



imec

COMPETITIEF ELECTRONICA ONTWERP
EN ASSEMBLAGE DICHT BIJ DE KLANT



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



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

OUTLINE

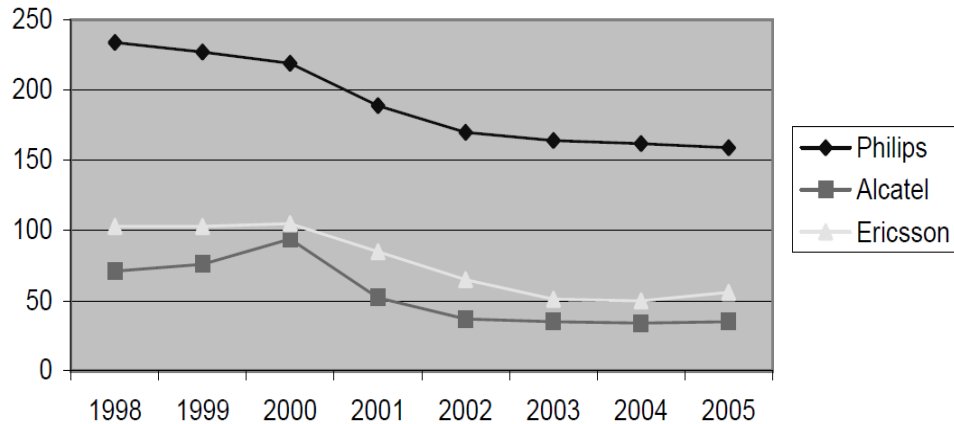
- 20th Century Manufacturing Outsourcing
- Outlook 2017
- Drivers for Re-shoring
- What is needed for local design & manufacturing?
- A scientific approach to electronics design & manufacturing



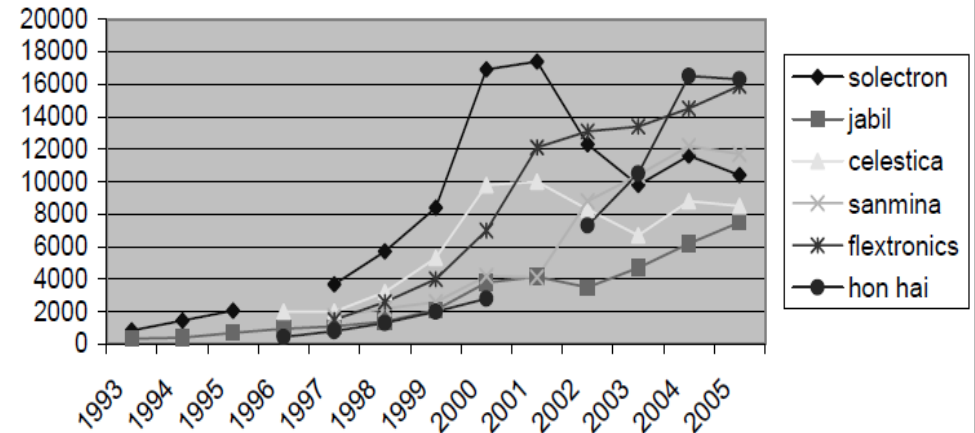
THE 20TH CENTURY MANUFACTURING OUTSOURCING

THE TREND

Employment in OEMs
(selected years; x 1,000 persons)



Sales by contract manufacturers
(various years; million USD)



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

US → Mexico

West → East Europe

} → China



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

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 ...
... 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 2017 - INDUSTRY

“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

Reshoring vaak startsein voor innovatie

By [Donata van de Ven](#) september 2, 2016



China's Evaporating Manufacturing Cost Advantage Leading to US Reshoring

By: [David Russell Schilling](#) | April 6th, 2017

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

Manufacturers' MONTHLY

Re-shoring tide is starting to turn

October 27, 2016 Alan Johnson



"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."

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



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

OUTLOOK 2017 - US

“THE TIMES THEY ARE A-CHANGIN’ ”?



