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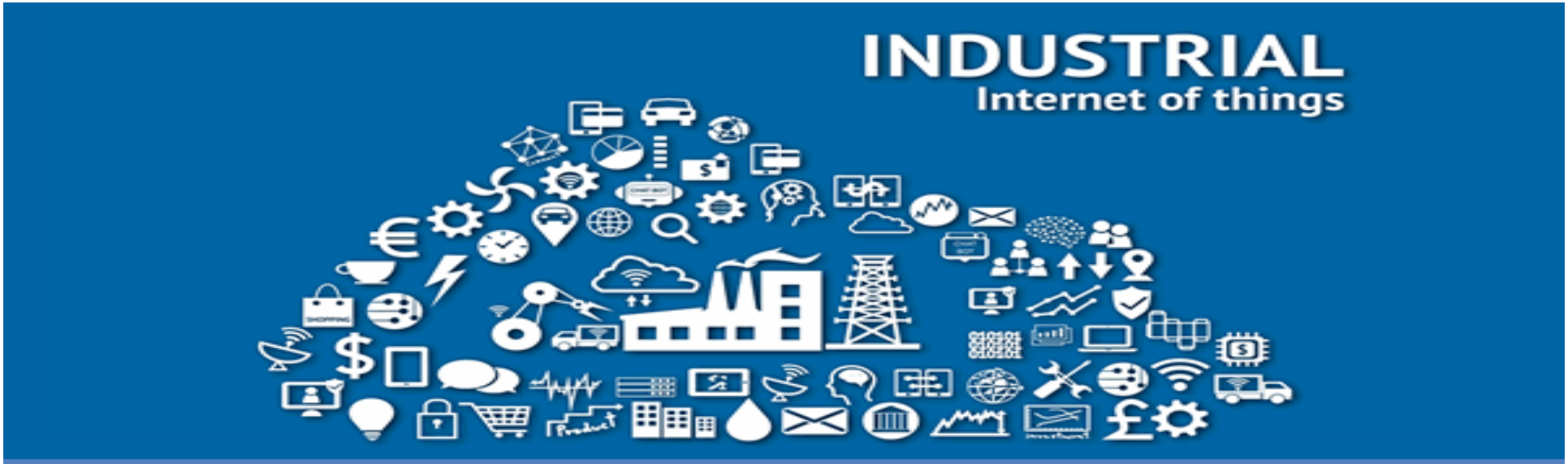
Contact: Amrita Kumar PhD, Grant Chang
Tel: 408 745 1188 / 307 4189
Email: akumar@acellent.com, grantc@acellent.com

Acellent Technologies Inc.
835 Stewart Drive, Sunnyvale CA 94085
www.acellent.com

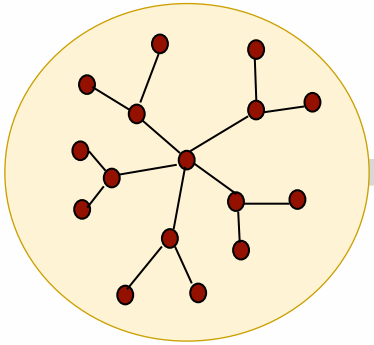
Industrial IOT – the wave of the future

https://www.i-scoop.eu/internet-of-things-guide/industrial-internet-things-iiot-saving-costs-innovation/



