



WHEN  
QUALITY  
MATTERS

Product Flexibility & multi-domain  
(sensor) inputs

[Tom.Limerkens@tm-solutions.eu](mailto:Tom.Limerkens@tm-solutions.eu)



Test & Measurement • Vision Inspection • Condition Monitoring  
Control Systems • Precision Assembly • High Tech Equipment



# Product testing Challenges

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- Faster product evolution



- Increased Product Complexity & Flexibility



- Increasing quality requirements
- 



- Reducing cost of Test

# Product testing Challenges

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- **Faster product evolution**



- Increased Product Complexity & Flexibility



- Increasing quality requirements
- 



- Reducing cost of Test

## Faster product evolution



**09/2000 –  
2005**



**02/2014 –  
04/2015**



**09/2014 –  
09/2015**

# Faster product evolution

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## Product testing Challenges

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- Faster product evolution



- **Increased Product Complexity & Flexibility**



- Increasing quality requirements
- 



- Reducing cost of Test

## Increased Product Complexity & Flexibility



- Calling
- Texting
- Custom Ringtones
- Snake



- Internet browsing
- Texting
- Music Player
- Emailing
- Photo
- Video
- Video conferencing
- Internet browsing
- Navigation
- Apps
- Calling

# Increased Product Complexity & Flexibility

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# Increased Product Complexity & Flexibility

The image shows a screenshot of the 'Fabric On Demand' website. The top navigation bar includes the company logo, a phone number (1-888-285-5758), and a slogan 'So easy. Sew cool. Join the handmade revolution.' Below this, a secondary navigation bar lists steps: 'Home | 1. Design Layouts | 2. Our Fabrics | 3. Upload Your Design | 4. Order | Fabric Pr'. The main content area features a large image of various fabric patterns on the left. To the right of this image is a vertical sidebar with icons representing different garment types: a dress, a shirt, a skirt, a jacket, a top, a pair of pants, a hat, and a bag. An arrow points from the text 'Start hier' to the shirt icon. Further right, a white long-sleeved shirt is displayed. To the right of the shirt, the price '89 €' is shown, along with a yellow button that says 'VOEG TOE AAN WINKELWAGEN'. At the bottom of the main content area, there is an orange banner with the text 'Let's Get Started With Your Order' and a green 'Get Started' button.

# Increased Product Complexity & Flexibility



## Product testing Challenges

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- Faster product evolution



- Increased Product Complexity & Flexibility



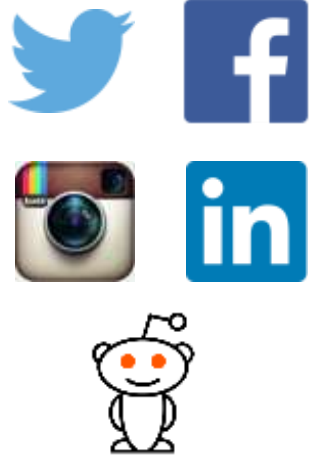
- **Increasing quality requirements**
- 



- Reducing cost of Test

## Increasing quality requirements

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- Empowered consumers on social media
- Global playing field
- #InstantNews

## Increasing quality requirements

1999



# Increasing quality requirements

# UNITED

# 2009

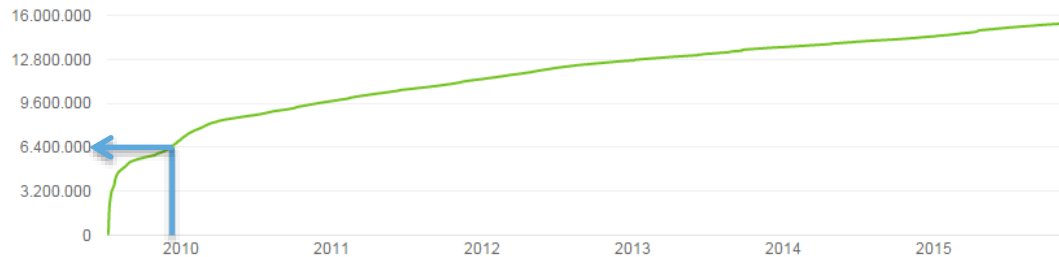


Videostatistieken Tot en met 7 nov. 2015 ?

AANTAL WEERGAVEN

15.387.887

Cumulatief Dagelijks ?



## Increasing quality requirements



September 22, 2014



Hashtag #BendGate created  
September 23, 2014



September 24, 2014



> September 25, 2014



## Increasing quality requirements

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- Sample test → 100% Testing
- Fast introduction of new tests based on market feedback



# Product testing Challenges

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- **Faster product evolution**



- Increased Product Complexity & Flexibility



- Increasing quality requirements
- 



- Reducing cost of Test

# Reducing cost of Test

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- Design for test
- Increase flexibility (HW & SW)
- Do more with existing sensors/data
- Increase equipment up-time
- Increase Test Value

# Reduce CoT : Design for Test

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- Take Testability into consideration in product design
  - Eg. JTAG
  - Provide clear testpads
  - Mechanical references
  - Mechanical handling capability of product
  - Optical references
  - Identification of DUT's (optical and/or electronic)



- Talk to your test / production facilities during development stage!

