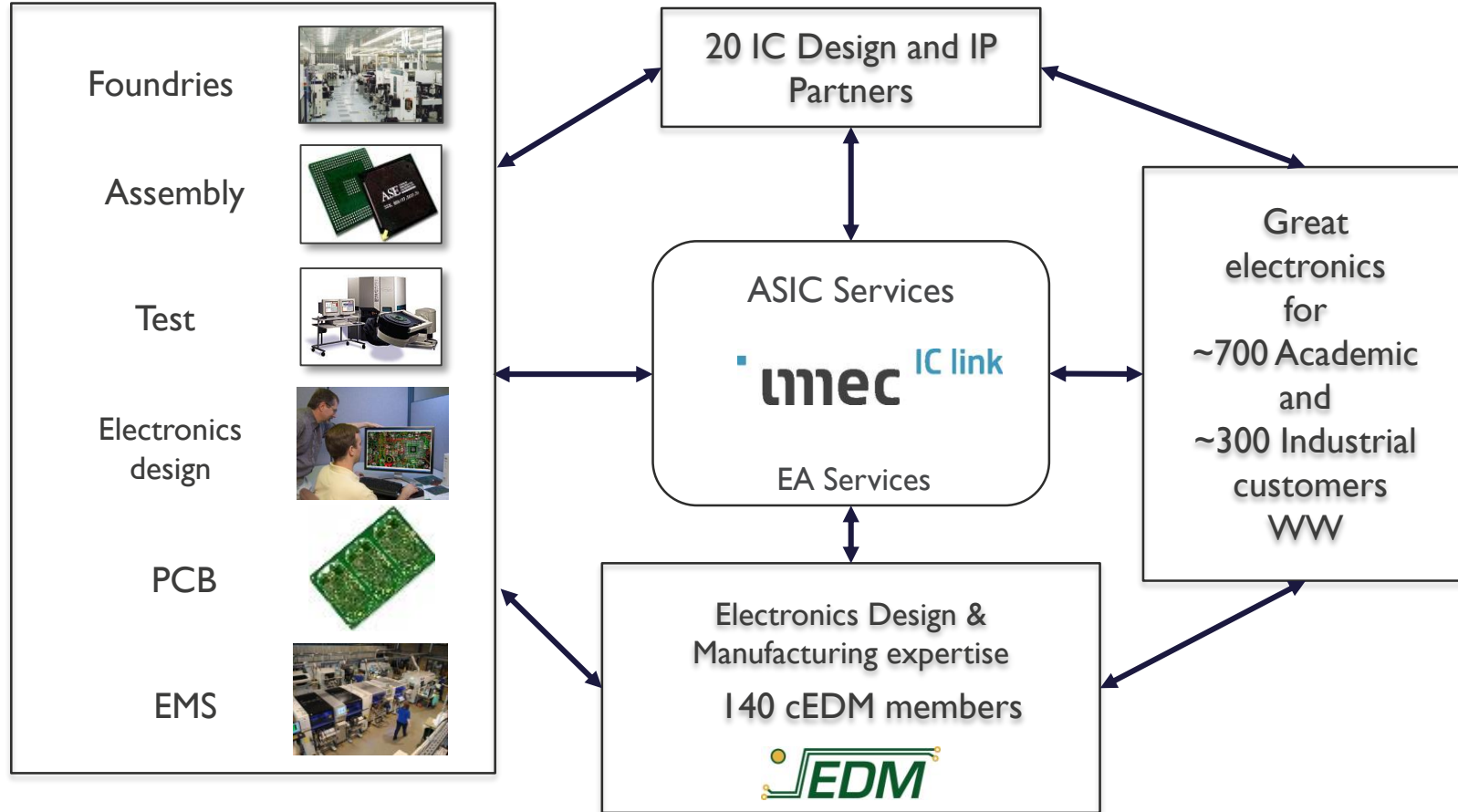
From ASIC design to volume production and system integration of electronic assemblies.



### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY



### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

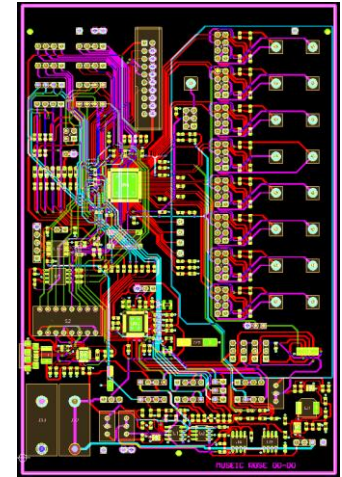
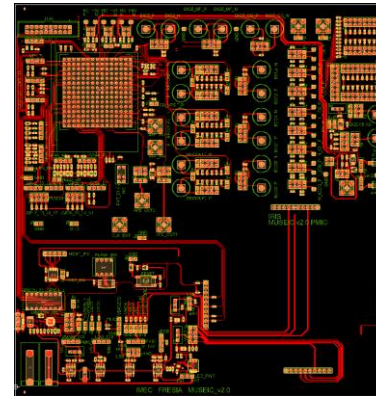


# 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

## ELECTRONIC ASSEMBLY SERVICE

PBA realization aspects

- Functional and Physical Design (DfX)
- Thermo-mechanical simulation and virtual prototyping
- Supplier selection & ordering: PCB, components, assembly
- Data transfer
- Tooling (stencil,...)
- Test
- Follow-up
- Quality and repair





# 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

## REALISATION EXAMPLE

### IMEC LIFE SCIENCES

- Complete Read Out System for Neural Data
    - Flex Board with wirebonded ASIC
    - Headstage board: 1,5Gbps serial stream
    - Miniature coax 5m
    - FPGA Board: data processing, amplification, corrections
    - GUI for user interaction
  - Technology:
    - 80um flex, 65um track width & spacing
    - Components 0.4mm pitch QFN/uBGA
    - Complex wirebonding / glob top specification
- Architecture, HW design, Layout, SW design,  
FPGA development, Prototyping, System Test



- IC-link EA takes the burden of Electronic Assembly: design, prototyping, test, industrialization and logistics.



## Researchers can focus on research

- *Fast, right first time, cost effective, industry grade*

and IC-link does this for your ICs to!

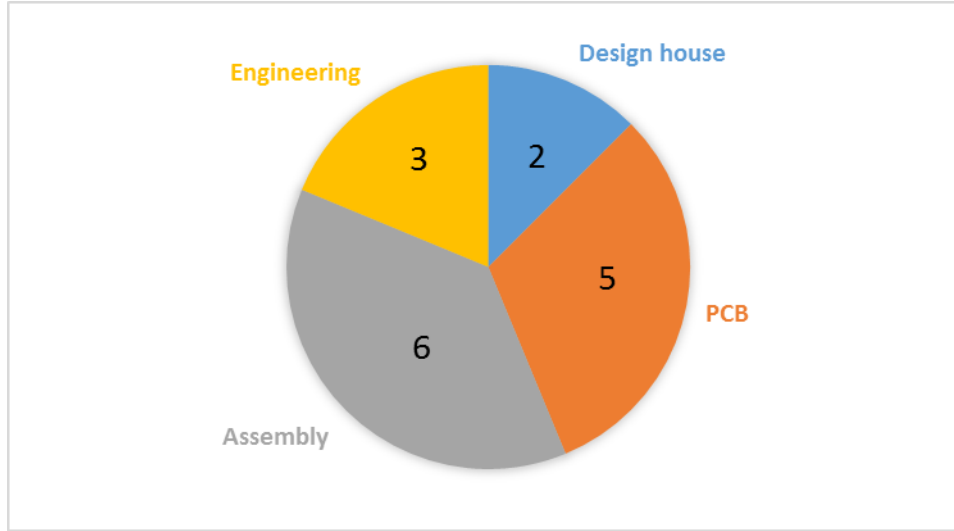
### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

