DESIGN AUTOMATION
& EMBEDDED SYSTEMS
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7 NOV
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PREDICTIVE NPI FOR SMART PRODUCTS

7 NOVEMBER 2018

GEERT WILLEMS – IMEC
CENTER FOR ELECTRONICS DESIGN & MANUFACTURING

EDM
Electronics Design & Manufacturing

Met steun van:
AGENTSCHAP INNOVEREN & ONDERNEMEN

CONTENT

Products for the "Smart World"

New Product Introduction for the Smart World

Technology Qualification

A Smart NPI (reliability) example

PRODUCTS FOR THE SMART WORLD

PRODUCTS FOR THE "SMART WORLD"

WHAT IS NEW ABOUT "SMART WORLD"?

1. Monitoring operation/use: (real time) feedback
2. Exploitation of an increasing amount of information
3. (Self-)Learning, dynamic, adaptable systems

Why now?

It has become affordable: low-cost, high-performance electronics.

PRODUCTS FOR THE "SMART WORLD"

"SMART WORLD" SYSTEM CHARACTERISTICS

Application level:

Software (AI) using

@ functional level:

A high number of (wireless) **interconnected & distributed electronic hardware** modules (sensing, computing, communication, power).

@ physical level:

- New electronic devices in all kinds of "environments": wearables, vehicles, machinery, building, infrastructure...
- Often hard-to-reach and/or harsh.
- Integration of electronics in new environments.

PRODUCTS FOR THE "SMART WORLD"

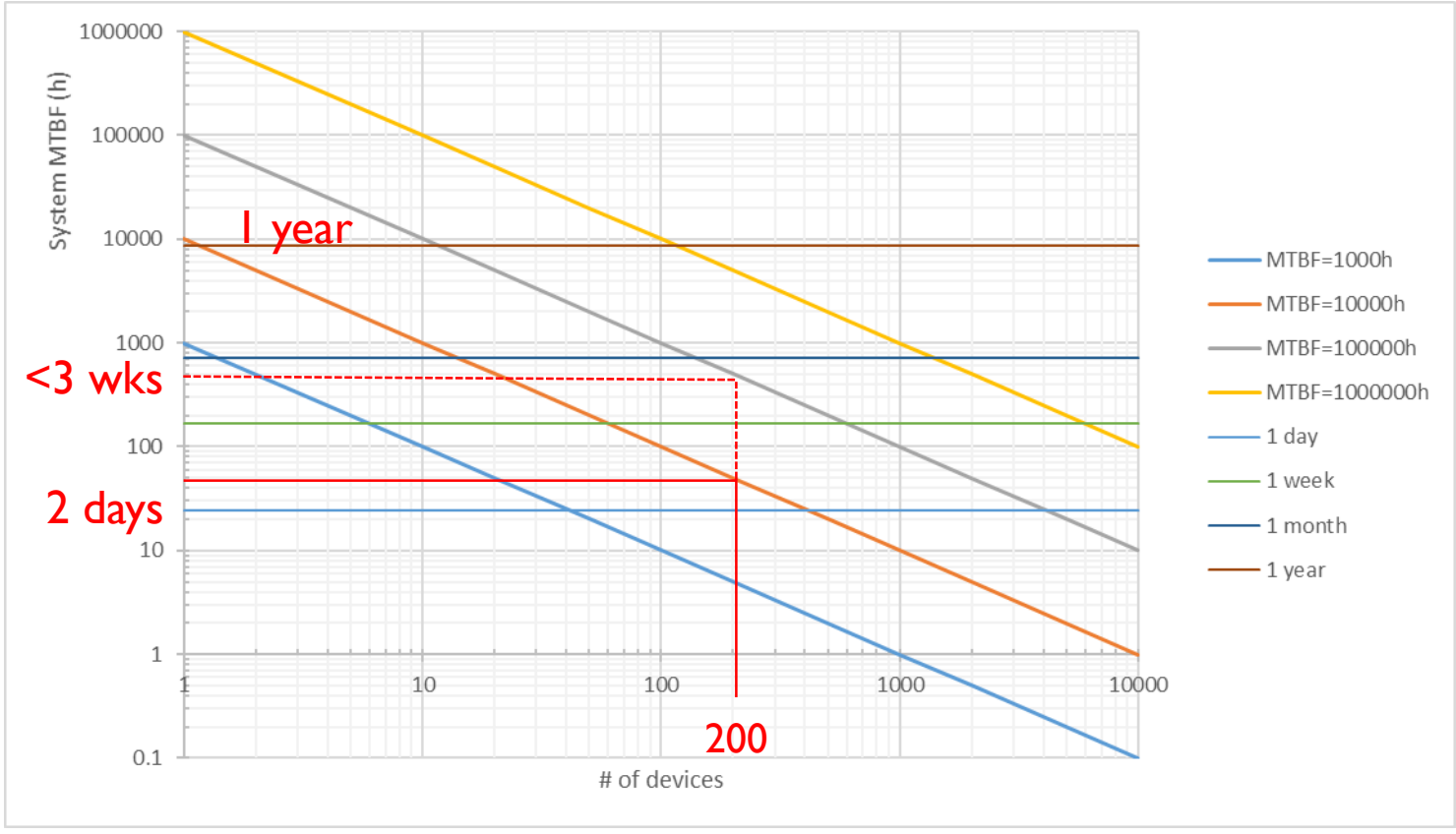
PRODUCT DEVELOPMENT REQUIREMENTS FOR THE "SMART WORLD"

- System adaptable to
  - Different applications
  - Different environments and mission profiles
  - Different volumes, markets (consumer, professional, safety critical)
  - Different product life cycles
  - All this may be variable over time for the same product
- Use of new electronic devices with little use history
- High quality, high reliability, low maintenance.
- Short time-to-market: fast development, scale-up and deployment
- Lowest possible cost

PRODUCTS FOR THE "SMART WORLD"