✉ info@reshorennow.org

Reshoring Initiative®
Bringing Manufacturing Back Home



Why the U.S. is now winning the fight to keep manufacturing jobs onshore

Article by Bart Taylor May 8, 2017, 09:28 am MDT

In 2014 and 2015 parity was reached between offshoring and returning jobs, indicating that the net bleeding of manufacturing jobs to offshore had stopped. As of 2016, for the first time, probably since the 1970s, there was a net positive gain in U.S. jobs. The U.S. has gone from losing about 220,000 manufacturing jobs per year at the beginning of the last decade, to adding 30,000 jobs in 2016.



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

OUTLOOK 2017 - EUROPE

“THE TIMES THEY ARE A-CHANGIN’ ”?



Briefing
21/03/2014

Reshoring of EU manufacturing

MANUFACTURING towards 20% GDP by 2020

Factories of the Future – Industry 4.0

Horizon 2020 “Industrial Leadership” category

2014-2020: **€17 billion**



European Reshoring Monitor

<https://reshoring.eurofound.europa.eu/>

**ERM annual report 2016:
Globalisation slowdown?
Recent evidence of offshoring and
reshoring in Europe**

<https://www.eurofound.europa.eu/publications/executive-summary/2017/erm-annual-report-2016-globalisation-slowdown-recent-evidence-of-offshoring-and-reshoring-in-europe>

Manufacturing in EU 2016: 15% GDP
33 million employees



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

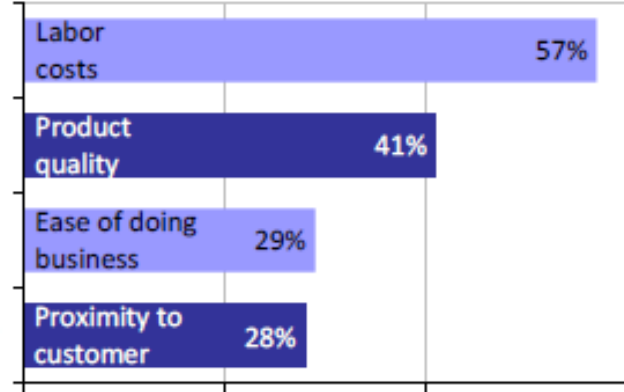
**ELECTRONICS
& APPLICATIONS**
WWW.EABEURS.NL

DRIVERS FOR RE-SHORING

Industry

- Rising total landed cost
 - Increasing labour cost
China: +10%/y ('00-'05) +19%/y ('06-'10)
+15%/y on-going
 - 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

Main production location reasons



Source: Graebel [paper](#) 2012

Governements

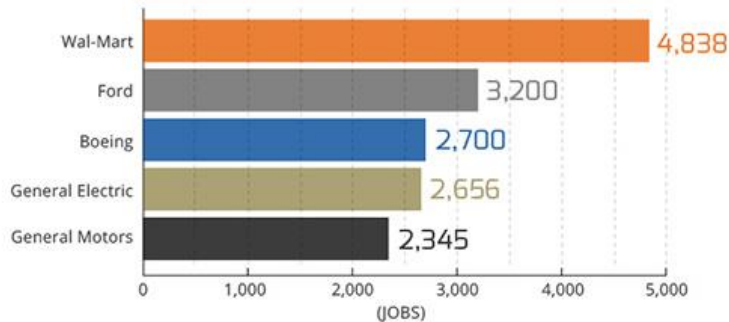
- Jobs: 1 manufacturing job + 2.5 support
- Higher pay than service sector
- More R&D → innovation, IP
- More export, less import