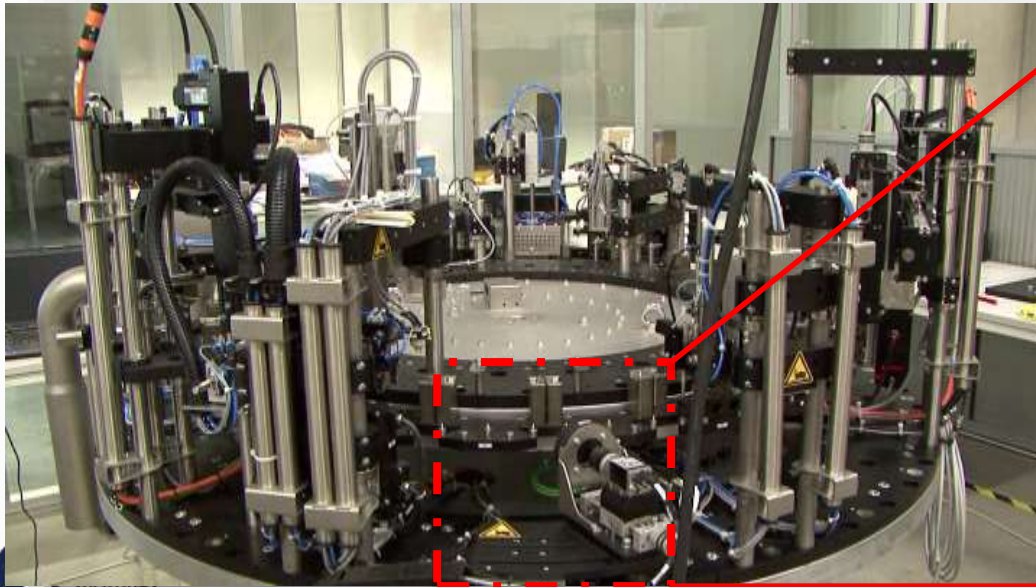
# Reduce CoT : Increase flexibility (HW & SW)

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- Make the process flexible
  - Modularize the process into different steps
  - Integrate Test combined on production tools
  - Allow for tests to be added/removed during product lifetime
- Use Sensors that can handle product change and variability
  - Cameras
  - 3D profile scanners
- Use SW architecture that allows for change
  - Modularity (Plugin architecture for dedicated algorithms)
  - End-user 'trainable'

## Reduce CoT : Modularize

- Make the process flexible
  - Modularize the process into different Test steps/tools
  - Allow for tests to be added/removed during product lifetime



# Handle product Variability + End User Trainable

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- Product change
  - New Features
  - Changing features
  - New Option combinations
- Product variability
  - Variations on featureset

## Handle product Variability + End User Trainable



# Handle product Variability + End User Trainable

V40 & V40CC

S60

XC60





# Handle product Variability + End User Trainable

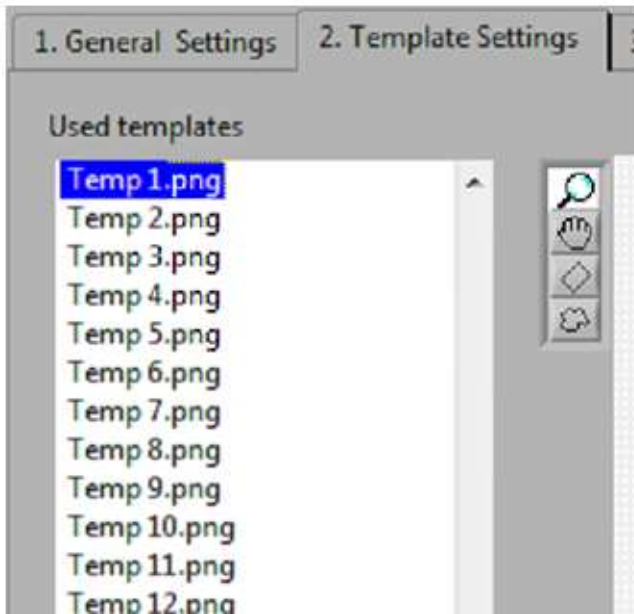
The screenshot displays the SAS Automotive Systems software interface, specifically the 'Color Pattern Matching' settings. The interface is divided into several sections:

- General Settings:** Includes tabs for '1. General Settings', '2. Template Settings', '3. Vision Settings', and '4. Test'.
- Area to search:** A large image of a car's interior dashboard and steering wheel. A green arrow points to a specific area on the dashboard, labeled 'Area to search'.
- Color Pattern Matching:** A panel on the right containing various settings:
  - Match Mode:** Set to 'Rotation Invariant'.
  - Color Sensitivity:** Set to 'Low Sensitivity'.
  - Search Strategy:** Set to 'Aggressive'.
  - Match Feature Mode:** Set to 'Color and Shape'.
  - Minimum Score:** Set to 550.
  - Color Score Weight:** Set to 800.00.
  - Minimum Contrast:** Set to 10.
  - Remeasure limit:** Set to 0.
- TEMPLATE:** A small image of a car's interior dashboard, highlighted with a green border and labeled 'TEMPLATE'.

A red arrow points from the 'Area to search' section to the 'Color Pattern Matching' settings panel. A green arrow points from the 'Area to search' section to the 'TEMPLATE' image.

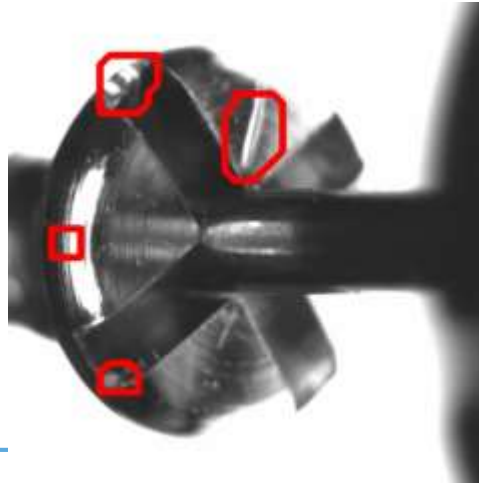
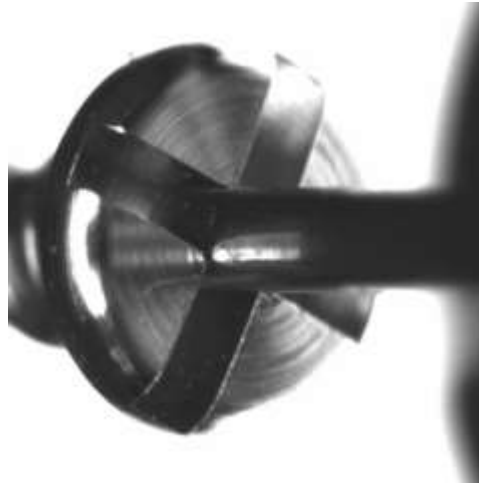
**SAS**  
Automotive Systems