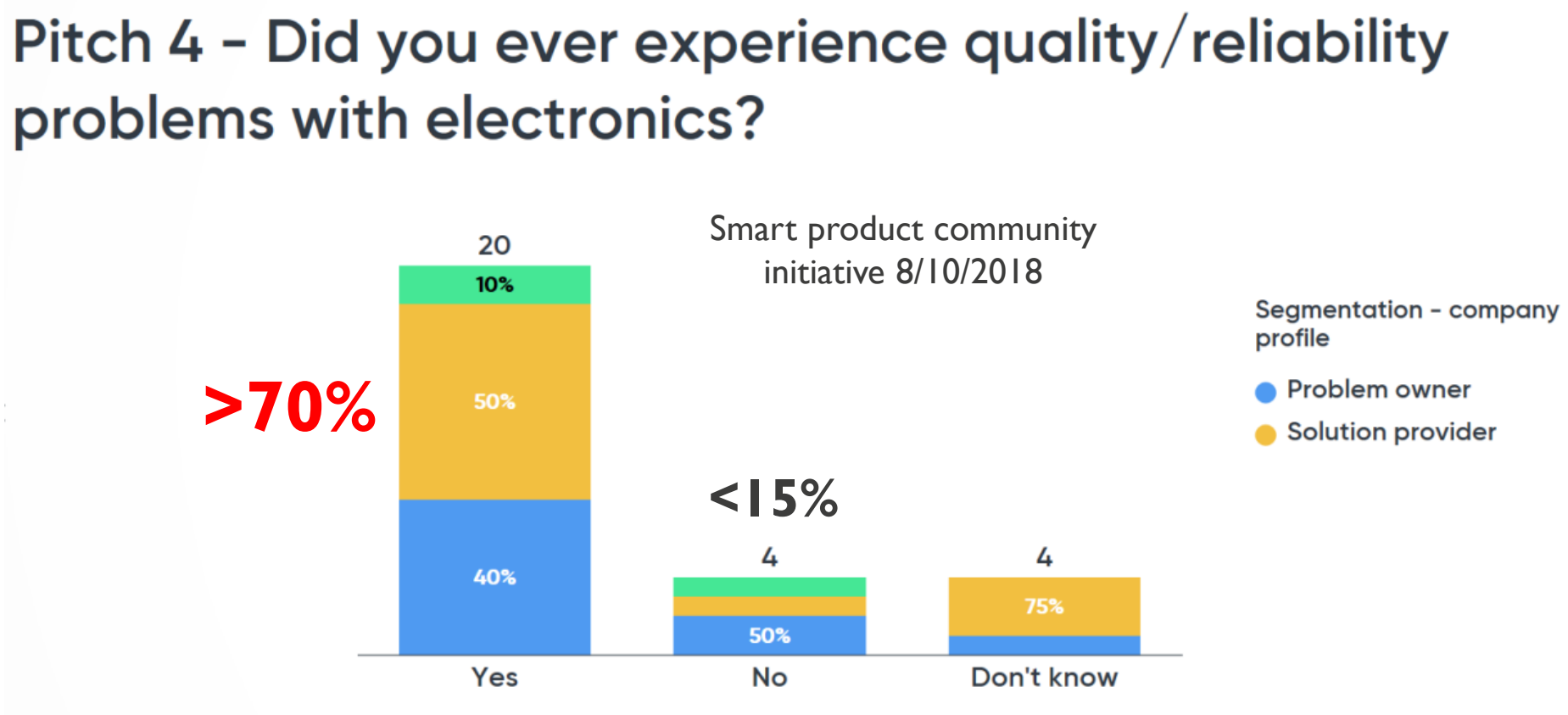
QUALITY AND RELIABILITY: TIME BETWEEN FAILURE

In the Connected World Reliability is Essential



PRODUCTS FOR THE "SMART WORLD"

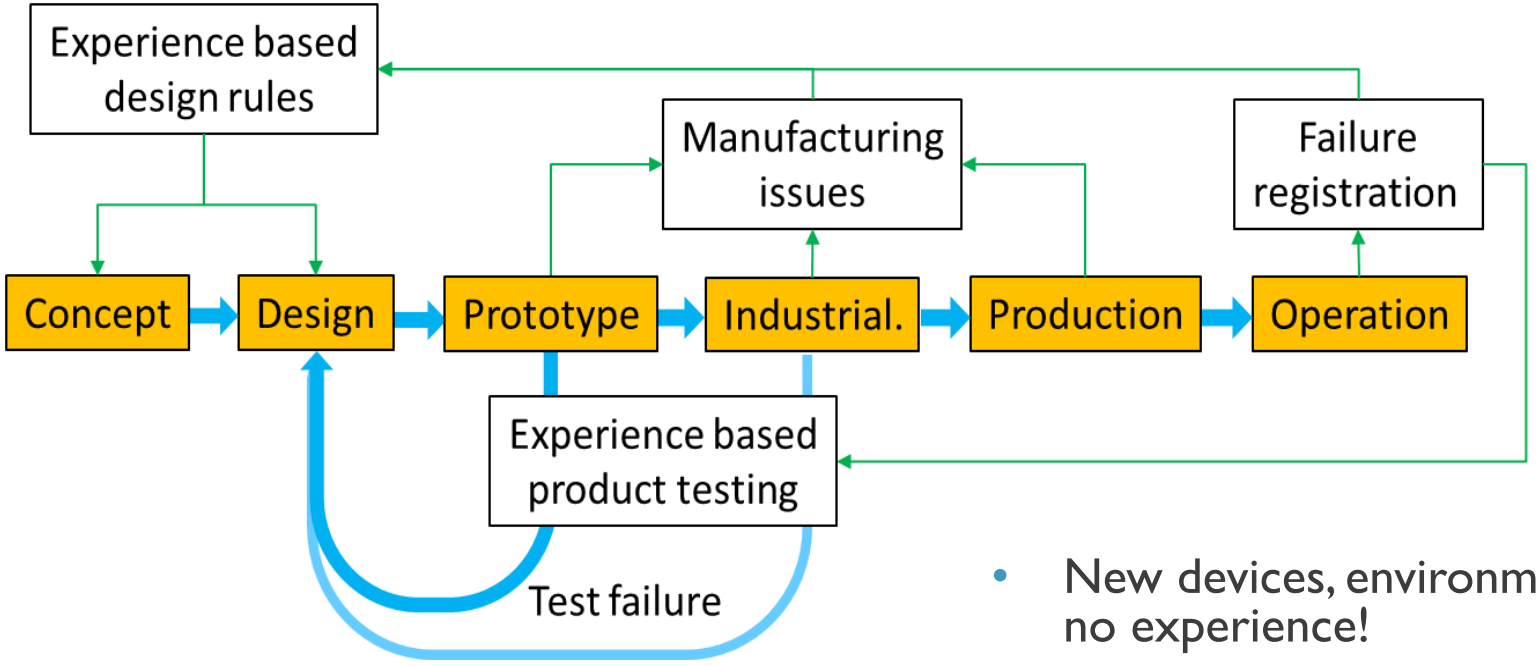
RELIABILITY CHALLENGE



NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

THE TRADITIONAL WAY



- New devices, environments, way of use: no experience!
- Hardware iteration:
  - Time consuming
  - High cost