REQUIRES THE ABILITY TO

SENSE and ACT



through sensors & actuators

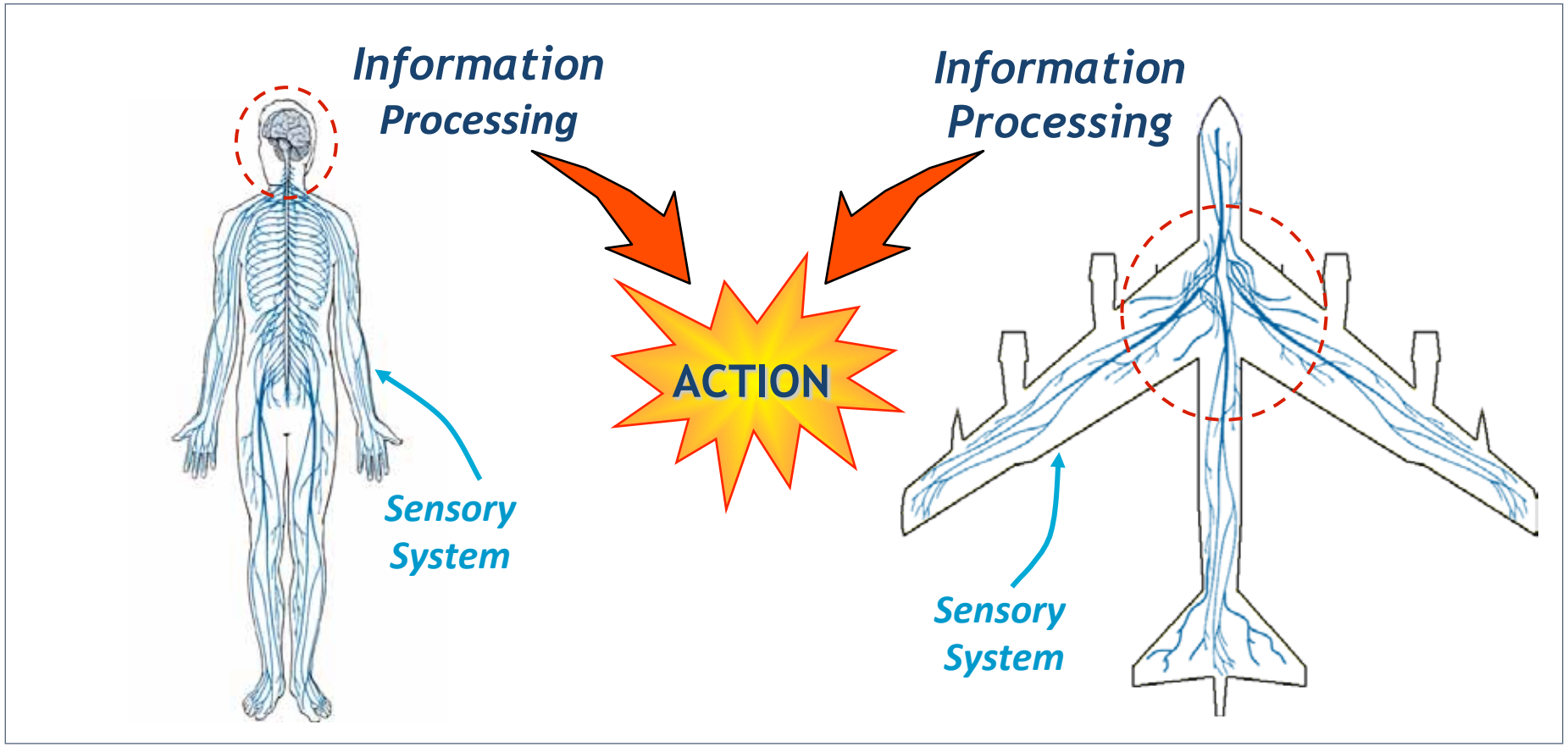
ANALYZE and VISUALIZE

using Big Data and Analytics

COMMUNICATE

using wide variety of networks

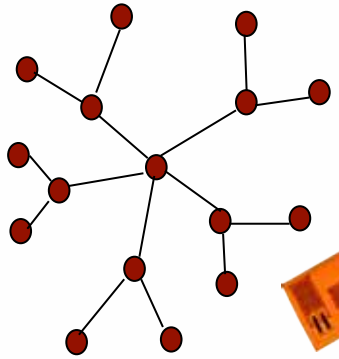
SHM Products



Intelligent Structures with integrated sensor networks :
“Information Technology”

