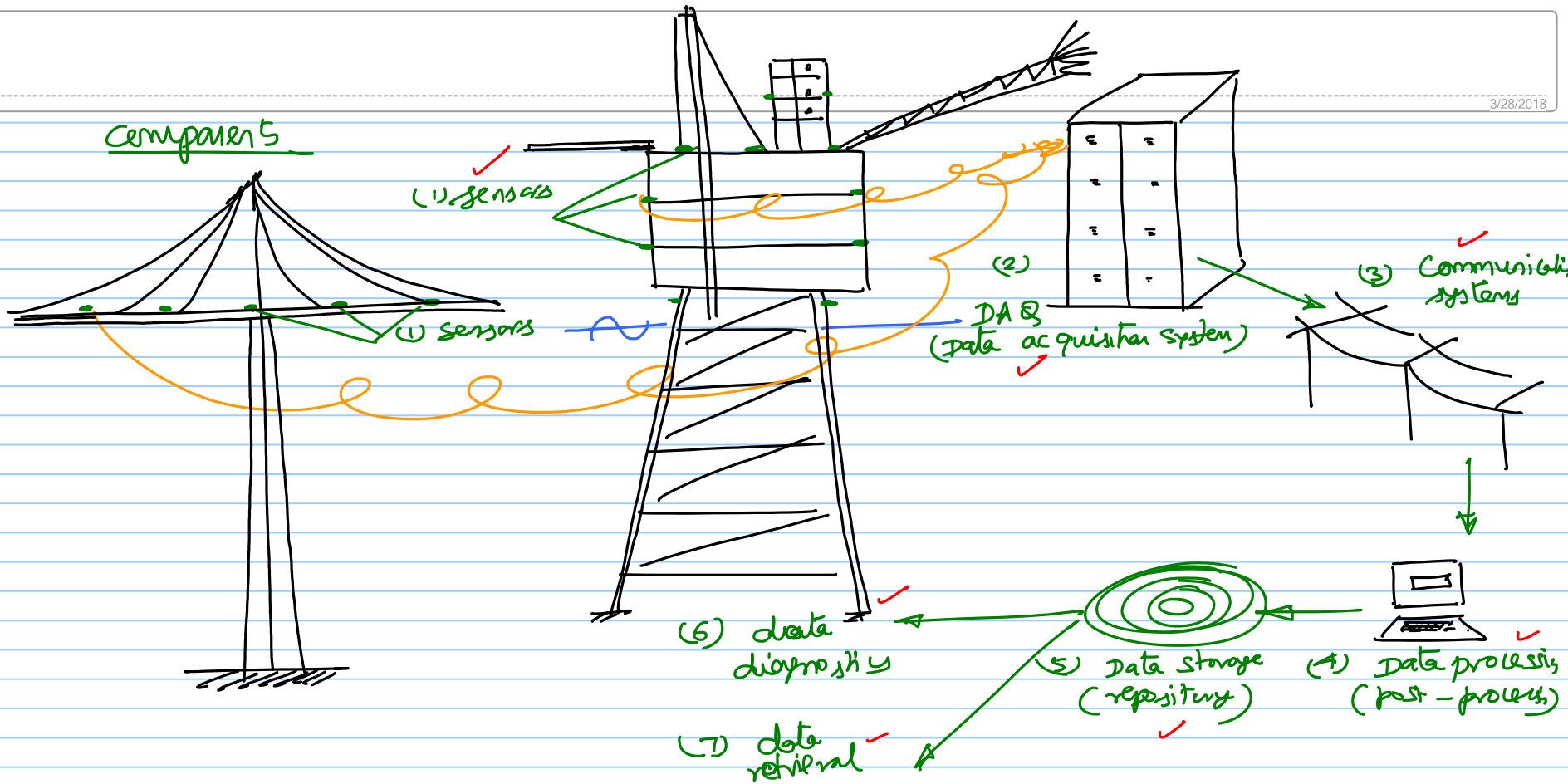
Note Title 3/28/2018

Module 1, Lecture 03 SHM

(1) Components of SHM

Note Title 3/28/2018



Note Title 3/28/2018

Components

(1) Sensors ← type of sensors
layout topography
scalability

(2) Data acquisition ← type of DAQ
wireless/wired

(3) communication systems ← R/F
internet

(4) Data processing – statistical analysis of the collected data

(5) repository – Data storage
↓
Data diagnostics / Data retrieval

Note Title 3/28/2018

seismic justification of SHM

- reduction in cost - inspection
- mitigating impact caused by unforeseen loads on structural members
- reduce unwanted/undesired repair
- ↑ public safety

Note Title 3/28/2018

(2) Challenges of SHM in Aviation Industry

Aircrafts – metallic structures
– designed for specific flight hours

Aircrafts are retired from flying once they reach a pre-decided flight hours or landing cycles – they can be retired

real-time fatigue analysis and damage assessment of aircrafts, particularly during landing cycles
– extend their flight hours || ↑ public safety
– or to pre-retire them

Note Title 3/28/2018

(1) Use of strain gauges and mechanical recorders to measure the deviations (during the landing cycles)

(2) Use of Flight Data recorder (FDR) using Electro-Mechanical Mirror computer (EMMC)

Use of SHM is clearly seen as a major advantage

- helpful to decide the suitability (fitness) of the aircraft
- to modify the design philosophies - arrived based on continuous monitoring

Note Title 3/28/2018

Anomalies - explained through SHM applications

(1) ✓ "Aircraft geometric configuration is not related to the structural load disbursement"

- By continuously monitoring the σ values, this assumption can be proved wrong
- found that aircraft configurations makes a significant difference on structural loads

(2) ✓ "Usage of all aircrafts is a large fleet averages out with time"

- This can also be proved wrong
- This is not true based on fatigue assessment
- fatigue damage depends on the "Actual usage"

Note Title 3/28/2018

and hence cannot be averaged for a large fleet

(3) ✓ Maintenance management – planned on the basis of design load spectrum

SHM helps to follow the actual measurements of the σ variation

– It was found that Average user spectrum is more severe than that of the design load spectrum.

Adid Ali khan et al. 1991. Challenges of SHM in aviation Industries, J. of space Tech, 4(1): 67-74.

Note Title 3/28/2018

Tools of SHM (for aviation industry)

(1) fuzzy pattern recognition

(2) neural networks

(3) Diffused ultrasonic waves technique to detect the structural damage, present in the unmeasured temperature members