# Handle product Variability + End User Trainable

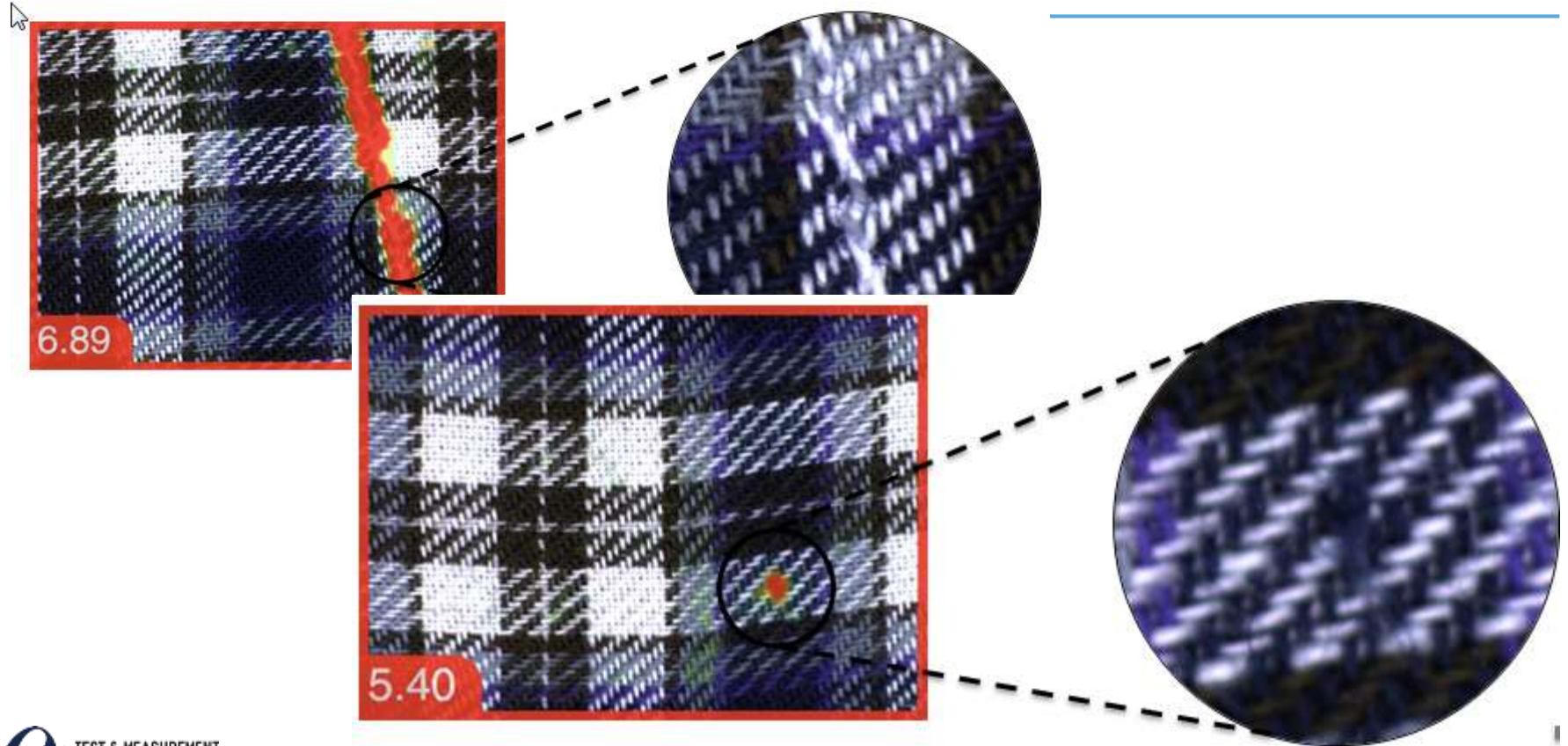


- What with low volume product
  - Difficult to define failures at start of production
  - Aesthetic pass / fail where simple presence / absence test is not enough
- Machine Learning
  - Make a mathematical model of a 'good' product
  - Include all variations in the model
  - Parts deviating from the model are 'fails'
  - Advantages :
    - Teach only on 'good' parts (Failure modes will appear automatically)
    - Retrain to include parts that are 'good enough'
    - No development is required at end-customer level

# Machine Learning

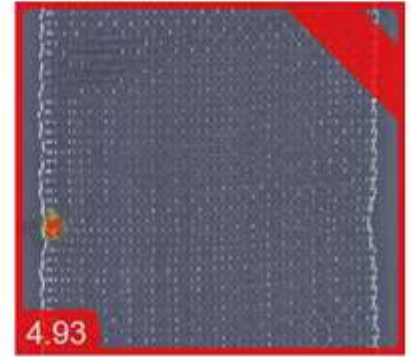
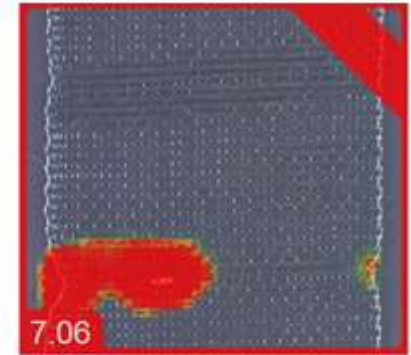
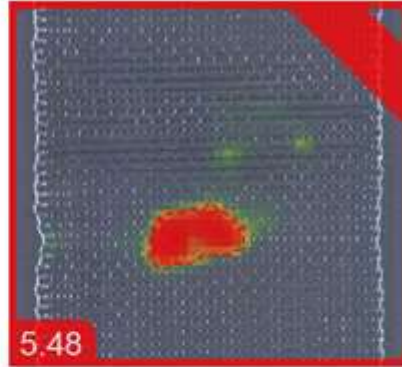


# Machine Learning





# Machine Learning



# Increase machine capabilities

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- Avoid very accurate mechanical product position reproducibility
- Use Vision as feedback on processes
  - Positioning
  - Process analysis