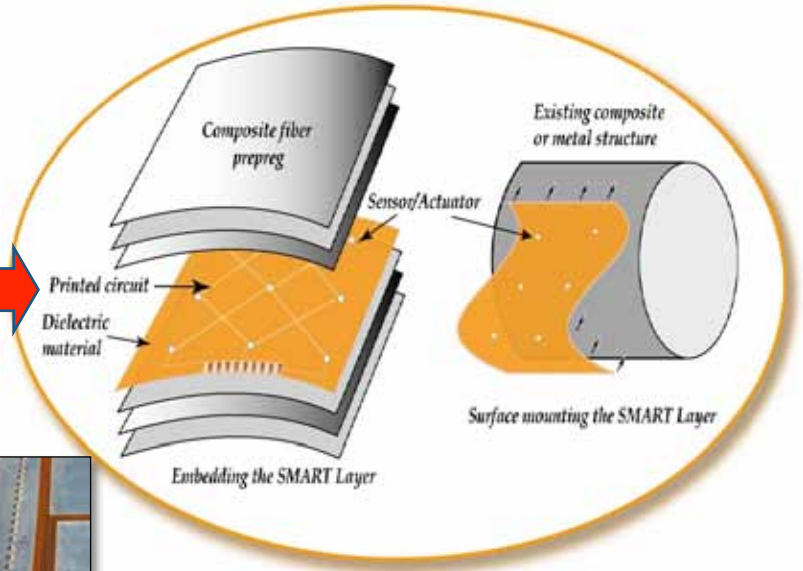
Acellent SMART LAYER Technology

Innovative sensor network concept



Integrated sensor network based SMART Layer

Easy installation

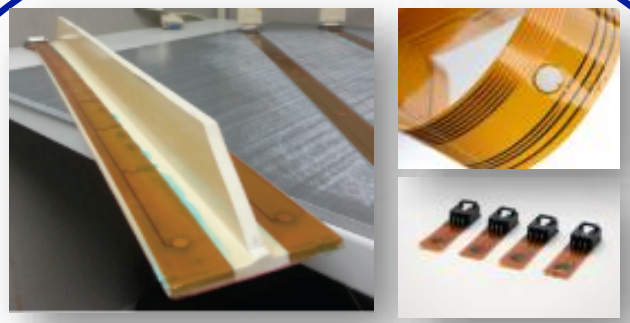


Ease of structural integrity detection

- Integrated sensor network
- Ease of installation using flexible thin film technology
- Uses a network of sensors
  - entire area can be monitored not just discrete points

