TESTIA
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Invisible Testing. Visible Innovation.

From NDT to SHM
A Practical Approach

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Since 1991

10+ SITES

300+ YEARLY WORKING PARTIES

1700+ TRAINEES PER YEAR

300+ CUSTOMERS

200+ PEOPLE

3 R&D CENTERS

We Advise
Studies, qualifications, procedures & audits

We Inspect
Your assets

E2E ENABLER OF YOUR PERFORMANCE

We Develop
NDT tools to boost your productivity

We Train
Your staff to NDT methods

FROST & SULLIVAN
2017 BEST PRACTICES AWARD
EUROPEAN NDT SERVICES CUSTOMER VALUE LEADERSHIP AWARD





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What is NDT?

Nondestructive testing or non-destructive testing (NDT) is a wide group of analysis techniques used in science and technology industry to evaluate the properties of a material, component or system **without causing damage**

Source: Wikipedia

- Equipment (sensors) cover a **wide range of different applications**
- **Active system** (usually excitation/measurement in one unit/equipment)
- Usually **time consuming**
- Damages in hidden structures can only be **inspected through other structures**
- Detectable **damage size often increase with the thickness** of the structure
- **Human interaction** necessary
- Only **scheduled inspection** possible
- Mainly **single**, separated **locations**
- To get access, **removing of installations** sometimes necessary

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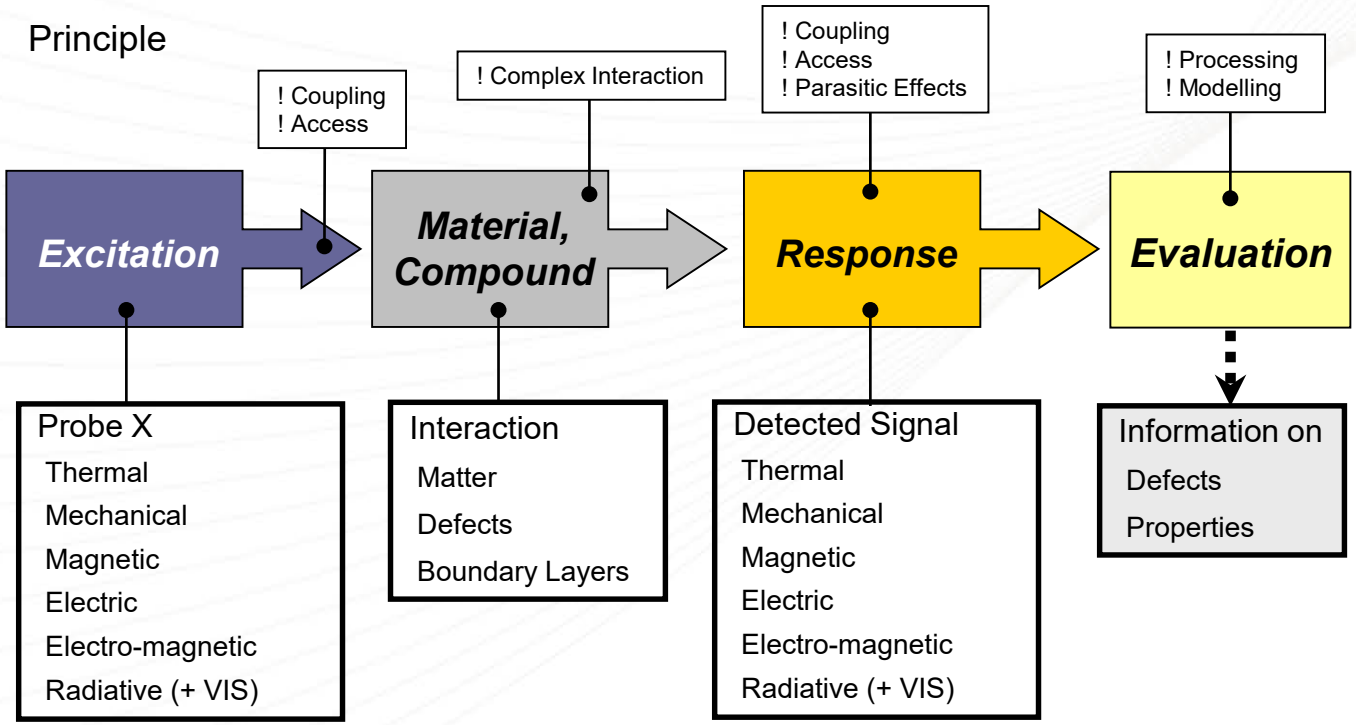
Sections of the NDT Process

NDT/NDI ***‚Non Destructive Testing / Investigation of materials and compounds with regard to defects, physical & chemical properties‘***



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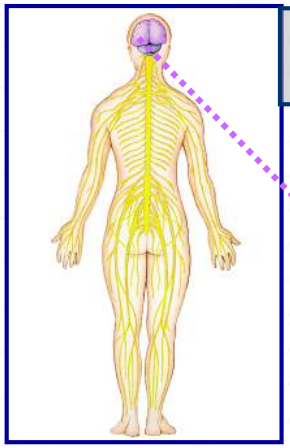
What is SHM?