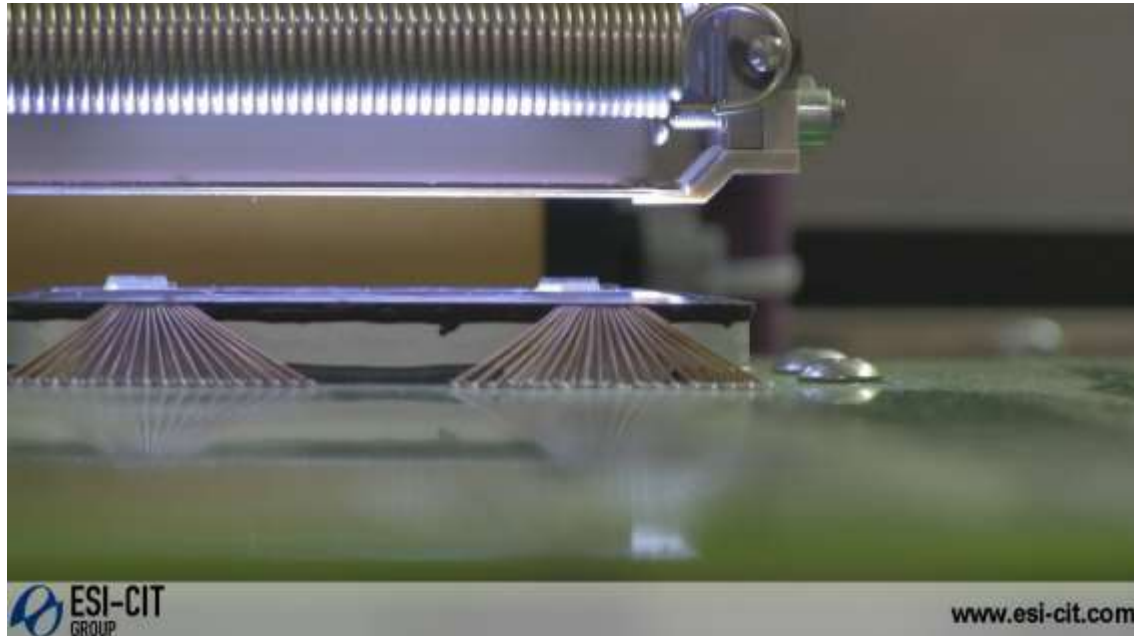
# Vision Feedback to Motion

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- High precision probing positioning
- Physical product dimension variation > required probing positions
  - Motion correction based on vision feedback
- Measure probing points for dimensional checks
- Operator assisted diagnostics during service intervals
  - Reduce downtime during error finding
  - Reduce service and cleaning intervals



## RT Pictures



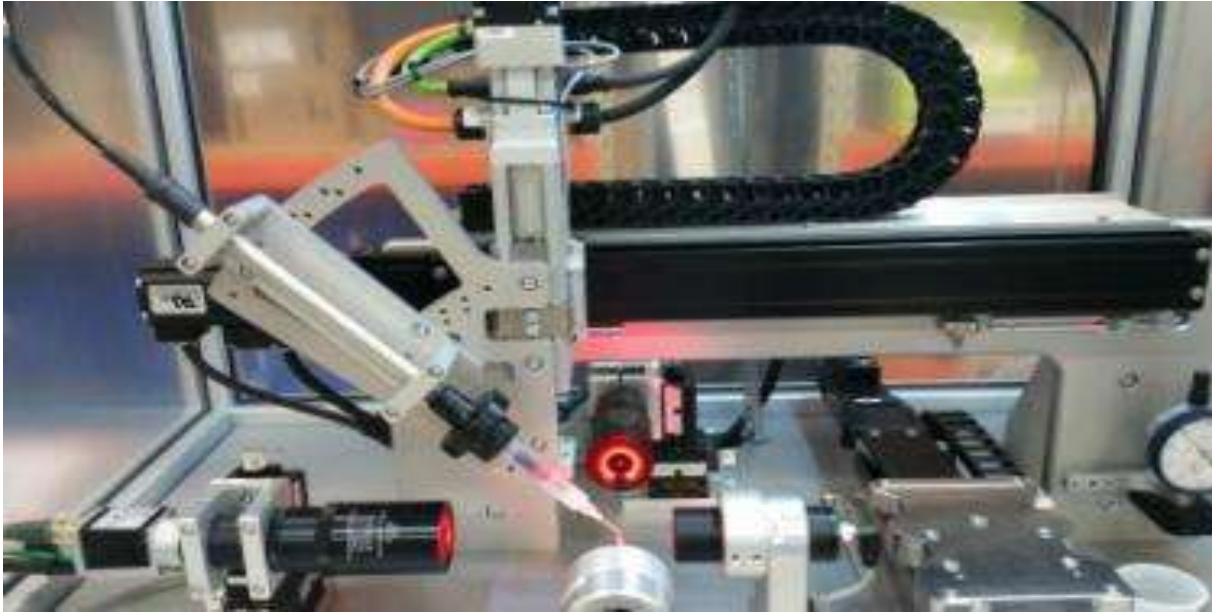
# Use cameras as feedback on motion systems

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# Glue dispensing

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# Application and Vision inspection for glue quality inspection