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

THE TRADITIONAL PRODUCT TESTING: BLACK BOX TESTING

Vibration
Shock
Heat
Cold
Moisture
Thermal cycling
Voltage/Power
EM pulse/radiation
...

"Alive"

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

THE TRADITIONAL PRODUCT TESTING: BLACK BOX TESTING

What did we learn by passing the test?

- The prototype passes the test.
- Does this guarantee anything regarding product operation?
  - New devices
  - New environment(s)
  - New application(s)
  - New ways of use
- What if any of the above changes?

What did we learn from a test failure?

- Test relevancy: did we discard a perfectly good solution?

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

WHAT DO WE NEED?

Product:

- Dynamical
- High Quality
- High Reliability
- Low Cost
- Time-to-market

Trustworthy PREDICTION of all Product Life Cycle aspects

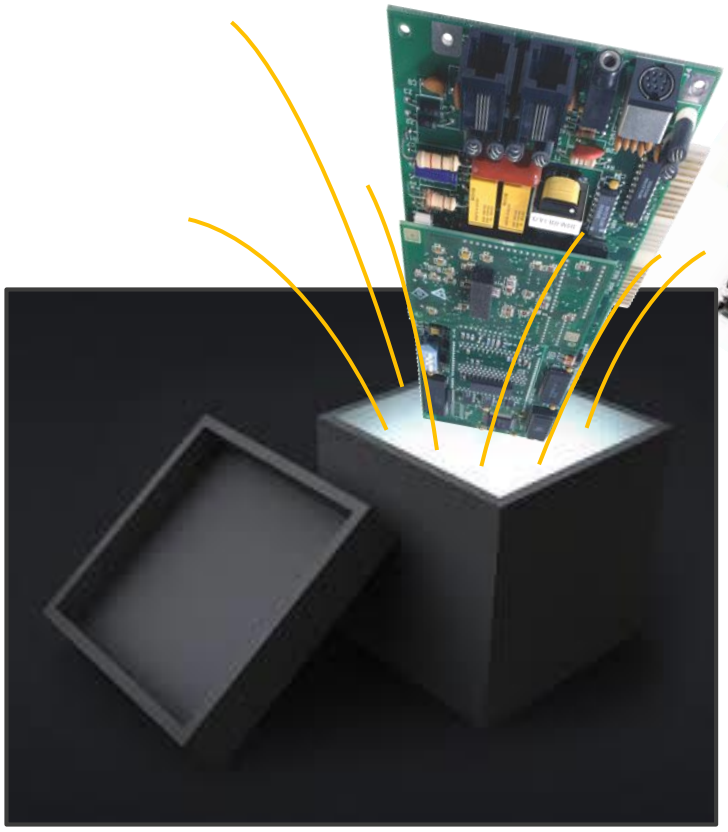
without costly, time-consuming prototyping, testing and design iterations

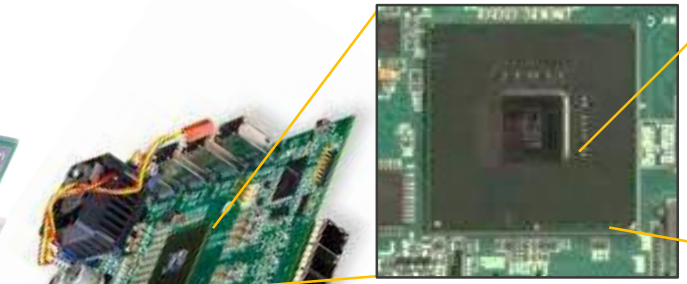
How do we do that?

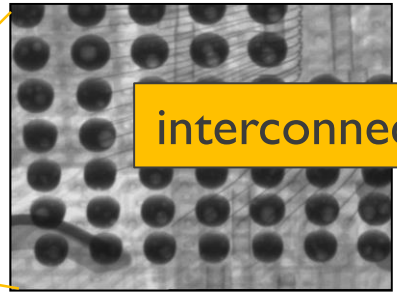

BLACK BOX
MediaCento VX
BLACK BOX
BLACK BOX
CAT5 RJ45
A/B/C SWITCH
BLACK BOX
VideoPlex+ Video Wall Controller

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

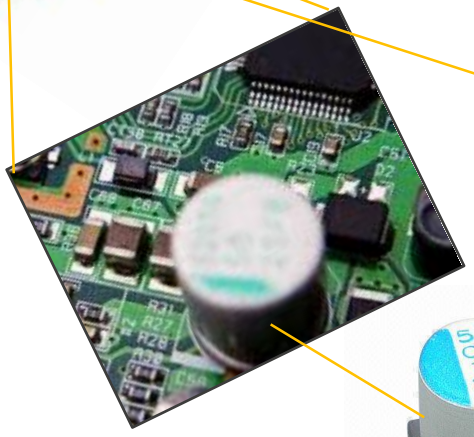
OPEN THE BLACK BOX

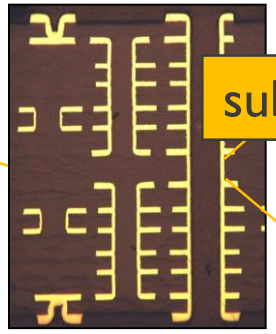


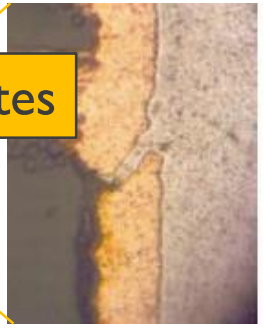




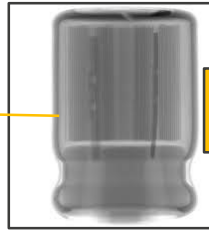
interconnections







substrates



components

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

THE WHITE BOX APPROACH: STRUCTURAL DESIGN AND VALIDATION

Electronics are physical structures consisting of a set of components electrically and mechanically connected to a substrate.