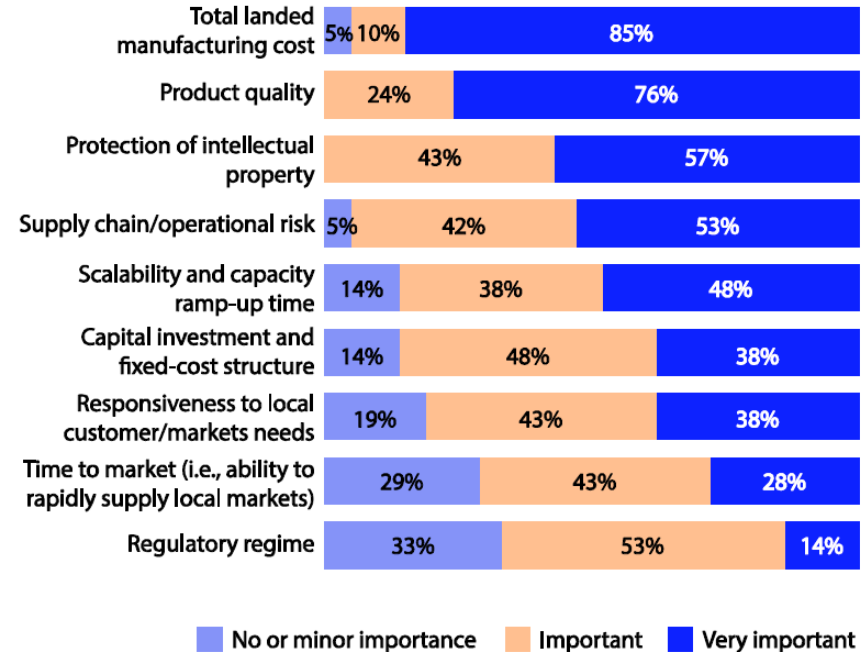
MOST LIKELY PRODUCTS TO BE RE-SHORED

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

The Top 5 “Reshoring” Companies Are:



Manufacturing sourcing strategy decision driver



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



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

WHAT IS NEEDED?

Product:

- Dynamical
- Quality
- Safety → reliable
- High value

FLEXIBLE AUTOMATION
reduce labour - increase quality

FAST Right-First-Time
Product development

PRODUCT RELIABILITY
PRODUCT LIFE CYCLE CONTROL



ED&A CASE: WHY START IN-HOUSE MANUFACTURING?



50K / yr - 20

(day mornings)

yr. > €10K

HERE: BETTER, FASTER and LOWER COST!

Automation & Design-for-manufacturing

- New and S...
- ... on component level

Quality remarks: reduction 10x!

Lead times prototypes (and series)

→ reduction of 65%




WHAT IS NEEDED?

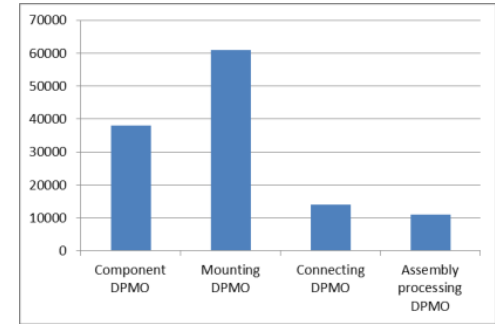
QUALITY QUANTIFICATION AND PREDICTION



New Quality method achievements

- 4 to 6 times better PCBA quality in 3 years
- Manufacturing Risks have become transparent

 Workshop 20, December 9, 2014



After decades of constant PCBA quality we have been able to improve it at our suppliers by a factor 4 to 6 in 3 years time by deploying the new Quality Quantification methodology embedded in imec's **Pred-X** tool in **ASML's** New Product Introduction process. Further quality improvement using this method at system level is the aim of ASML's ZHDR project.

www.movip.nl – www.cedm.be

ASML
Dick Van Hees



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

WHAT IS NEEDED?

COMPETITIVE LOCAL MANUFACTURING

- Manufacturing knowledge PCB & assembly @ design: materials, processes, structure
It is feasible. It is not “rocket-science”.
- Design-for-Manufacturing:
 - Quantitative modeling not just “by experience”
 - Guidelines & tools
 - DfM & DfAssembly: design evaluation
- Manufacturing automation:
 - Placement equipment - robotization
 - Component feeders
 - Tracking & tracing - Industry 4.0 – IoT in the factory – small batch optimization
- Data standardization and data cleansing



WHAT IS NEEDED?

Product:

- Dynamical
- Quality
- Safety → reliable
- High value



Design-for-eXcellence

Manufacturing plus Reliability, Logistics, Cost,...

Trustworthy PREDICTION of all
Product Life Cycle aspects

(without costly, long duration prototyping & testing)

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.