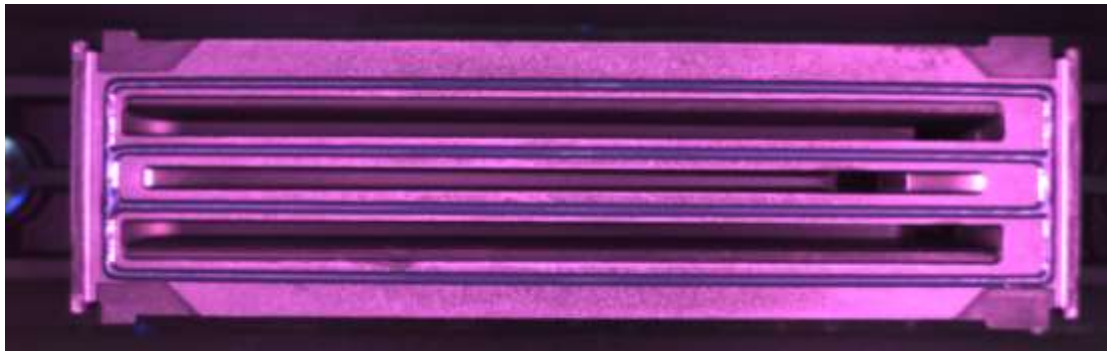
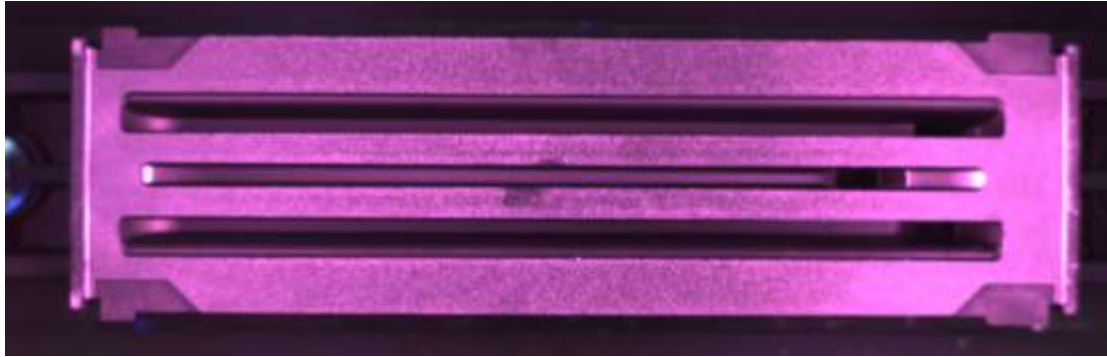
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- Process to place glue bead for sealing purposes
- Glue process is critical
  - Product lifetime guarantees
  - Leak prevention to electronics
  - Product performance
- Large variation in glue batches >> Volumetric dosing is required
- Frequent changes in glue paths due to product variations and product improvements

- 5 axis motion system for glue applications
  - X, Y, Z for motion path
  - Dispenser A and Dispenser B as stepper motors on Motion system
- Advantages
  - Glue nozzle speeds can be calculated based on motion path.
  - Glue dispensing speed can be compensated for different motion paths
    - Corners in XY and in Z plane
      - Inner corners need less glue
      - Outer corners need more glue
    - Fill areas with thinner layer of glue

- After glue application
  - Verify if glue application is correct
  - No gaps (leaks) and with correct volumes (glue path width)
  - Glue correction paths are calculated and correction is tried once
- Current improvement investigation
  - Use profile scanner to get absolute volume of applied glue
  - Feedback results to dispensing compensation during batch to compensate for glue aging effects

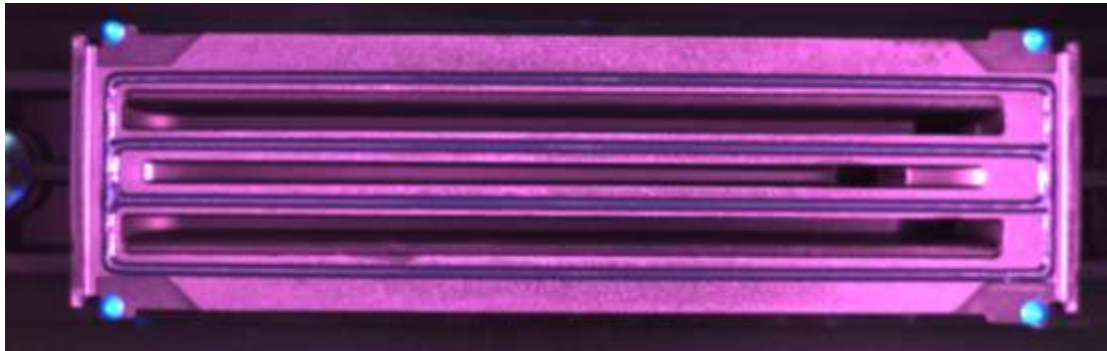
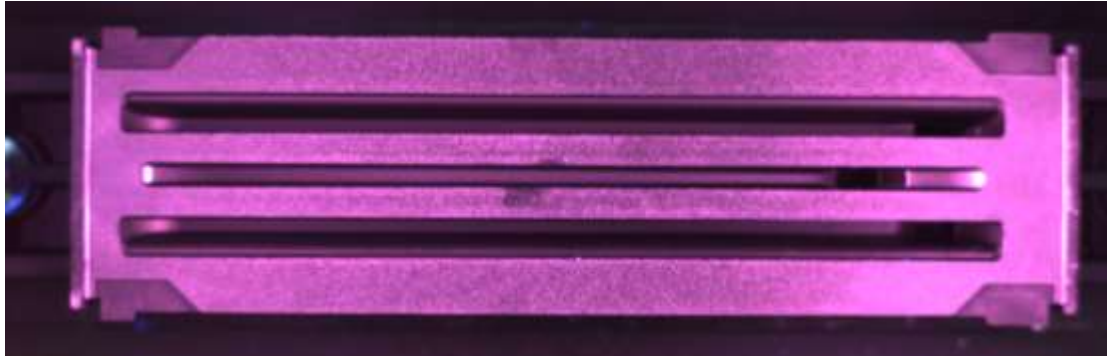
## Flexible Inspection: (White)