ACELLENT'S SHM SYSTEMS

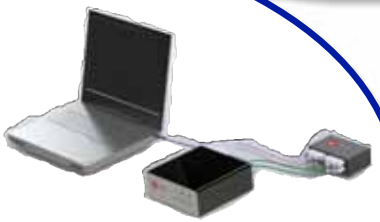
SMART® LAYER SENSORS



1

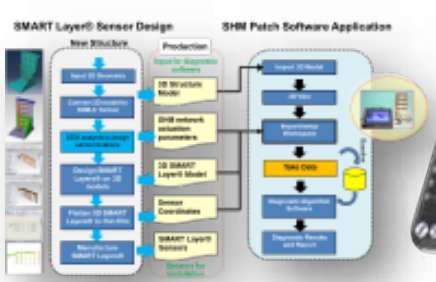
2

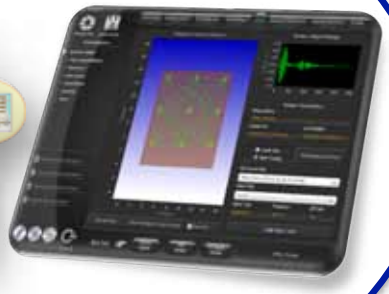
On-board



Off-board

3





SHM HARDWARE

HOT SPOT MONITORING
CORROSION MONITORING
DYNAMIC STRAIN MONITORING

SHM SOFTWARE

LARGE AREA MONITORING
IMPACT DETECTION AND MONITORING
LOAD MONITORING

SMART Layers Products and Applications

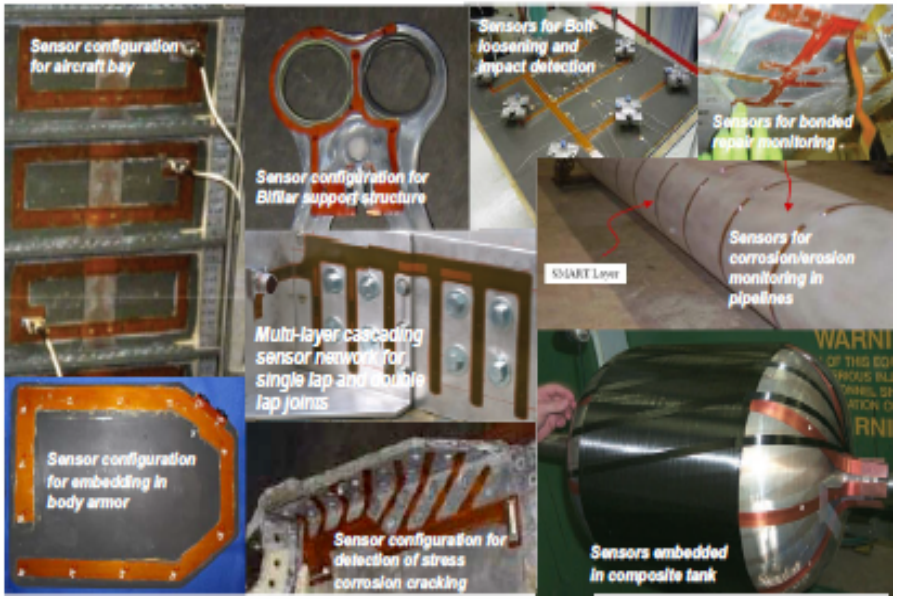
SMART LAYER PORTFOLIO

Standard SMART Layers®

Multi-Sensor SMART Layer® strips with predetermined sensor spacing allows for ease of installation and precise sensor spacing.

Custom SMART Layer® Sensor Networks

Custom SMART Layer® sensor networks provides the utmost flexibility in design, allowing it to conform to challenging geometries with precise sensor placement for consistent reliable damage detection results.



INSTALLATION KITS & CONNECTORS

INSTALLATION KITS

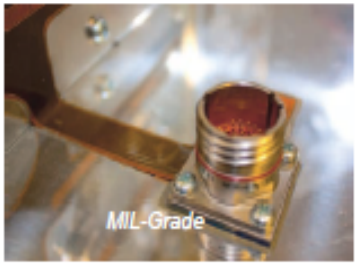
SMART Layer® Installation Kit

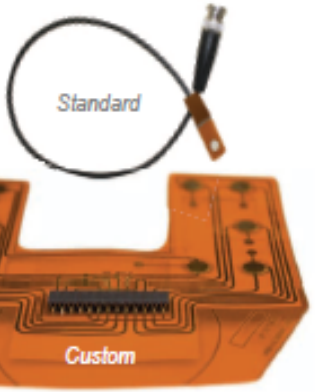
Sensors can be individually surface-mounted with permanent epoxy adhesive or permanent mounting tape, followed by pressure and heat to cure and seal the epoxy, and coated to meet environmental requirements. Install kit pictured can be obtained from Acellent for ease-of-installation.

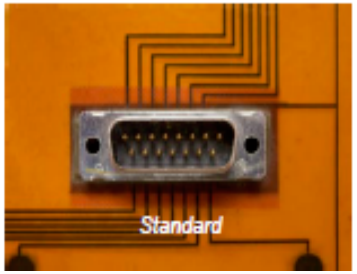
SMART Layer® Installation Services

Acellent provides custom on-site or off-site installation services depending on the need of the install. Please contact sales@acellent.com for more information.