FAST, RIGHT FIRST TIME, COST EFFECTIVE, INDUSTRY GRADE

- Industrial track record in product development, industrialization and manufacturing of EA team members
  - Industrial New Product Introduction know-how esp. manufacturing related
  - Industrial good practices
  - From customer needs/wish list to industrial specification
- Active network in the electronic supply chain
  - Selection of partners with the right capability
  - Delivery performance: fast, correct
- Design-for-eXcellence of prototypes: manufacturing, test  
Basis for “right first time” and total cost control: minimization of iterations
- Reuse of solutions e.g. data readout  
Efficient and cost effective

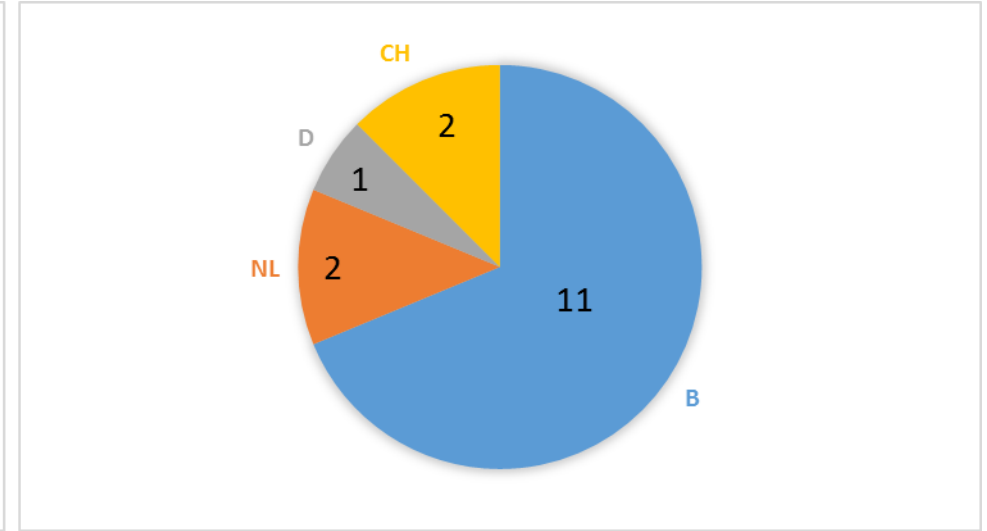
# 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

VIEW ON SUPPLY: SINCE 2015



Standard rigid PCB/PBA +:

- Flex & Flex-rigid PCB and assembly
- High density/high speed substrates
- Bare die assembly: wire bonding, flip-chip
- Special assembly



Mechanics:

- Wearable: wrist band, patches ...
- (small) Box build
- Bio-compatibility

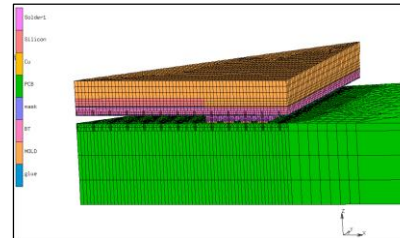
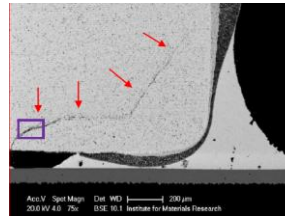
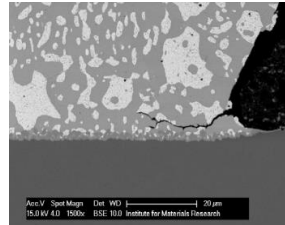
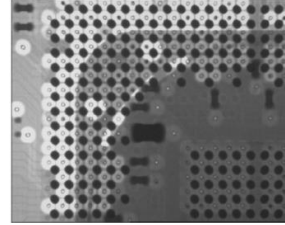
2017: +50%

# 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

## R&D & ENGINEERING SUPPORT

- Field failure analysis:  
root cause and mitigation
- Design, Qualification, Manufacturing  
guidelines and consultancy
- Thermal & thermo-mechanical  
FEM simulation
- Qualification PCB / PBA
- Product design &  
industrialization services

Funding: Vlaio KMO, KMO portefeuille



## Access to wide range of analysis techniques:

- Sample preparation
  - Cross-sectioning, dye-and-pry
- Analysis
  - Optical microscopy
  - X-Ray
  - SEM-EDX,
  - SAM
  - chemical analysis
  - TGA, TMA
  - bending, warpage
  - shear/pull, mini-sharpy
  - solderability,...