**PASS**



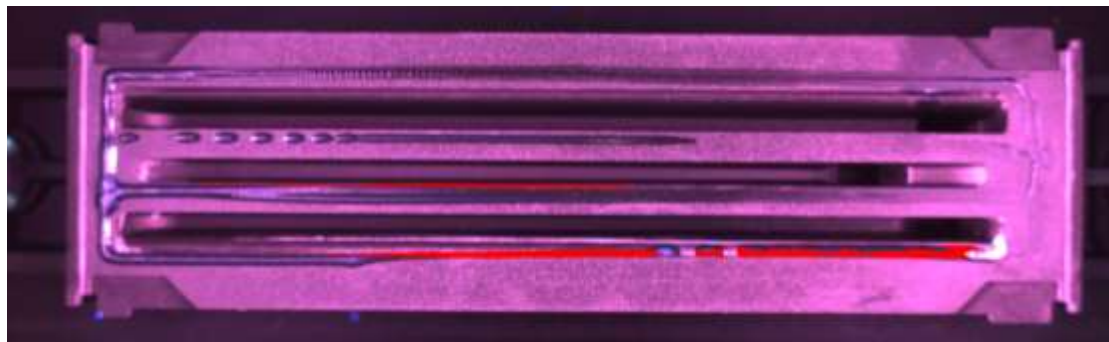
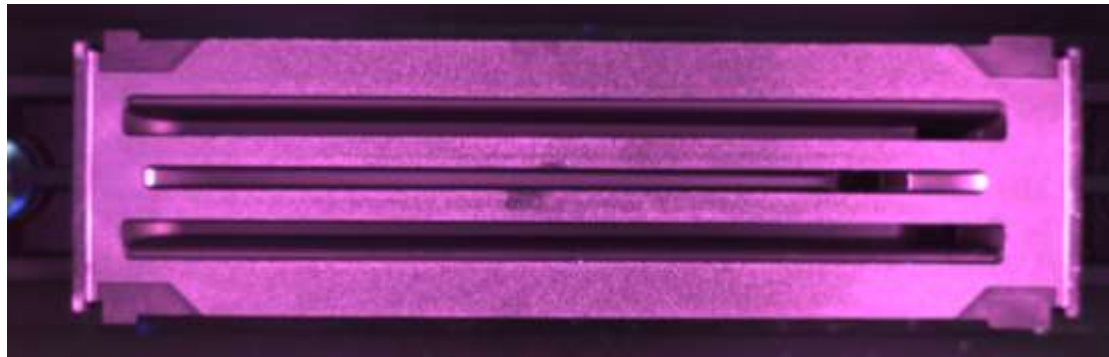
## Flexible Inspection: (White + UV)



**PASS**



# Flexible Inspection



**FAIL**

# Reducing cost of Test

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- Design for test
- Increase flexibility (HW & SW)
- Do more with existing sensors/data
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## Reducing cost of Test

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- Design for test
- Increase flexibility (HW & SW)
- **Do more with existing sensors/data**
- **Increase equipment up-time**
- **Increase Test Value**