CONNECTOR TYPES







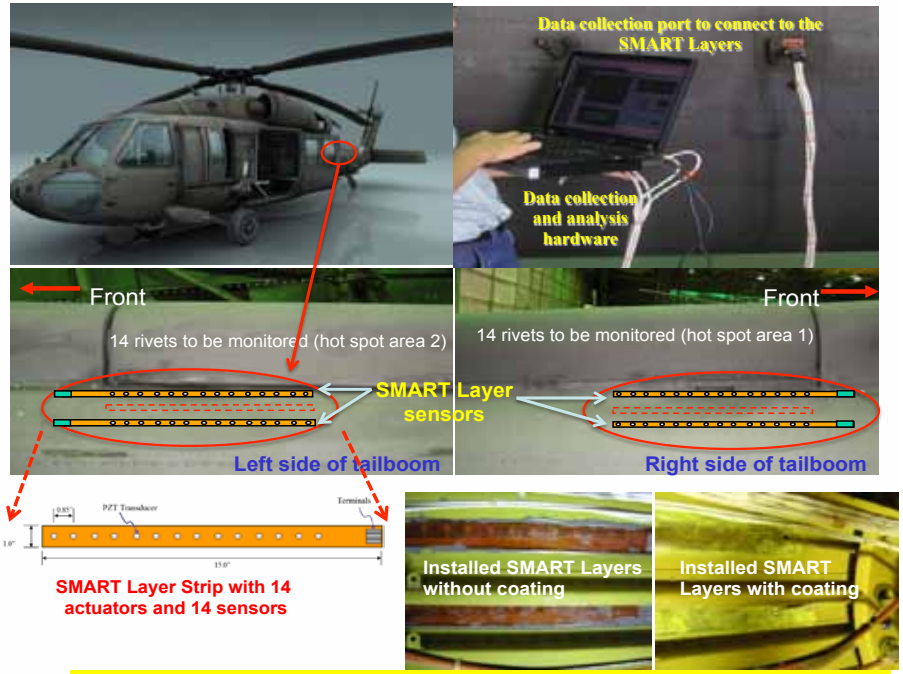
Airworthiness

Designed and tested for all inspection environments

EMI shielded: SMART Layer are efficiently shielded for electromagnetic interference.

MIL-Std testing

- Salt Fog & Humidity Tests
  - (MIL-STD-810F section 509.4)
  - (MIL-STD-810F section 507.4)
- Successfully tested as per MIL-STD-810G to satisfy the Flight Test and Fielding Demonstration Airworthiness Requirement (AWR) requirements
  - ✓ High Temperature Storage Test
  - ✓ Low Temperature/Low Pressure (Altitude) Storage Test
  - ✓ Temperature/Altitude/Humidity Test
  - ✓ Blowing Dust Test
  - ✓ Blowing Rain Test
  - ✓ Blowing Sand Test
  - ✓ Dynamic Tests including Vibration, Functional Shocks and Crash Hazard Shocks



Flight tested for > 6 years (900 flight hours)

Operational Temperature

- Continuous operating temperature: -67 °F ~250 °F
- Short time high temperature exposure: ~390 °F
- Low temperature survivability: -321 °F

Flight Tests *(Completed and Ongoing)*

- **F-16** – flight tested for 18 month on bonded repair on aircraft
- **OH-58C, OH-58D** - flight testing completed
- **Airbus A340, A350** - flight testing ongoing
- **Embraer** – flight testing ongoing