SHM is the **continuous**, **autonomous** in-service monitoring of the **physical condition** of a **structure** by means of **embedded or attached sensors** with a minimum manual intervention, to monitor the **structural integrity** of the aircraft.



***Human nervous system*: detection of intensity and location of pain and doctor visit judgement**

Evaluation

***SHM system:* monitoring of airframe and evaluation of the follow up maintenance actions**

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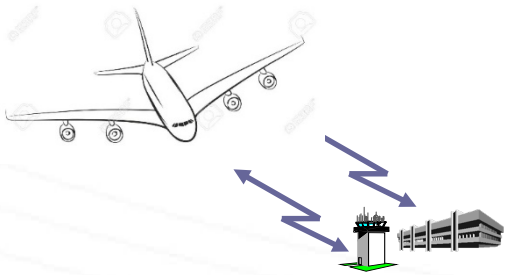
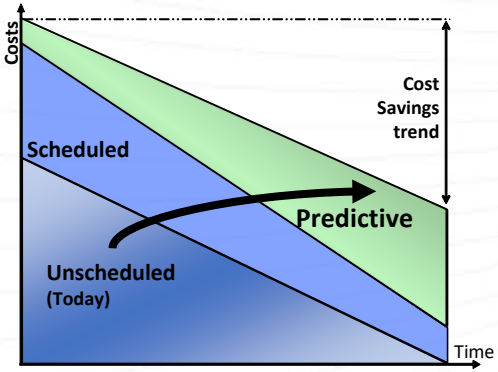
The Global Approach



A structural status communication

- Use of real-time diagnostics (On-Condition maintenance)
- Prognostics will avoid unnecessary unscheduled maintenance
- No physical access required
- Shorter inspection time



- Less scheduled and unscheduled maintenance

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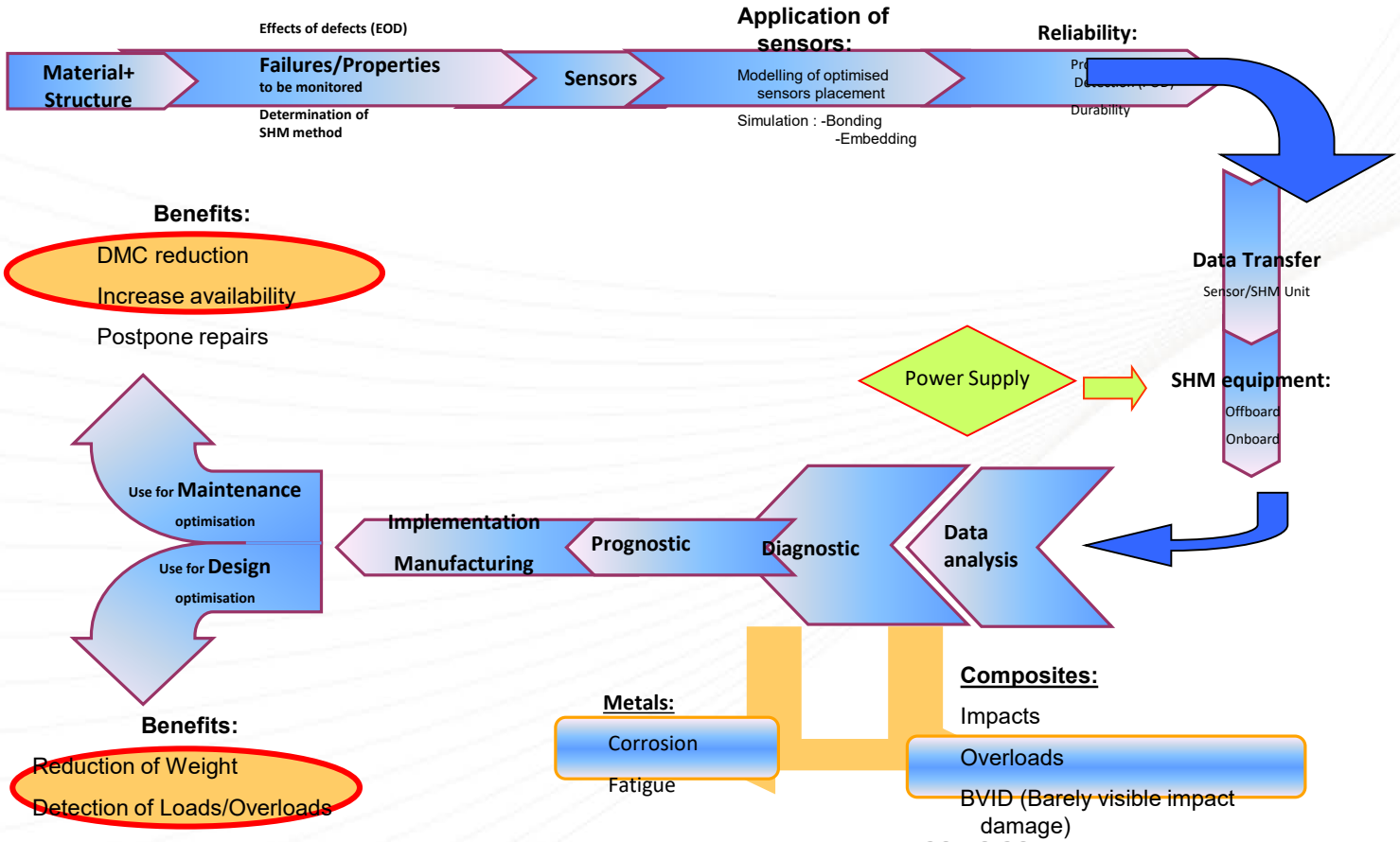
SHM = Complexity