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

ECU



2016 report

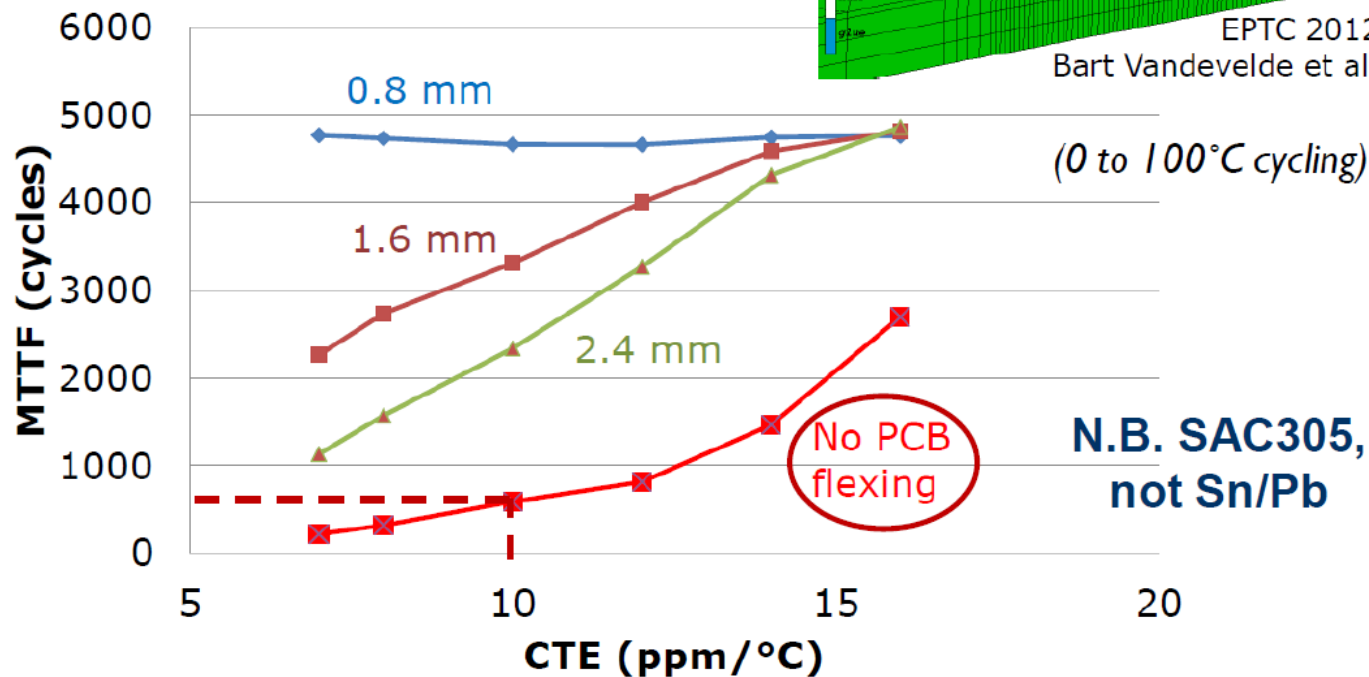


6. Reliability of BGA Impact of board thickness

Truck manufacturer
acknowledges our
prediction of 2012.

Prevention is
possible w/o
high testing
costs

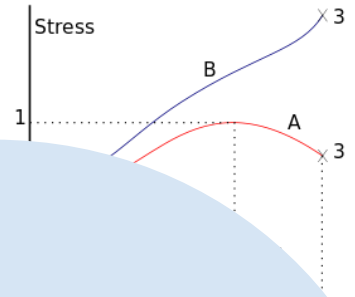
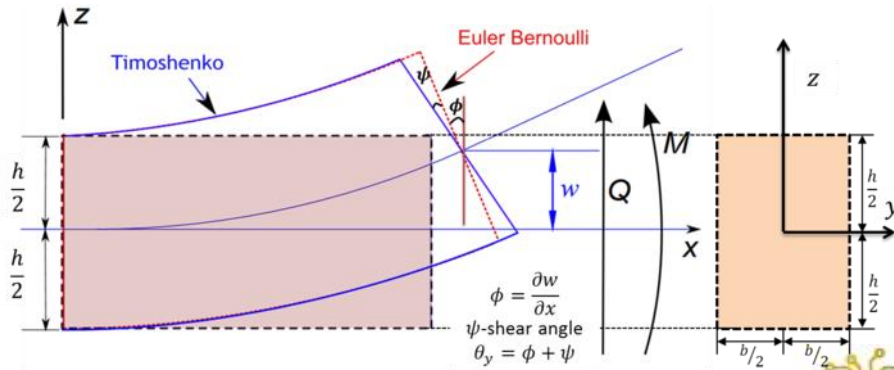
**PBGA 27x27 area array
1.27mm pitch**





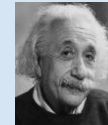
HOW TO PREDICT?
OR THIS WAY?