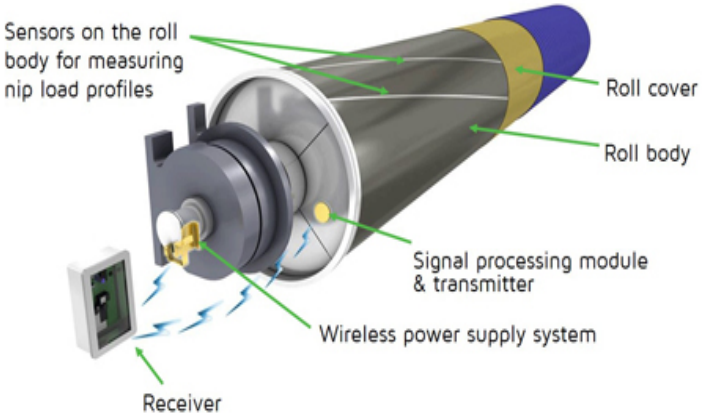
- **UH-60 Black Hawk**
  - Complete SHM system installed on Black Hawk aircraft at NASA Ames
  - Sensors have been flying **for >72 months for 900 flight hours**
  - Successfully undergone **survivability and functionality test of sensors** through **sand blast testing** in brown-out conditions at Yuma Proving Ground. Data was taken continually to check sensor signals

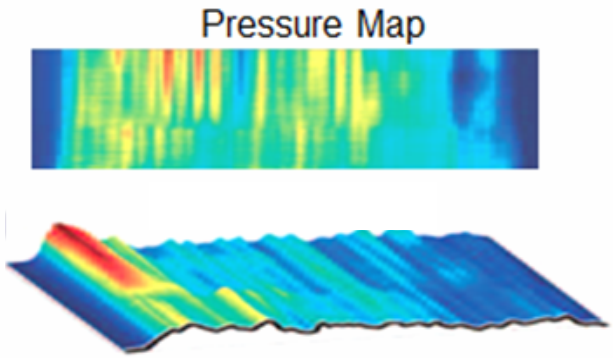
Condition	Range
Ambient temperature	40 ~115°F
Aircraft weight (gross)	Up to 22,500 lbs.
External sling load	Up to 7,600 lbs.
Environments	Rain, heavy dust, and loading

Example: iROLL

Valmet *iRoll* system is a manufacturing roller monitoring system that is being used by the industry

- Structural Health Monitoring Solution is applicable to the Paper Industry
- Provides the optimal monitoring and maintenance procedures throughout the papermaking process.
- Help achieve the desirable result.
- The whole industry is focused toward integrity management.

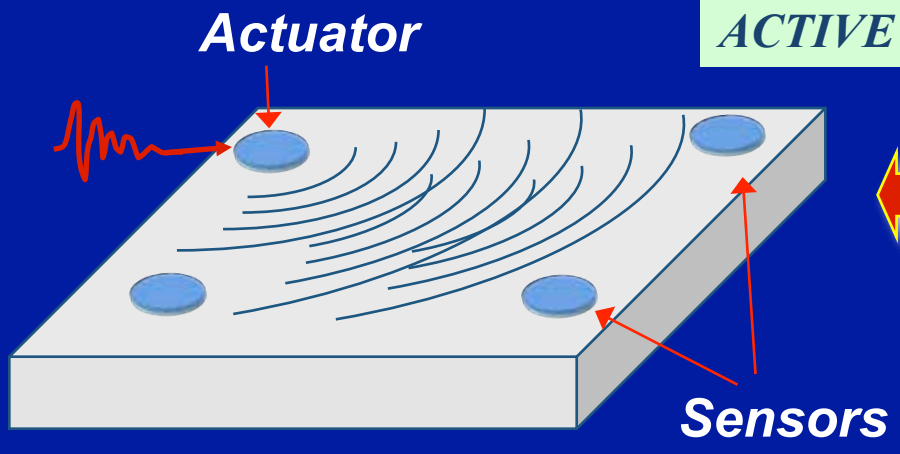




The *iRoll*, a real-time smart roller monitoring system for ensuring the integrity of paper manufacturing rollers