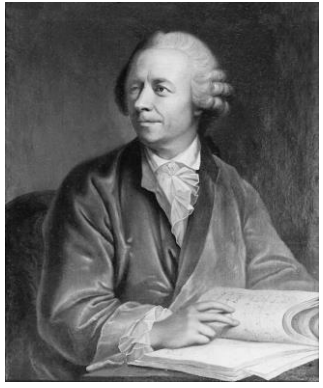
Understanding the product structure and how the building blocks and their interconnections perform and respond to loads allows to predict how the system will perform and respond: *"White Box" Technology Qualification.*

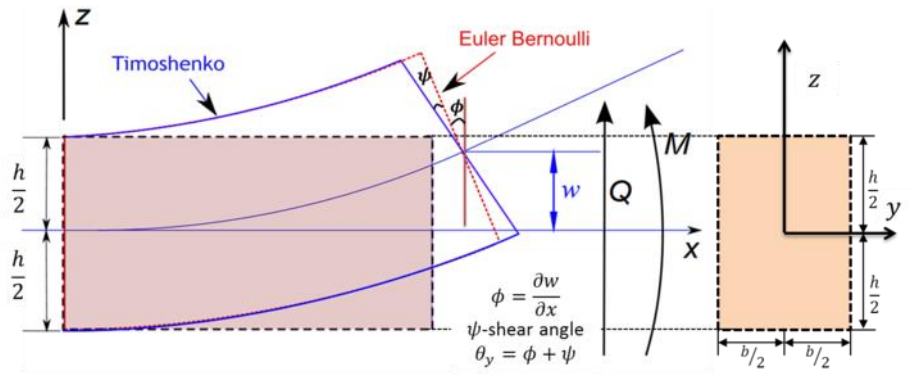
The impact of changes in building blocks, system build-up, environment, way of use, ... on performance, response and lifetime can be predicted.