Analysis partner: imomec – Univ. Hasselt

### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

#### DESIGN-FOR-X SUPPORT



**Allora Factory / Creotronics**  
FMEA Analysis – Reliability feedback

Mobile Temperature sensor with  
LORA communication





### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

#### DESIGN-FOR-X SUPPORT

## Imec ondersteunt Vlaamse Internet-of-Things start-up Sensolus op weg naar Antarctica

Posted on **January 25, 2016** by **admin**



Kris Hermus, 25 januari 2016 – Imec heeft Sensolus, een Gentse start-up die energiezuinige oplossingen ontwikkelt voor Internet-of-Things (IoT) toepassingen, ondersteund bij de optimalisatie van zijn sticknTrack GPS tracker met geïntegreerde SigFox communicatiechip ([www.stickntrack.com](http://www.stickntrack.com)).

Imec heeft de bestaande hardware module van Sensolus grondig onder de loep genomen en aanbevelingen gedaan voor toekomstige optimalisaties.

### **SENSOLUS**

Reliability Analysis & improvement

GPS tracking with  
Sigfox communication



### 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY



上海微创电生理医疗科技有限公司  
Shanghai MicroPort EP MedTech Co., Ltd.

IMEC TAIWAN  
GATEWAY TO ASIA

LONG TERM HEALTH MONITORING  
ULTRA LOW POWER PHYSIOLOGIC SENSING DEVICE.



### 3. HARDWARE SERVICE TO RESEARCH AND

## IMEC TAIWAN: GATEWAY TO ASIAN MARKET AND MANUFACTURING



# 3. HARDWARE SERVICE TO RESEARCH AND INDUSTRY

## IMEC TAIWAN: DOMAINS OF EXPERTISE

### imaging solutions

#### OPTICAL ASSEMBLIES

- Discrete lenses, collimators, filters,...
- Glass, Plastic, Quartz,...
- Zemax modelling, DfX, tool release

#### EMBEDDED SOFTWARE

- DSP & image processing
- Image quality optimization
- GPU, FPGA real-time IP implement

#### CAMERA PLATFORMS

- Custom made imaging solution
- Complete camera housing design
- Stereovision, Computational image



### IoT smart devices

#### SENSOR SELECTION

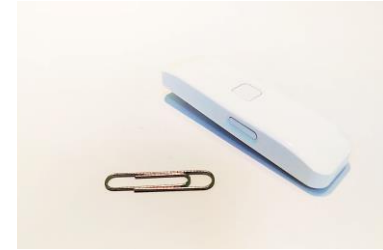
- Mixed signal interfacing
- Best technology selection, modelling
- Performance evaluation

#### EMBEDDED SOFTWARE

- PHY, API, DSP signal processing
- Wireless protocol
- SDK, cloud handshaking

#### DEVICE PLATFORMS

- Multi-sensor reference designs
- Complete functional modules
- Towards standards compliancy (FDA, EN, IEC, CE)



### conformal structures

#### STRUCTURE DESIGN

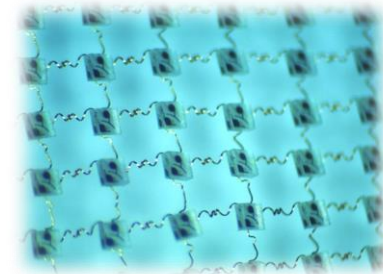
- Finite element modelling
- Best technology selection
- Functional application design

#### PROTOTYPING

- Mesh structures, sensor arrays
- Functional sub-modules
- Wafer level components

#### INDUSTRIAL TOOL DESIGN

- Semiconductor process flow R&D
- Manufacturing tool design
- Statistical evaluation, FMEA



# THANK YOU



embracing a better life



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