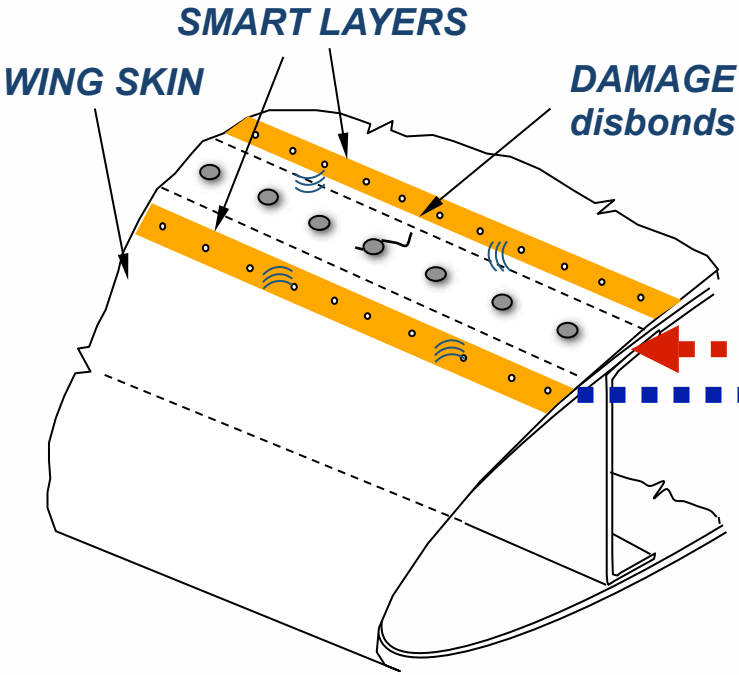
https://youtu.be/CmFS7nuXCsA

HOW DOES THE SYSTEM WORK?



ACTIVE SENSING

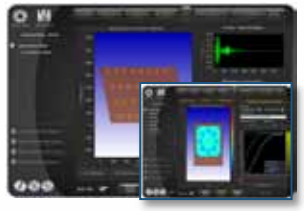
- Actuators excite structure
- Surrounding sensors record the transient stress waves