The Mechanics of Electronics



$$\frac{1}{C} = \frac{M}{\sigma}$$

SCIENCE
*The next best thing
to a crystal ball*



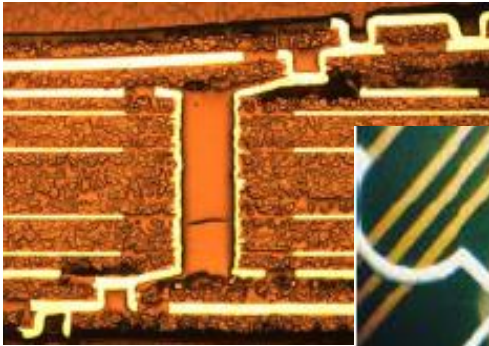
$$u_0 + \frac{\partial u_0}{\partial x} \Delta x$$

AN EXAMPLE OUT OF THE CEDM TOOLBOX

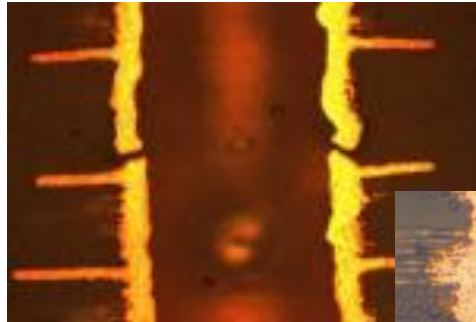
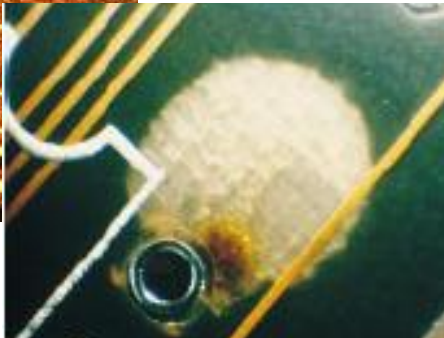
PCB VIA LIFETIME AND DELAMINATION PREDICTION

PCB FR4 laminate:

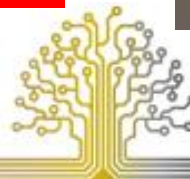
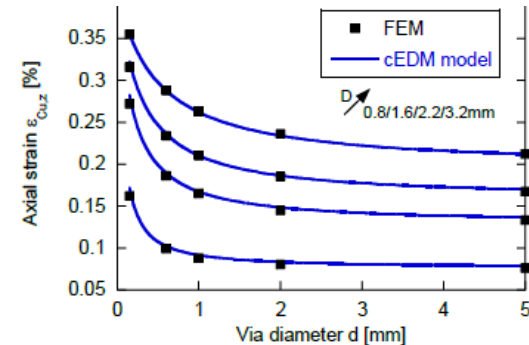
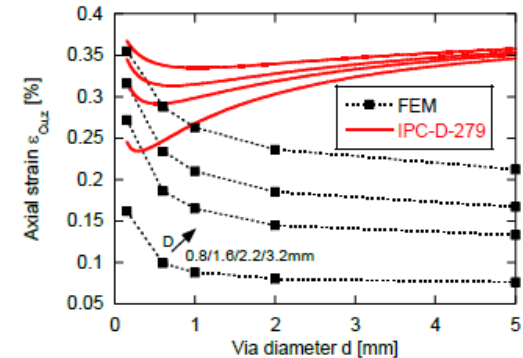
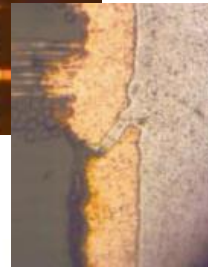
- (Cohesive) delamination and via failure
- Prediction of failure probability: production & operation
- >200 laminates: *PCB Laminate Overview*