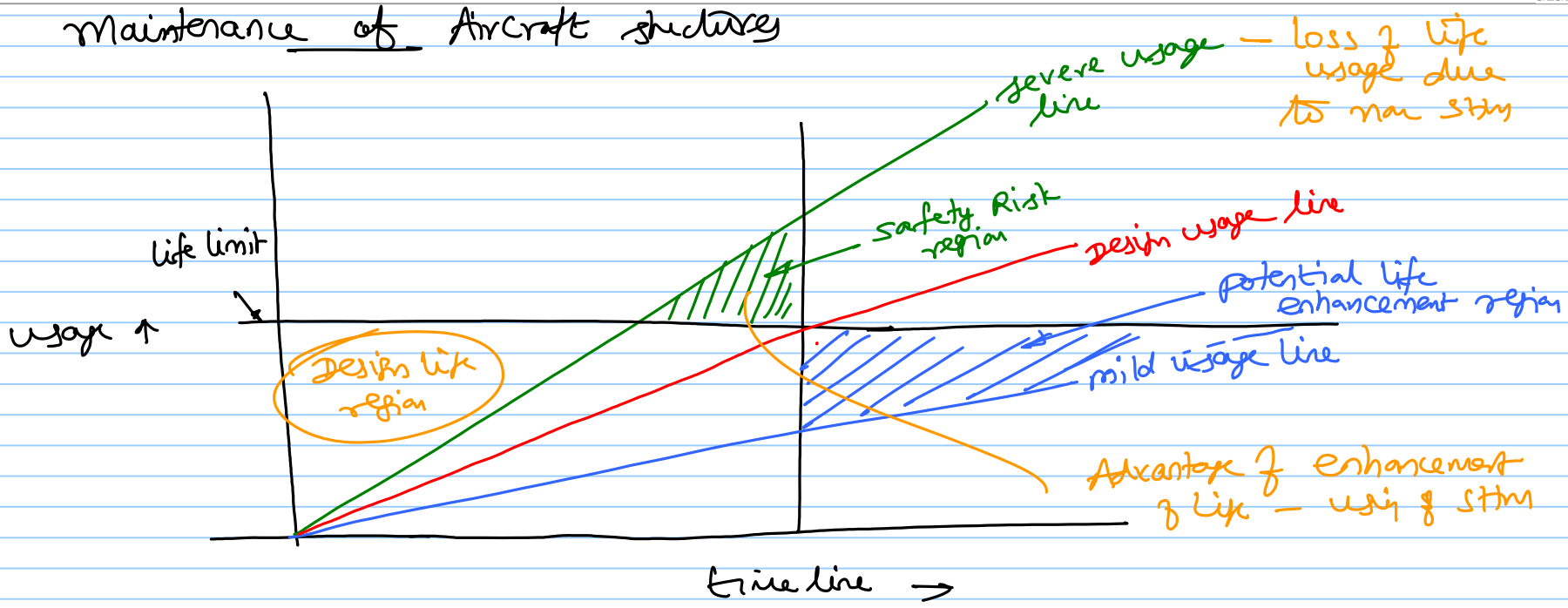
(4) Vibration-based technique

(5) Intelligent parameter varying technique for location of damage

6) use novel sensor layout in SHM.

Note Title 3/28/2018

Maintenance of Aircraft structures



Application of stdy ← under usage of service life
↑ service life (usage) by continuous monitoring its & diagnosis tools

Note Title 3/28/2018

Passive sthm: means that · observing a structure as it evolves
- a physical parameter and its state evolve as a result of interacting with the Environment

Ex: Acoustic Emission (AE),

Active sthm – structure is equipped both with sensors & actuators
– structures which are unmanned (petroleum production platform – unmanned)
– actuators prompt forces, opposite to the structural motion and initiate a recentering capability of the platform under Environmental loads
— SMART STRUCTURES.

Note Title 3/28/2018

Example

Boeing 787 Dreamliner
- equipped with embedded sensors for continuous Health monitoring

location

- shell fuselage
- lower wing skin
- door shutters

probability of damage is relatively high during loading

Note Title 3/28/2018

Common types of sensors - used in SHM

1) Fibre Bragg Diffraction Grating sensors

- embedded in structures
- They are laser-marked with optical-interference parameter
- any local strain caused by the deformation
  - results in sensor measurement
  - will transmit wavelengths | This can be detected

(2) Acoustic emission sensors

- Acoustic signals generated by presence of cracks, delamination of fiber (or) breakage
  - measurable

(3) Smart sensors - sensor coatings

- paints (or) coatings applied on the surface
- integrated with piezo - (or) ferro-electric elements
  - Carbon nano-tubes
  - They are useful to detect variations in Strain
- A detailed spectroscopic analysis is required to process the strain variations caused by the damages in local scale - detected on the coatings

(4) Microwave sensors

- useful to indicate moisture ingression, when embedded
- very useful / efficient in composite structures

(5) Imaging Ultrasonic sensors

These sensors contain a small, ultra-sonic wave transducer, which generates signal, that passes through the material

- change in reflection indicate flaws, cracks or bond damage

Summary

(1) components of SHM process

(2) Aviation Industry
- service life (flight hrs) ↑

(3) Variety of sensors - SHM is civil infrastructure