SHM is not

only a sensor

SHM – Transdisciplinary Approach



What to detect or measure?

- Measurement of in flight real A/C constrains
  - Analysis of repercussion (ex: hard landing, tail bumper)
  - Recording of exceptional, aerodynamic loads/strains
  - Recording of loads in hot spot areas
  - Customisation of A/C life cycle
  - Flight control coupling for limitation of in flight constraints
- Detection of damages
  - Inspection in hazardous areas without direct access
  - Weight saving through sizing cases deletion (e.g. broken stringer)
- Monitoring of damage propagation:
  - Postpone repairs to planned checks
  - Reduction of downtime – Increased availability

Approach:

- Multi Disciplinary approach:
  - System compatibility, Cabin, Costumer support, Maintainability

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Benefits of SHM

SHM

Continuous and autonomous monitoring of defects, stress/strain, environmental and flight parameters by means of permanently attached or embedded sensor systems in order to ensure the structural integrity.

Maintenance / Operatability

Reduction of inspection time

Deferred maintenance / repair

Maintenance on demand

- **Reduced DOC, DMC**
- **Increased Availability**

Design

Optimised structural efficiency

New design philosophies

- **Weight saving**

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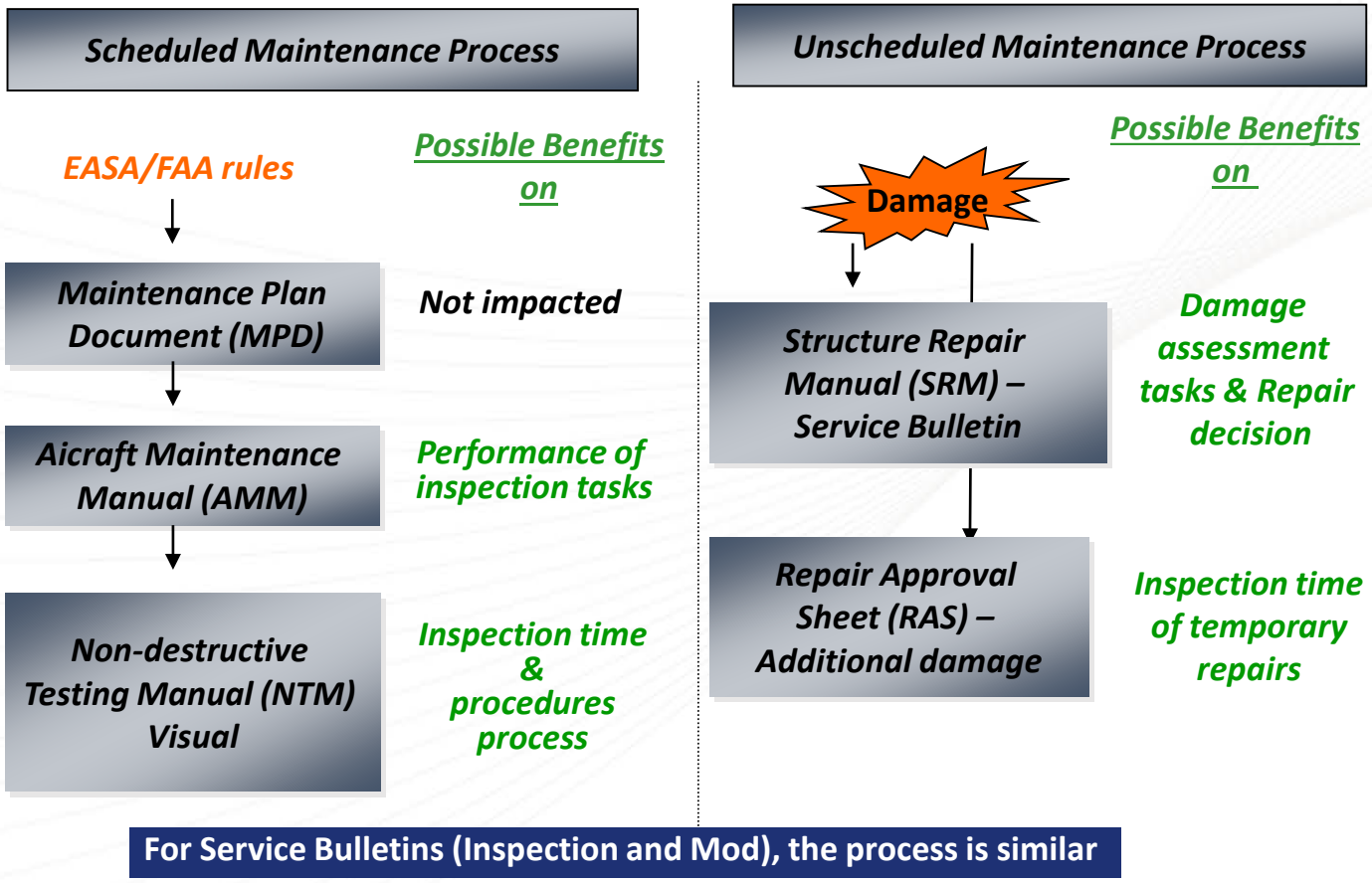
Benefit of SHM



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3rd Option for Service Bulletins

- Damage detection in metal and composite structures to **replace ISBs** by SHM

Benefits:

- Avoiding development of complex NDT technology and complex description in NTM

  ➡ benefit for OEM

- Avoiding of penalizing inspections and opening areas with difficult access (100% of aircraft to be inspected, number of expected damages is only a few %)

  ➡ benefit for operator

- Use of SHM standard equipment, to be performed by non-specialist

  ➡ benefit for operator

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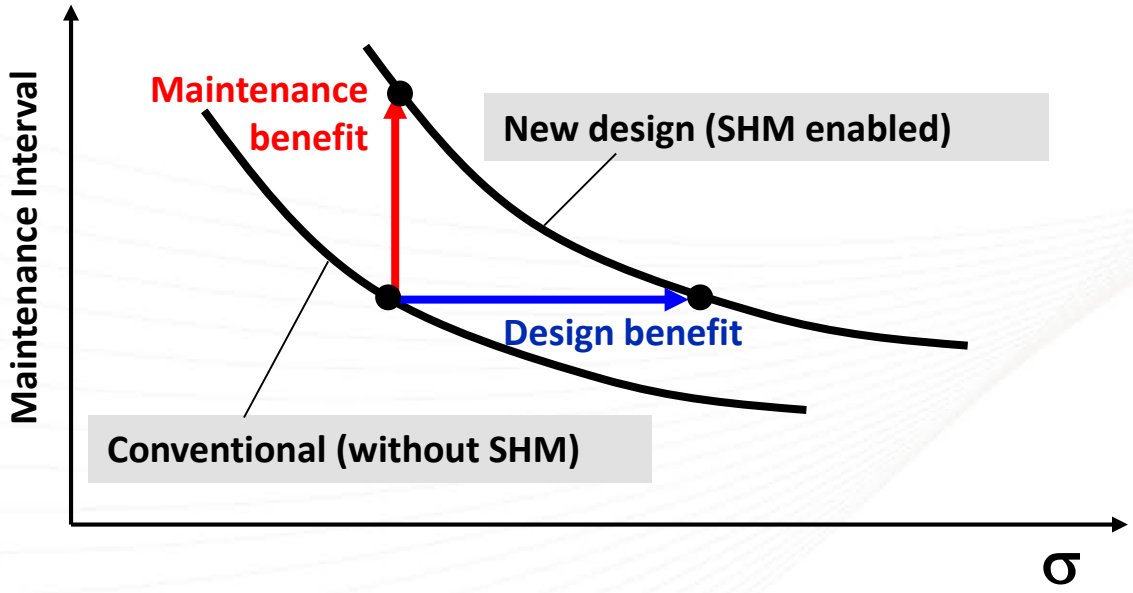
New, SHM enabled Design