Delamination

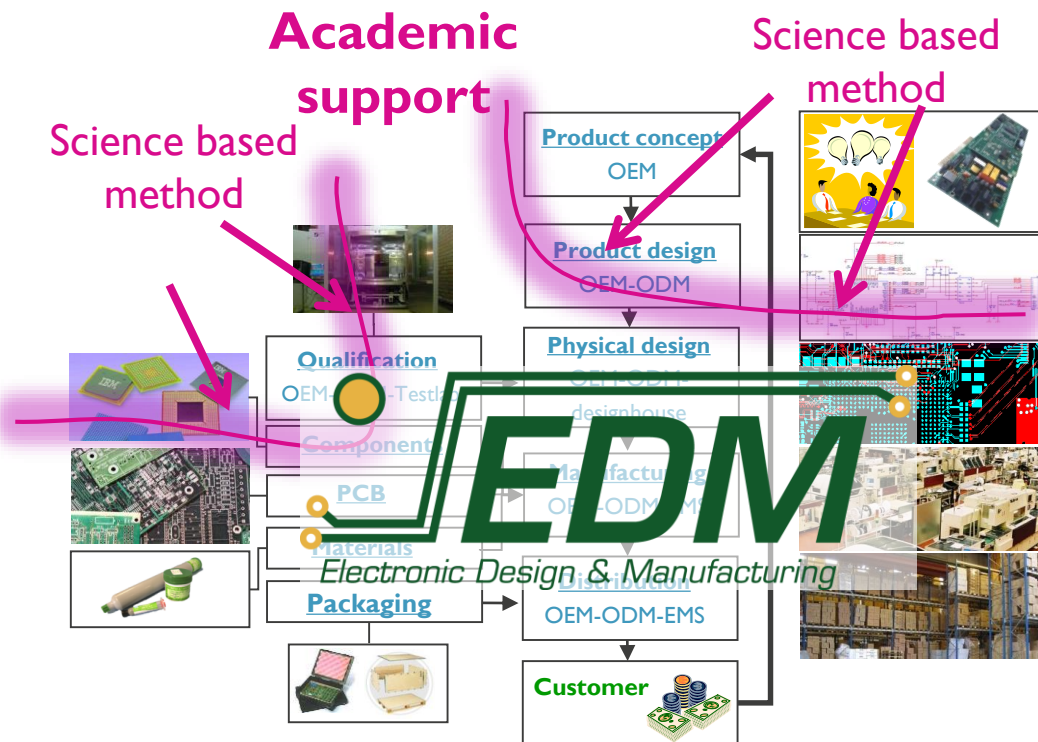


Via cracking



A SCIENTIFIC APPROACH TO ELECTRONICS DESIGN & MANUFACTURING

SCIENTIFIC/ACADEMIC SUPPORT



Experience-based industrial approach

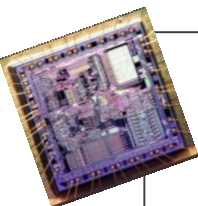


A SCIENTIFIC APPROACH TO ELECTRONICS DESIGN & MANUFACTURING

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'.



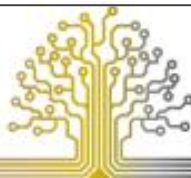
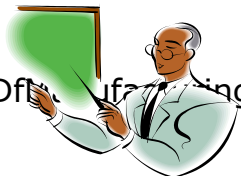
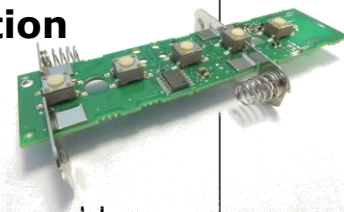
Integrated Circuit realisation

- Materials
semiconductors, metals, insulators, interfaces
- Process-steps
oxidation, implantation, deposition, litho,...
- Production-flow
IC process flow
- Test and analysis
- Design – layout - TAD
- Reliability



Electronic Assembly realisation

- Materials
polymers, metals, solder, interfaces
- Process-steps
lamination, drilling, plating, litho, printing, assembly...
- Production-flow
substrate build-up, assembly flow
- Test and analysis
- Design – layout - Dfma, manufacturing
- Reliability