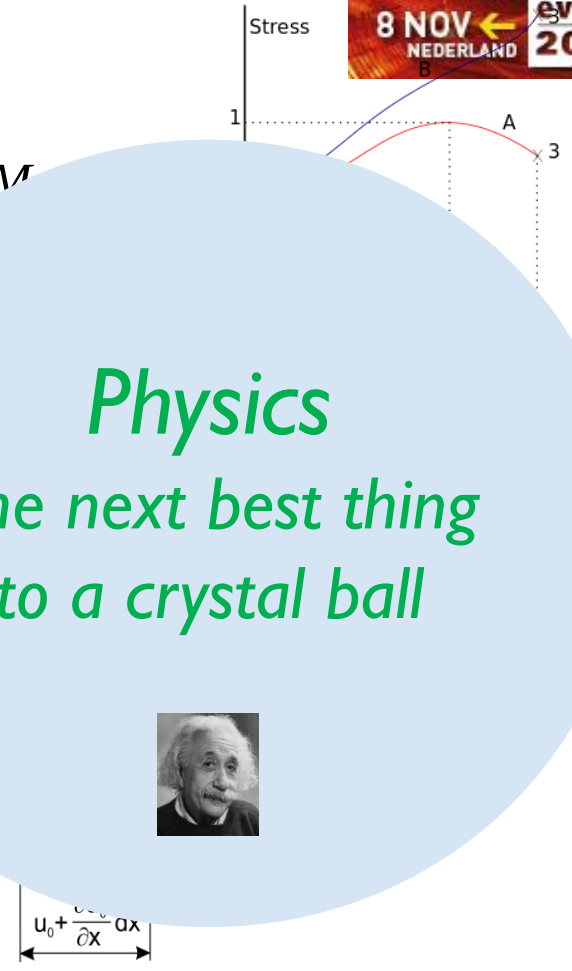
NPI FOR THE SMART WORLD

THE WHITE BOX APPROACH: UNDERSTANDING THE BASICS









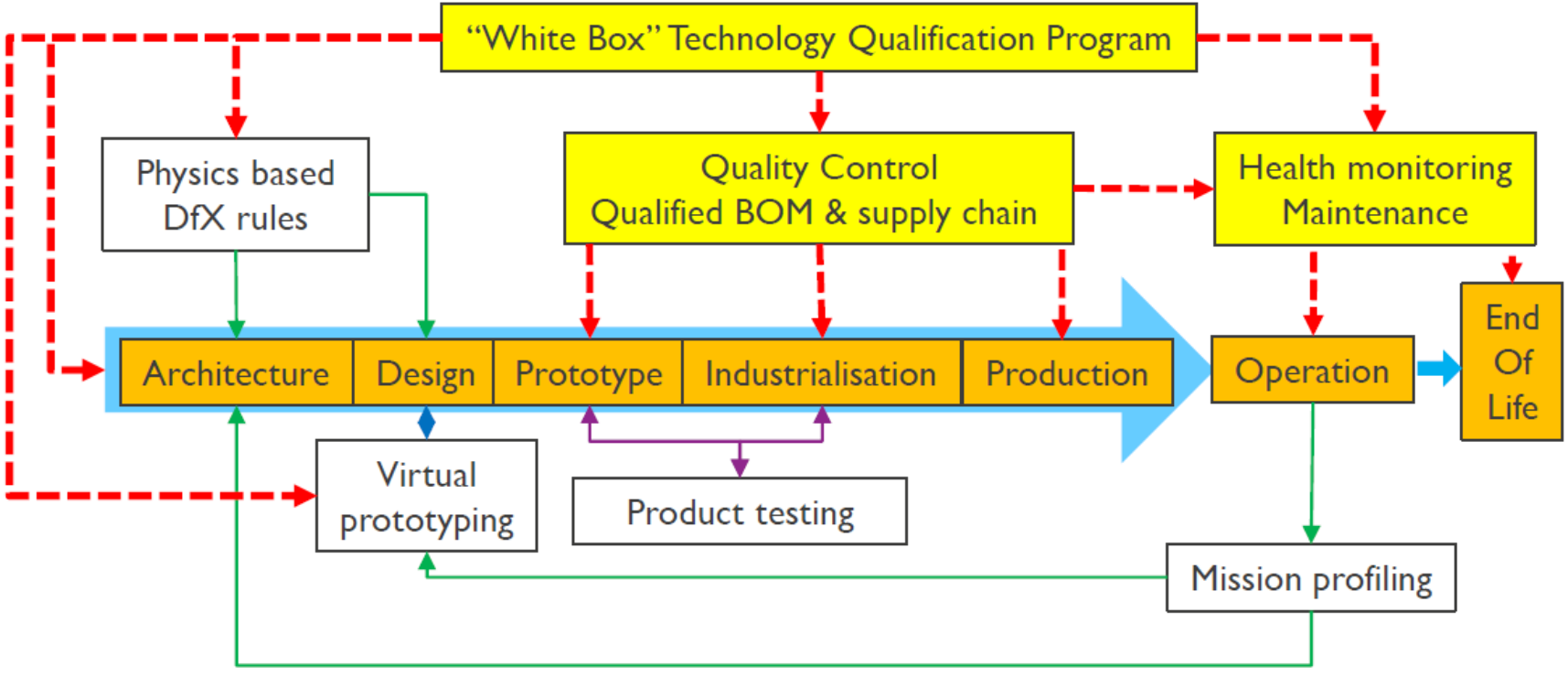
Physics

The next best thing to a crystal ball

The Mechanics of Electronics

NEW PRODUCT INTRODUCTION FOR THE SMART WORLD

THE WHITE BOX APPROACH: PREDICTIVE PRODUCT LIFE CYCLE MANAGEMENT



“WHITE BOX” TECHNOLOGY QUALIFICATION

TECHNOLOGY QUALIFICATION
DEFINITIONS

- **Electronic Assembly Technology**

comprises all materials, components, substrates, configurations, methods, processes, competences and suppliers used to build, repair and maintain Electronic Assemblies.

- **Technology qualification**

is the methodology applied to evaluate if a predefined sub-set of a technology fulfils all requirements to be considered fit-for-purpose for a specific set of applications, operational conditions and lifetime, while fulfilling additional Design-for-eXcellence requirements related to cost, manufacturability, quality, robustness, reliability, repairability & maintenance, environmental impact, etc.
→ Qualified Electronic Assembly technology Class (QEAC)

- **Technology Qualification is not product specific**.

The added value of the Technology Qualification Program is that it provides qualified building blocks for Electronic Assembly development and integration leading to a Qualified-by-Design product for all aspects (DfX elements) that are not product functionality specific.

TECHNOLOGY QUALIFICATION

BASIC STEPS

1. Define application domain and corresponding system requirements.
2. Identify, select and specify relevant industry standards and regulations.
3. Qualification of QEAC building blocks:
    1. Components → Approved Components List (ACL)
    2. Substrates
    3. (Assembly) materials
    4. Approved Suppliers List (ASL)
4. Assembly design, processes and process flow qualification
    1. Design rules (layout)
    2. Assembly instructions
5. Assembly qualification qualifies the substrate-component-interconnect material combination.




Do we need to test everything before we can start product development?




TECHNOLOGY QUALIFICATION
QUALIFICATION: A PRAGMATIC APPROACH

Qualification is a relative concept.

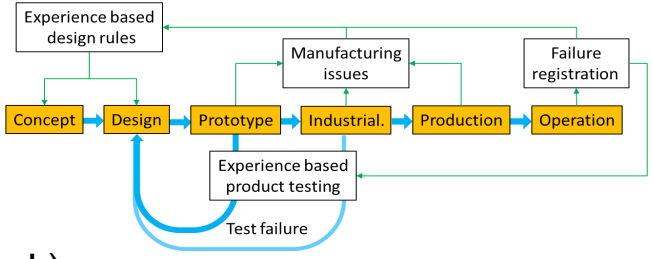
At the minimum: have a look at everything you are using!

Qualification approaches:

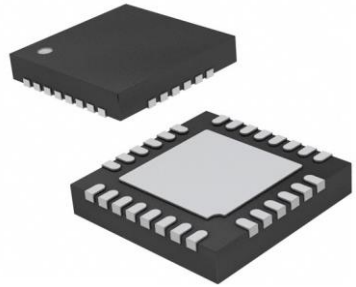
1. Historical track record
2. Supplier declarations and certifications
3. Specification testing
4. Qualification testing
5. Simulation

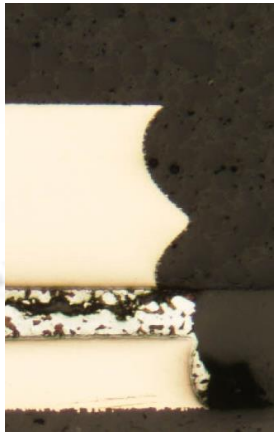
A SMART NPI (RELIABILITY) EXAMPLE

SMART NPI: QFN IN AUTOMOTIVE
TRADITIONAL NPI APPROACH



- First PBA design with 7mm x 7mm QFN (1 month)
- Build PBA (12 weeks incl ordering)
- Validation: 1500 cycles -40°C to150°C (1 month)
  PBA failure: QFN solder joints
- Redesign PBA with other package type (2 wks)
- Build new PBA prototype (12 weeks)
- Qualification (1 month)
  Hopefully it passes...