SHM can provide a design benefit (weight saving) or a maintenance benefit

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SHM in Maintenance – MSG3

Applications & Solutions

Testia support along the process chain

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Basic Maintenance Definitions & History

Maintenance as defined by World Airlines Technical Operations Glossary (WATOG*)

*today replaced by ATA Common Support Data Dictionary

Scheduled or Preventive Maintenance

That maintenance performed at defined intervals to retain an item in a serviceable condition by systematic inspection, detection, replacement of wear-out items, adjustment, calibration, cleaning, etc.

Unscheduled or Corrective Maintenance

That maintenance performed to restore an item to a satisfactory condition by providing correction of a known or suspected malfunction and/or defect

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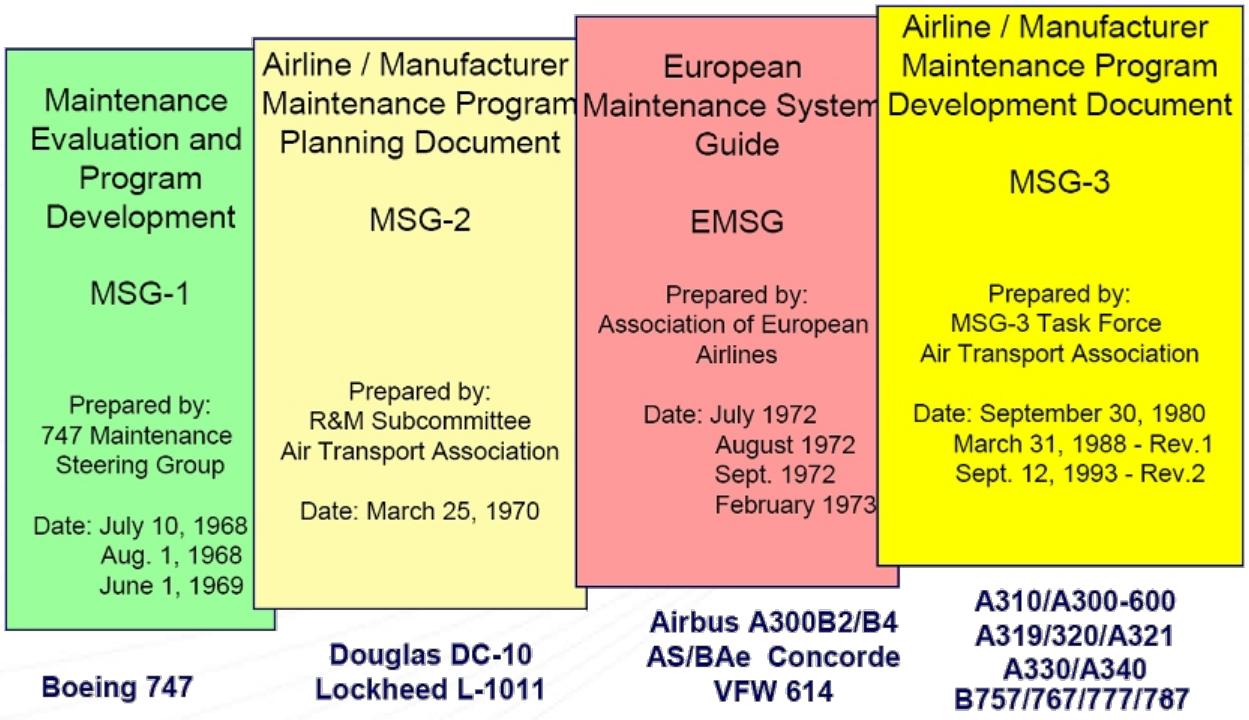
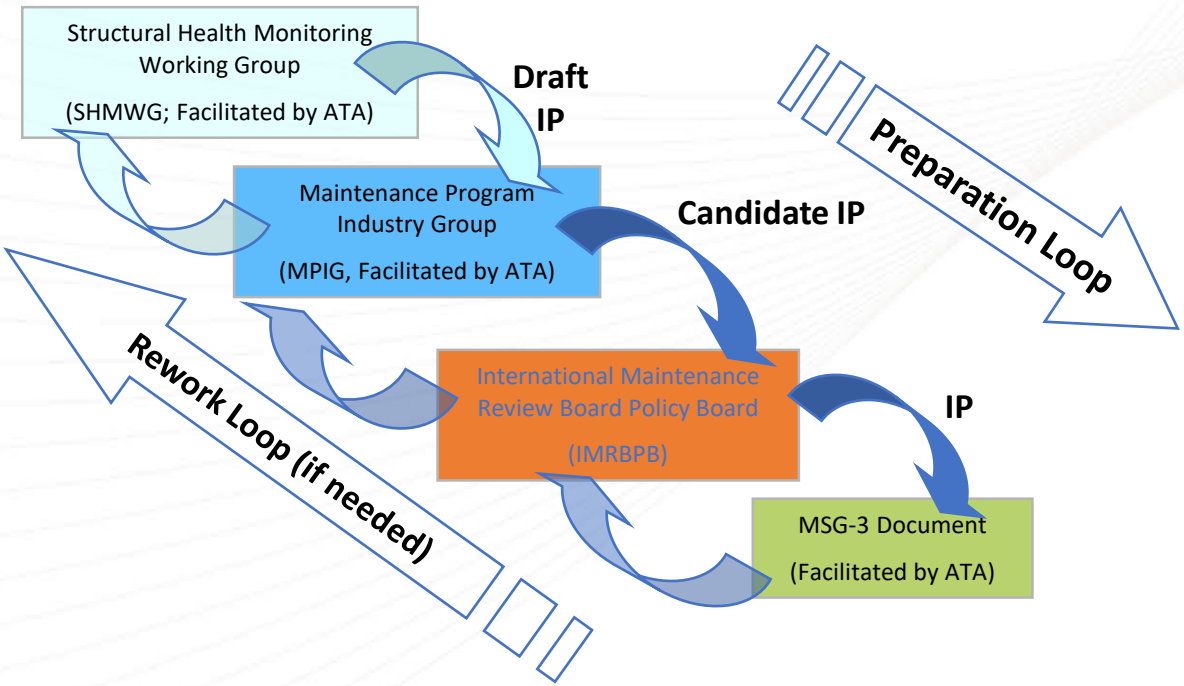
MSG-3 & Maintenance Review Board Process