## Do more with existing sensors : Process

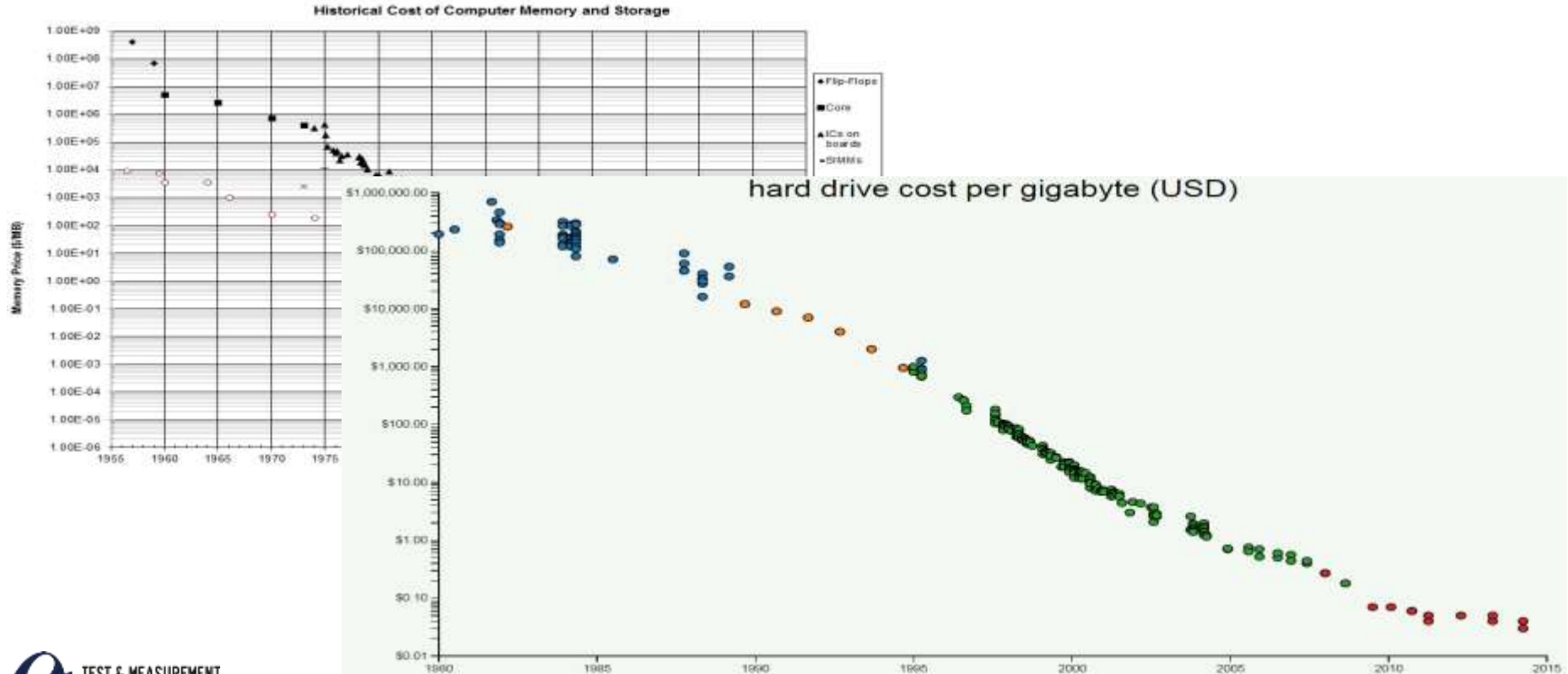
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- Use existing sensors
  - Opening / Closing times of cylinders
  - Use torque values of motors as a process value
  - Use vacuum pick time to correlate product surface quality



- Data is cheap

# Re-Use of Data



- Data is cheap
- Information is costly
- Product variations increase and product updates come faster and faster
  - Time to learn and optimize processes becomes smaller and smaller
- Gathering data alone is not enough to learn from it

# Factory



# Machine





# Machines Producing data

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- Generate data always with as much context as possible
  - Product IDs
  - Module IDs
  - Jigs, machine positions, machine parts
  - Engineering Units
- ALWAYS Log data structured and unambiguous so it is machine readable
  - XML
  - TDMS (with XML context meta data)
  - JSON
  - CSV With unique column names in each file
- Document on a central location how data is generated (for cross process investigation)

# Factory



# Machine



## Machines Consuming data

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- Some processes repeat similar measurements in each machine.
- Make Process inventory of actual actions/measurements in equipment to identify duplicate processes. (eg Thickness measurements)
- Make sure Factory provides data in machine readable way
  - WebServices
  - DataBase
  - TDMS DataFinder Server
  - MES
- Register which processes use what data
  - PFMEA to determine dependencies and impact on business
  - Future process changes can be evaluated before something 'falls over'

## Increase Equipment uptime

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- Actively monitor actions in a machine
- Actively monitor and track use of wear part usage
- When a problem occurs
  - More related data allows you to locate problems ‘faster’
  - Correlation requires good product identification
- Data is usefull, but needs management!

- Logdata :
  - When data is logged, define a data owner and lifetime!
    - Who owns the data
    - Who manages the data
    - When can the data be deleted
    - How to reduce data and lifetime
  - Log data with all contextual information available
    - Unambiguous storage of data
    - Save engineering units
  - Store data description documents on a central location
    - Make data accessibility possible for process engineers
    - Make data accessible for data mining tools!!!
- Date Re-Use :
  - Make sure to register which process uses what data