30/31 MEI & 1 JUNI 2017
JAARBEURS UTRECHT

ELECTRONICS
& APPLICATIONS
WWW.EABEURS.NL

A SCIENTIFIC APPROACH TO ELECTRONICS DESIGN & MANUFACTURING

Development: critical aspects

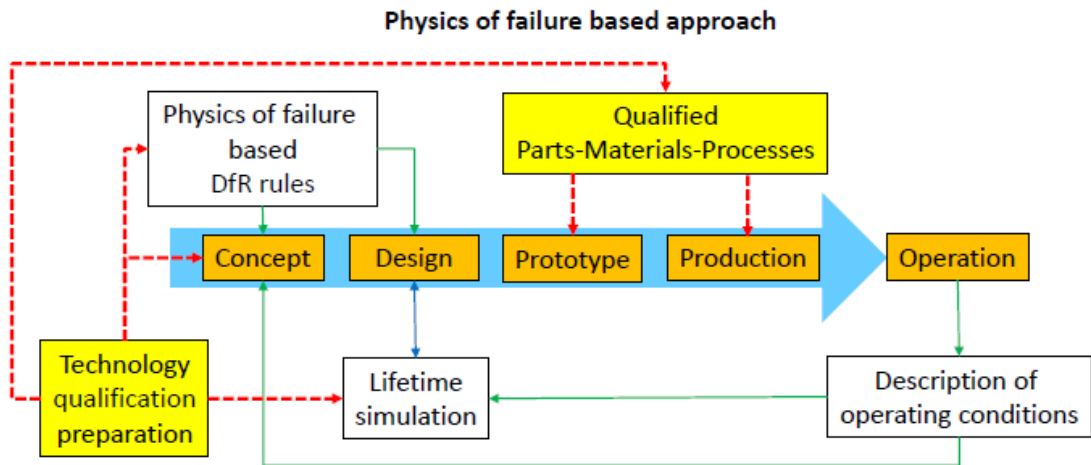
- Engineering cost
- Time-to-market

Minimize:

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

Maximize: PREDICTABILITY

Design-for-X guidelines & tools: virtual prototyping



A SCIENTIFIC APPROACH TO ELECTRONICS DESIGN & MANUFACTURING

Manufacturing: critical aspects

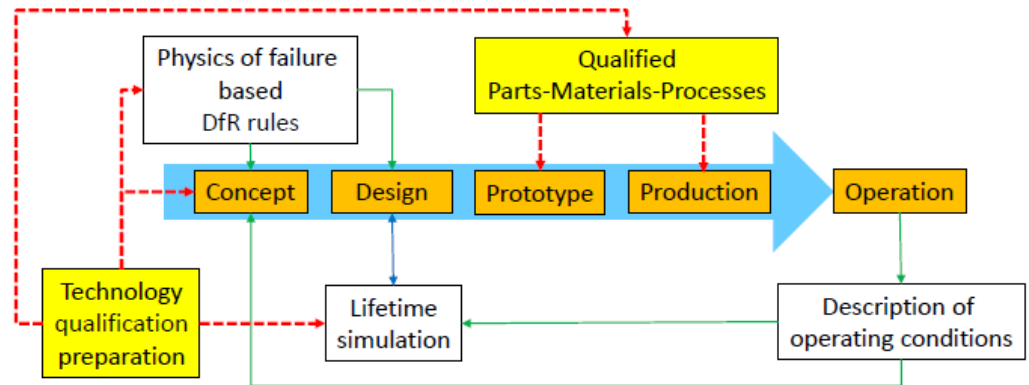
- Cost
- Volume ramp-up
- Delivery performance
- Quality

Maximize yield

Minimize labour

Minimize Work-in-Progress (test & repair)

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



A SCIENTIFIC APPROACH TO ELECTRONICS DESIGN & MANUFACTURING

QUANTIFY – GUIDE – DIMENSION – PREDICT – PREPARE – EVALUATE

Design: selection and specification

- Components
- Substrates
- Materials

Physical design: layout

Manufacturing and assembly

- Manufacturing process flow
- Process set-up and compatibility
- Yield & test coverage & quality
- Cost

Qualification

- Simulation
- Effective, physics based testing

New Product Introduction:

fast, minimal cost, less & quantified risk

Operation

- Maintenance program
- Lifetime prediction
- Warranty costs – cost of ownership



You want to be successful with local design and manufacturing of new products?

*There is no experience
or history of the future.*

Science is the only* tool available
to prepare for future success.

*with a significant and trustworthy track-record



Dank u wel



imec

embracing a better life