MSG-3 Document Evolution



MSG3 preparation process

The MPIG delegates the preparation of Issue Papers associated with extensive MSG-3 revision proposal to dedicated working groups (i.e. L/HIRF, SHM...)



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MSG-3 Document Revision Process

who is the "ATA MSG-3 SHM WG?"

Supporting the IP draft process with their advise

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MSG-3 Document Revision Process

who is the "MPIG"?

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MSG-3 Document Revision Process

who is the "IMRBPB?"

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MSG 3 Revision

The term **S-SHM** is introduced as a maintenance task level in MSG-3:

Scheduled SHM (S-SHM):
S-SHM is the act to use/run/read out a SHM device at an interval set at a fixed schedule

The structure section is revised to select **S-SHM** tasks and interval **in lieu of classic inspections**

Structure inspection tasks for Accidental Damage (AD), Environmental Deterioration (ED) and /or Fatigue Damage (FD) can be replaced by a scheduled interaction with a SHM device where demonstrated to be applicable and effective

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Inpection level according to MSG3, as of today

1. Visual Inspection

GVI (General Visual)

DET (Detailed)

Steered by MPD

Performed in according to AMM, etc.

2. NDT (Non Destructive Testing)

SDET (Special Detailed)

Using of Tools and equipment

Procedures mainly in NTM

Steered by MPD, SB, etc.

3. SHM

SDET (alternative to NDT)

Permanent installed sensors

Procedures for Off-Board use in NTM

On-Board and/or On-Line use via IVHM architecture

“Automated SHM”

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SHM in MSG-3 IP105 (pending since 2010)

The MSG-3 principle concept avoids reference to specific (SHM) technology details as it should cater for the full range of application scenarios

In this respect two further scheduled maintenance SHM classification categories have been defined:

SHM Operation Mode

- ***Scheduled SHM (S-SHM)*** *– from IP92, no change*
- ***Automated SHM*** *- SHM technology which does not have a pre-determined interval at which maintenance action much takes place, but instead relies on the system to inform maintenance personnel that action must take place*