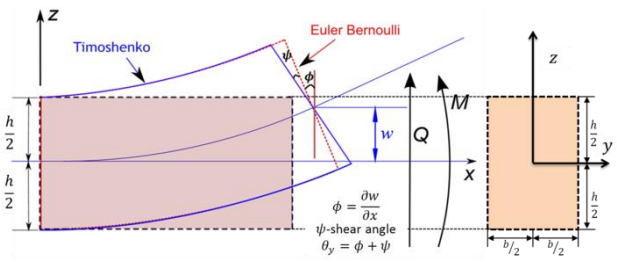


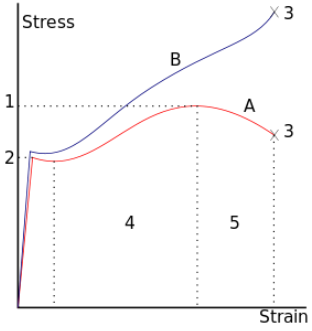


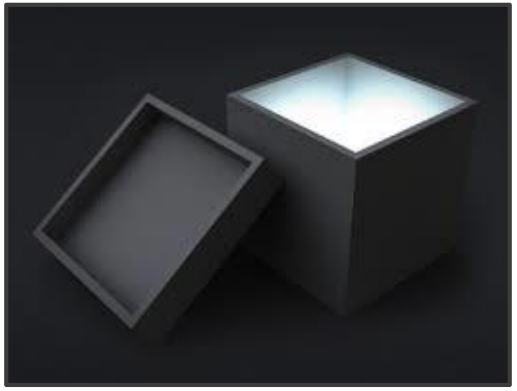
Penalty: +19 weeks time-to-market
+50KEuro material, labor, test

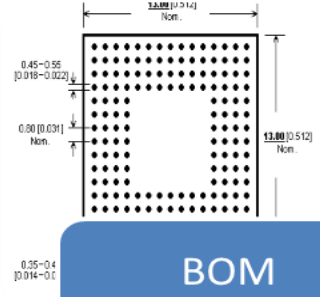
SMART NPI: QFN IN AUTOMOTIVE

OPEN THE BOX: SOLDER JOINT FAILURE PREDICTION

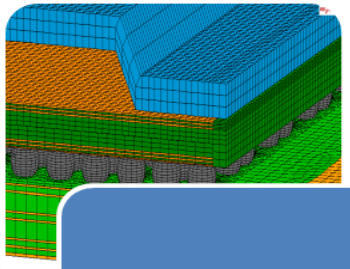




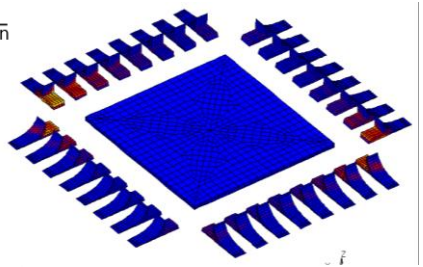




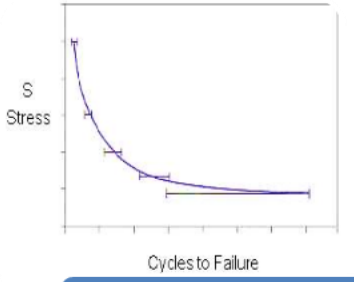
BOM + Mission profile



Modelling / Quantification / Simulation



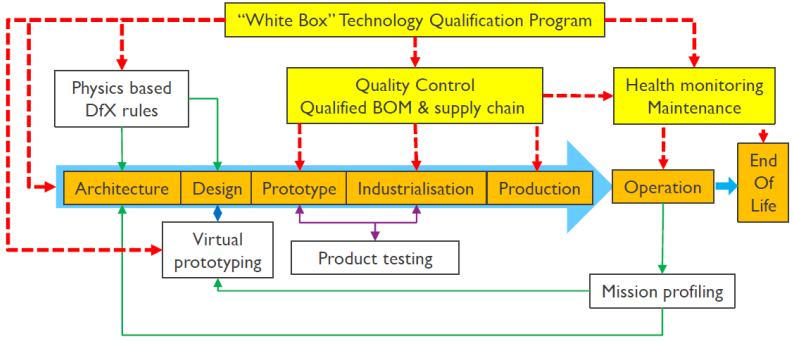
Cyclic strain in solder joints



Life time model

SMART NPI: QFN IN AUTOMOTIVE
THE WHITE BOX NPI APPROACH

- Qualification of QFN packages for automotive:
  QFN max. 5 x 5mm² and mold CTE>8ppm/K
  Thermo-mechanical simulation required for QFN>3mm
- @Design an automotive qualified package is selected
- Virtual prototyping *1500 cycles -40°C to 150°C* (2 d)
  Improve design if necessary (1d – 2 wks) (<10%)
- Build prototype (12 wks)
- Product Qualification test (1 month):
  pass (for Solder Joint)
- Go to industrialization