Actuation Signal

Sensor Data

Damage detection
Damage location
Damage size



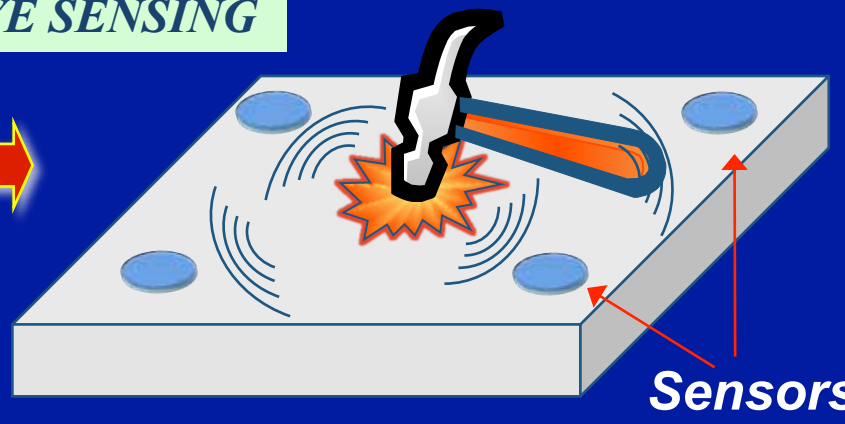
SHM software

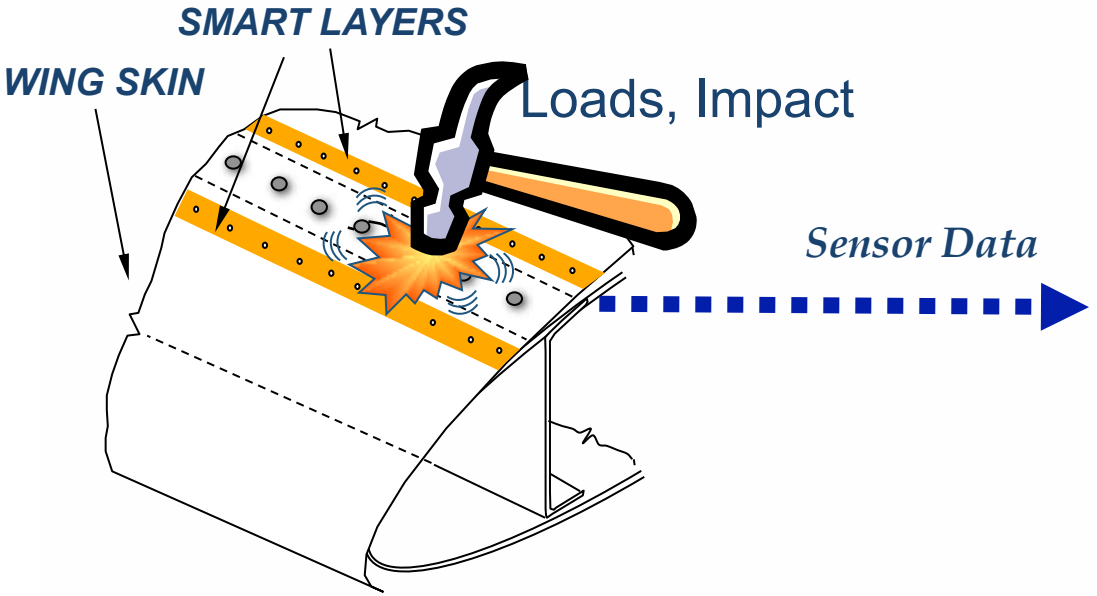
ScanGenie hardware

HOW DOES THE SYSTEM WORK?

- Impacts excite structure
- Sensors record stress waves
- A log of the impact time, location and force is made.

PASSIVE SENSING

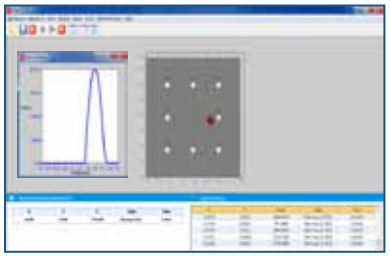




Sensor Data

IMGenie hardware

AIM software



Impact Detection
Impact location
Impact Force *(with calibration)*

SHM System Usage (*metal & composite structures*)

Off Board Monitoring System

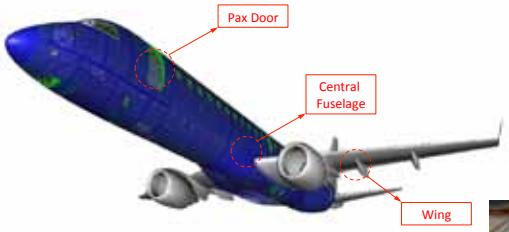
- *Manual data collection*
- *Retrieve reference data or priori data*
- *On spot data analysis*
- *Damage quantification*
- *Report result for maintenance action*

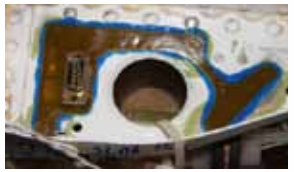
On Board Monitoring System

- *Robust in variable conditions*
- *Minimal to no human intervention during operation*
- *Autonomous data collection*
- *Autonomous data analysis*
- *Real time damage diagnosis*
- *Real time damage quantification*

Large Area:
- Impact monitoring
- Damage detection

Small area:
- Hot-spot monitoring





Wing spar

PAX door

Summary

- Sensors integrated with the structure → **no structural disassembly**.
- Inspection can be performed in **minutes, 24/7**
- Enables **Condition Based Maintenance**.
- **Easy to operate and use**, monitors **a small or large structure** on a new or existing aircraft.
- Sensors **easily and reliably integrated** with the host structures
- The system can be used to reliably
  - **detect,**
  - **localize and**
  - **quantify** damage size
- Enables decisions on whether to **repair or replace** the component

Questions