SHM Technology Type

- ***Damage Monitoring System*** *– SHM technology that uses sensors to* ***directly*** *monitor structure for deterioration conditions*
- ***Operation Monitoring System*** *– SHM technology that uses sensors which do* ***not directly*** *check the structure for damage, but instead correlate various measurements (e.g. environment conditions, loads) to make an inference to the probability or likelihood of damage*

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Application at In-Service – some examples

Structural Health Monitoring (SHM)

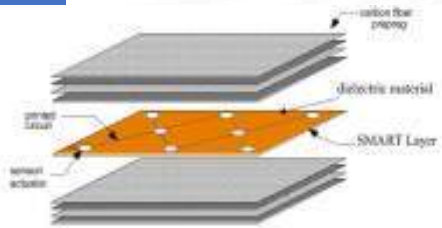
- Sensors permanently applied on the structure
- Fast automated inspection
- No „physical“ access necessary
- Continuously monitoring of known flaws
- Inspection outside the maintenance schedule

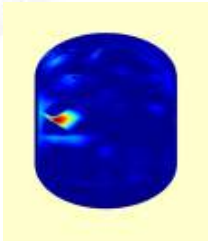
COMPOSITES

- Impact detection and localisation
- Repair monitoring
- Delamination detection
- Debonding

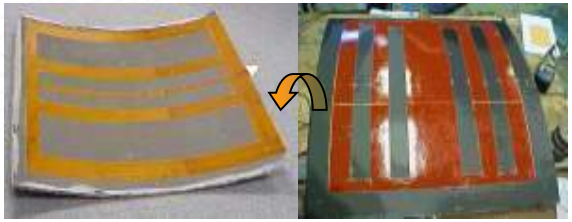
METALS

- Crack detection
- Crack growth monitoring
- Corrosion detection





Example: CVM



Example: Acousto Ultrasonics

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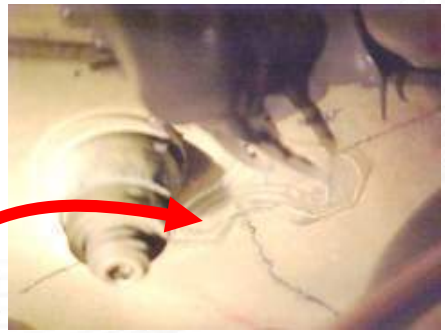
Maintenance Application

Damages caused by corrosion



Fatigue Cracks

Inspection of Hidden areas without removal of installations

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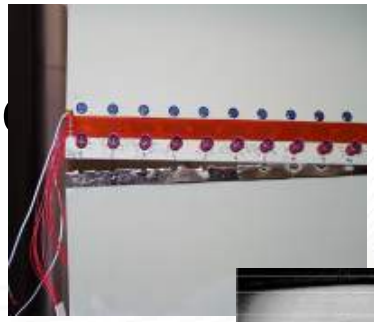
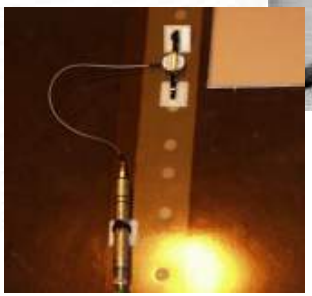
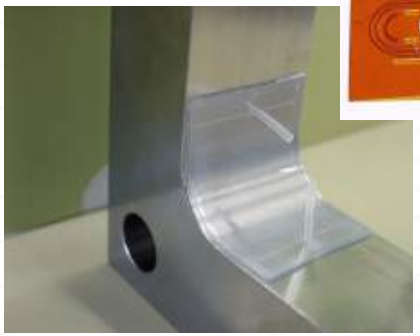
Examples of damage and load sensing technologies

- A large scope of sensing technol
  - CVM (Comparative Vacuum Sensors)
  - Acoustic Emission
  - Foil eddy current sensors
  - Acousto Ultrasonic
  - Fibre Bragg Gratings (F
  - …





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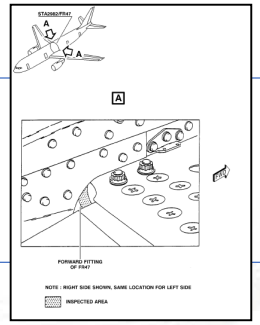
Documents

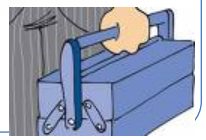
- Develop and prepare documents for installation, instrumentation and protection
- Work in close cooperation with OEM, operators and authorities



Consultancy

- Act as focal point for all involved parties
- Make the link between OEM, system integrator and operator
- Expert in SHM Toolbox application