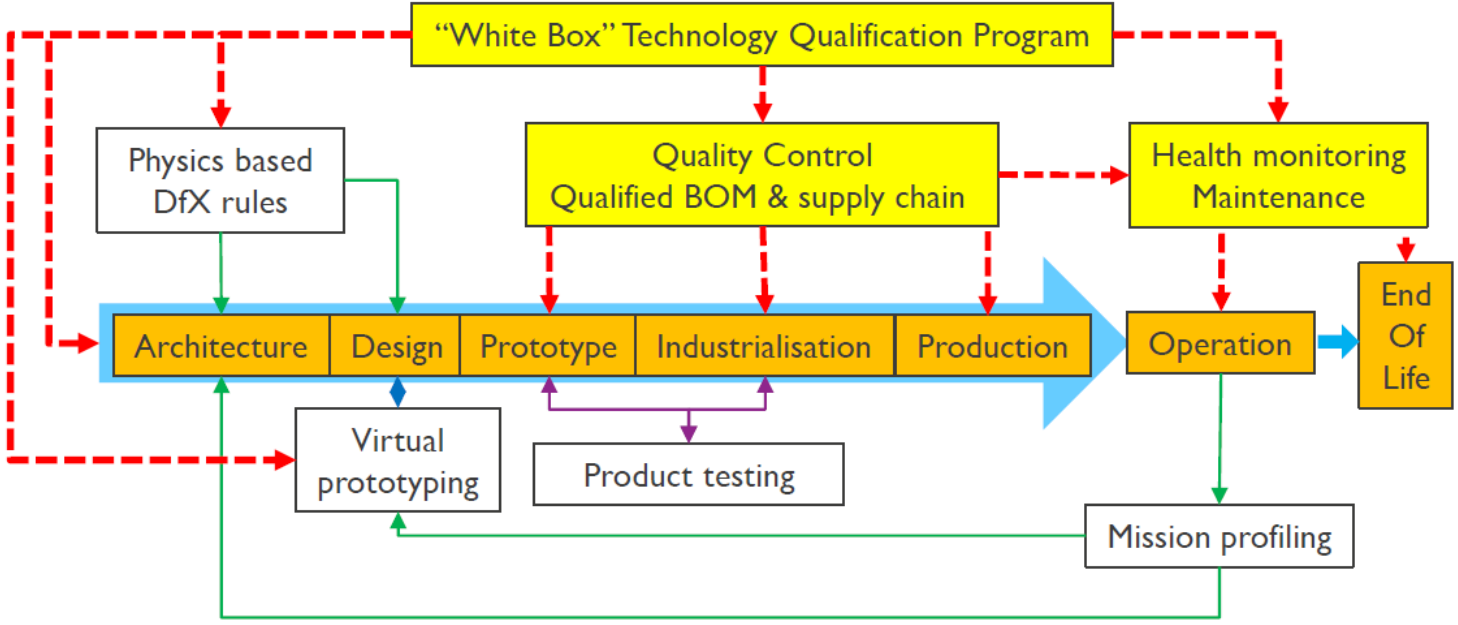
Fail at virtual prototyping penalty (<10%):
- 1d to 2wks design effort
  no extra ordering/test delay
- 1 to 5KEuro extra labor
  no extra material nor test cost

10x faster & 10x lower cost
Higher reliability level

CONCLUSION

CONCLUSION: NPI FOR THE SMART WORLD

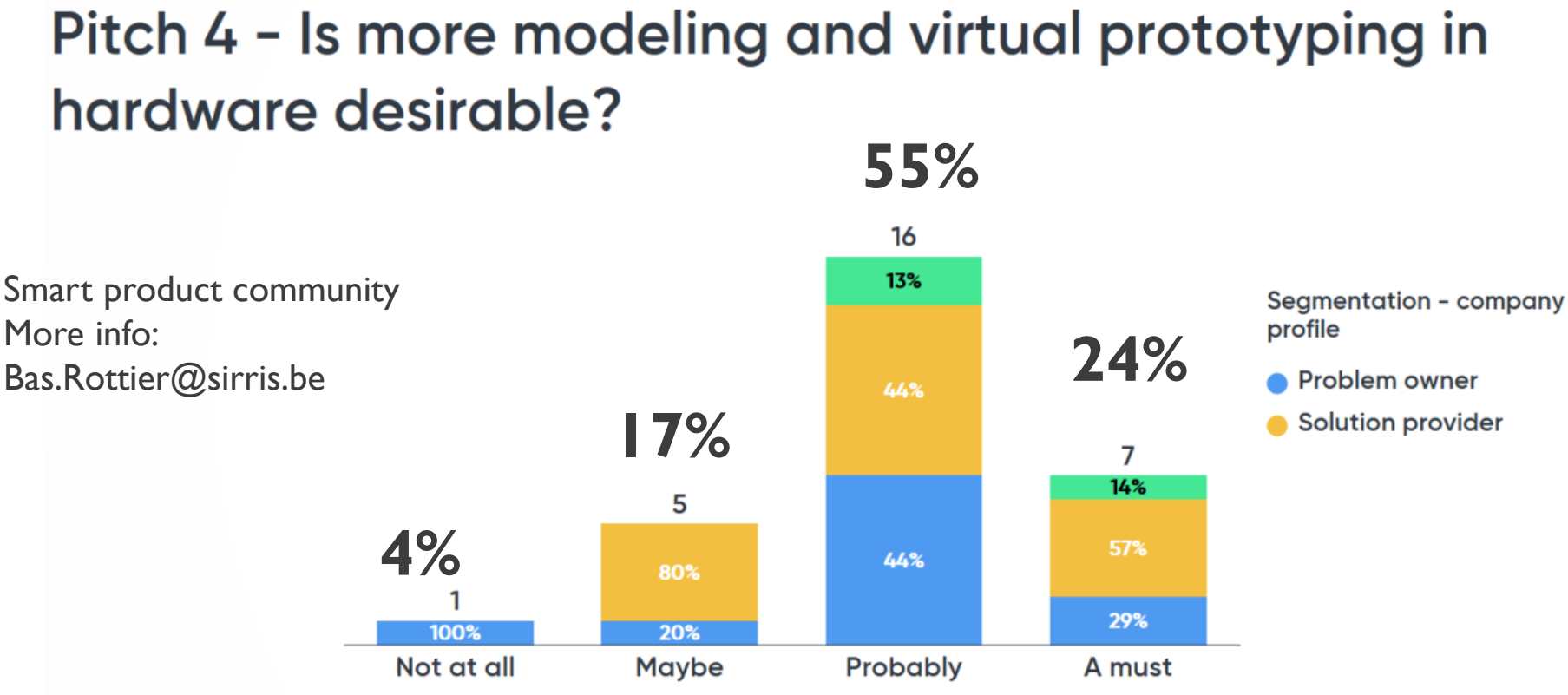
REQUIRES A WHITE BOX APPROACH



A Smart World requires **Smart** *Design-for-eXcellence, New Product Introduction* and *Product Life Cycle Management:* ***A "white box" approach***