'SHM Toolbox'



Installation

- Install sensors, cables, connectors, etc.
- All kind of sensors to be installed
- Worldwide service
- Service for all industries & all customers

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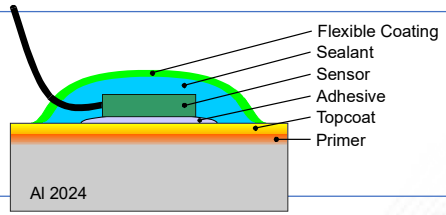
Protection

- Protect all SHM elements according to OEM needs

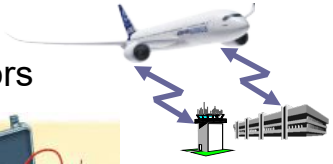


Functional Check

- Perform functional checks of the system
- Certify performance
- Calibration & recalibration of systems

System Operation

- Being in-situ to perform the measurements
- Using tools to remote analyze areas with sensors
- Frequently reporting to customers



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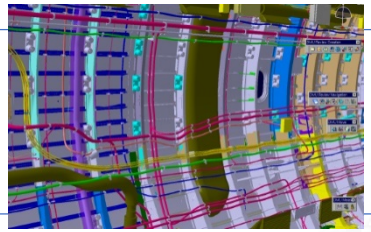
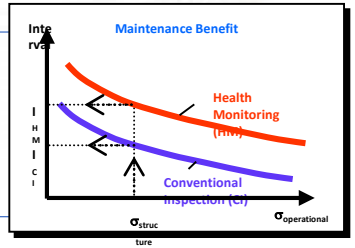
Analysis

- Collect and store data (if requested)
- Evaluate data
- Diagnostic of data
- Simulation



Predictive Maintenance

- Use analyzed data to support prediction of failures
- Provide predictive maintenance solutions (Big Data analysis)
- End-to-End Life-Time-Monitoring



Repair & Maintenance

- Repair sensors, cables, connectors, etc.
- Reinstall sensors and protect
- Periodically check of sensor and equipment function

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Training

- Perform trainings for installation and operation of sensor systems
- eLearning for remote training & education
- Hands-On trainings for all sensor types

Supplier & Partner

- Provide the „Tool Box“ with the right technology for the right application
- Be a partner for SHM technology developer

‘SHM Toolbox’

Customer

- All Aerospace OEM
- Airlines, MRO, …….
- Other industries (construction, automotive, wind, ……)

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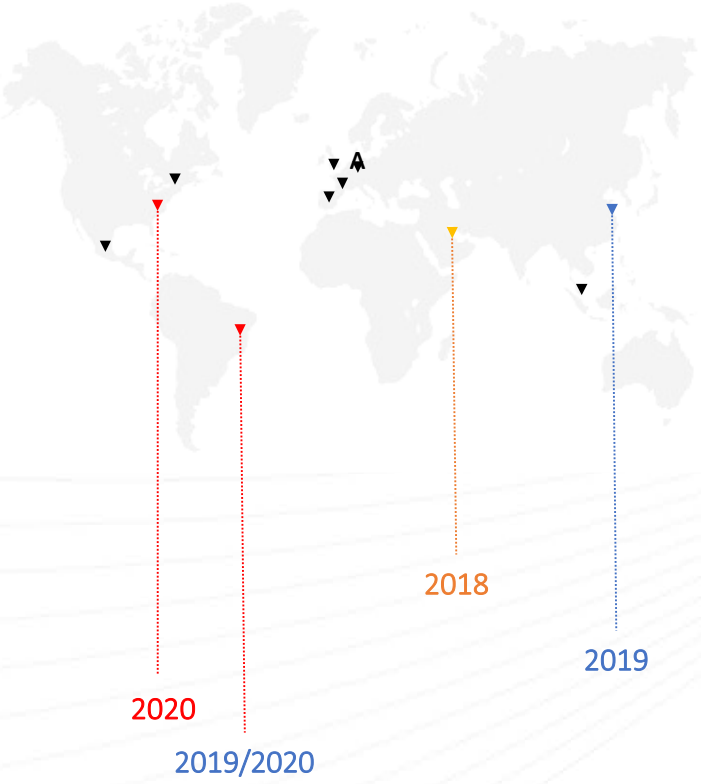
Testia could be your enabler of your regional policy



- Perform **locally** all SHM relevant Services
- Analyze and evaluate data in selected data analytic centers

→ **Your local SHM workforce**

→ **Engineer & deliver your regional innovation initiatives & services**

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Thank you for your attention

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WE...

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...THANK YOU