CONCLUSION
THE NEED FOR A WHITE BOX APPROACH

Smart product community
initiative 8/10/2018



Smart product community
More info:
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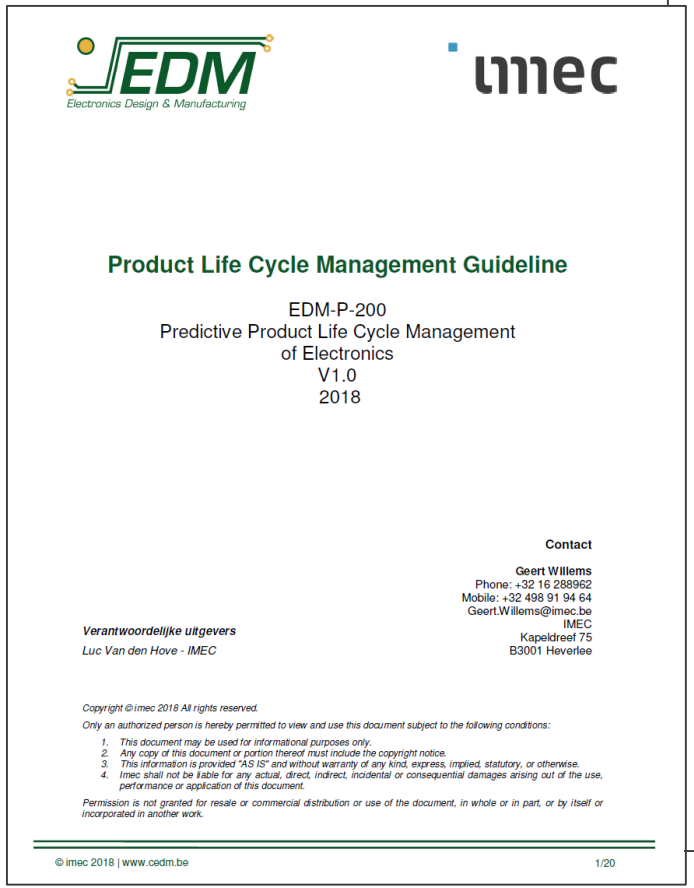
CONCLUSION

GUIDELINES COMING UP



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Product Life Cycle Management Guideline

EDM-P-200
Predictive Product Life Cycle Management
of Electronics
V1.0
2018

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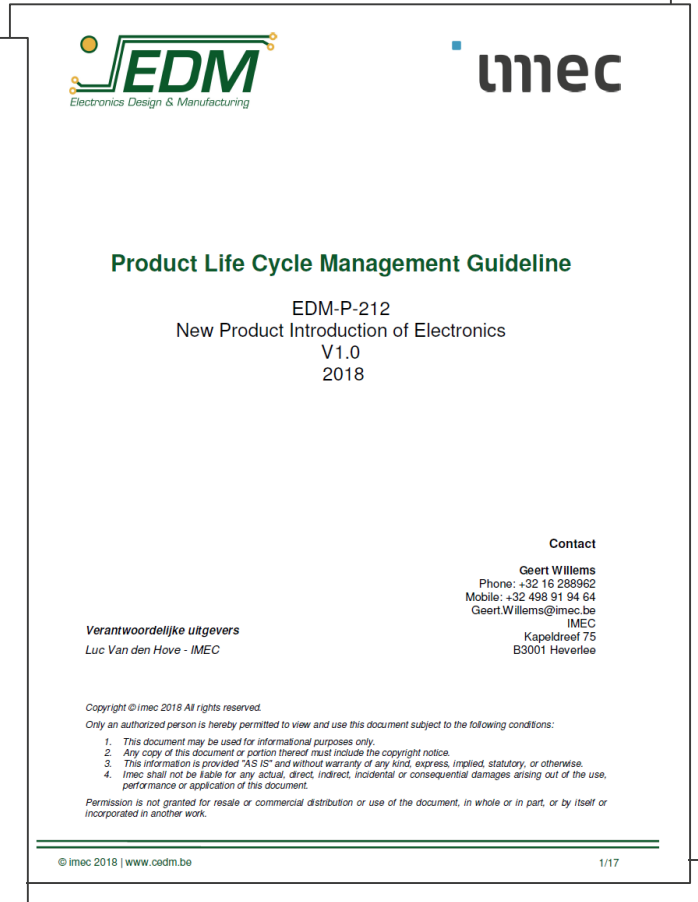

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Product Life Cycle Management Guideline

EDM-P-212
New Product Introduction of Electronics
V1.0
2018

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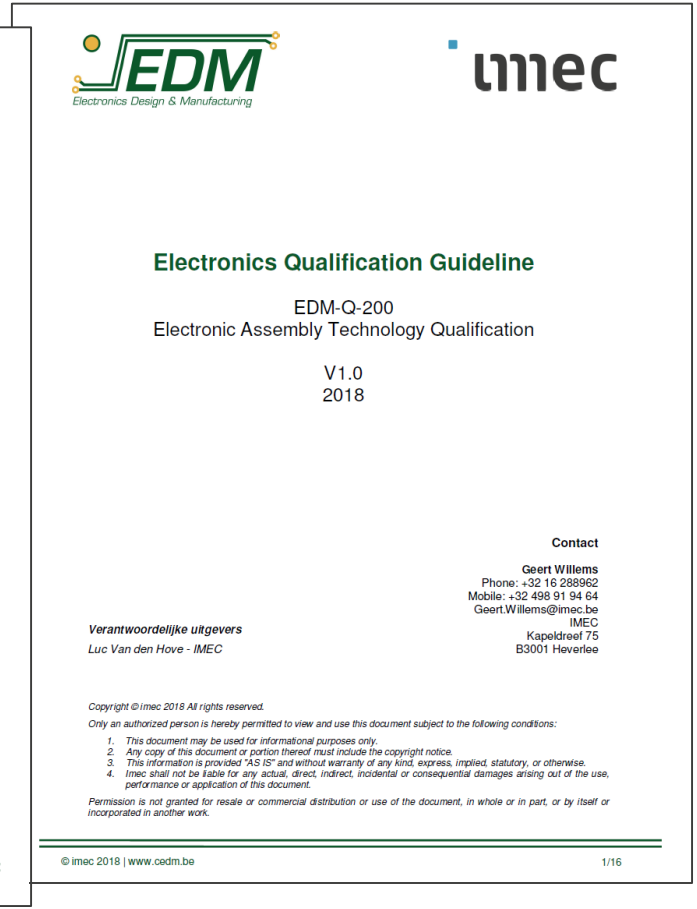

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Electronics Qualification Guideline

EDM-Q-200
Electronic Assembly Technology Qualification

V1.0
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THANK YOU

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embracing a better life

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