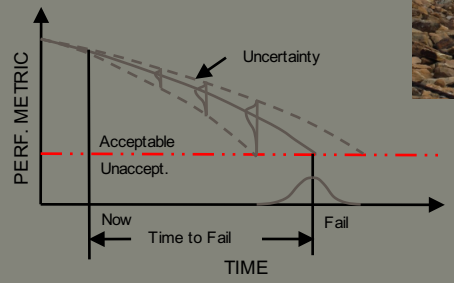
STRUCTURAL HEALTH MONITORING FOR CIVIL WORKS

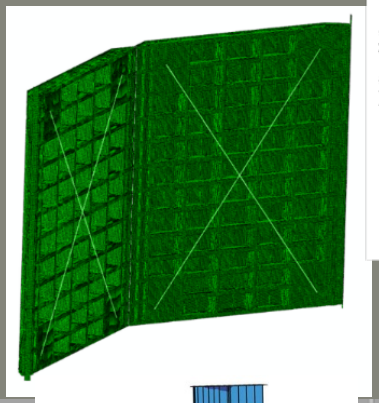
PIANC WG199 Kickoff, 10 NOV 2017

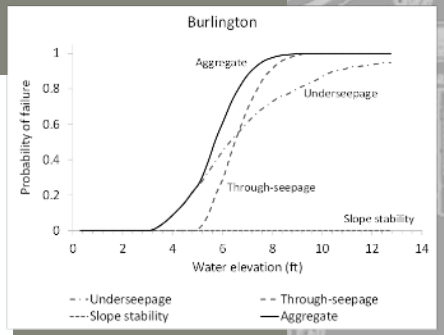
Matthew D. Smith, PhD, PE
Lead – SHM R&D

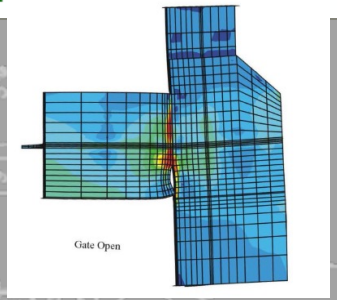
Quincy G. Alexander
Chief – Sensor Integration Branch

U.S. Army Corps of Engineers
Engineer Research and Development Center
Vicksburg, MS, USA









"The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation."

US Army Corps of Engineers ®

U.S.ARMY

USACE INFRASTRUCTURE

- $250B infrastructure replacement value
- 12,000+ miles of navigable inland waterways
- 926 commercial harbors
- 191 locks
- 353 hydroelectric power generation units
- 694 dams
- 14,700 miles of levees
- Over 800 bridges
- Buildings, roads, recreation sites, environmental projects, etc…

MORE THAN SENSORS

Structural Health Monitoring (SHM) – Science of making ***accurate condition assessments*** about the ***current and future ability*** of a structural component or system ***to perform*** its intended design function(s), based on:

- Sensor/inspection data
- Multi-physics (structural/thermal/hydraulic) models
- Statistical models

We are combining SHM with Decision Analysis to provide a clear line-of-sight between observations and investment and operational decisions

- What is Structural Health Monitoring?

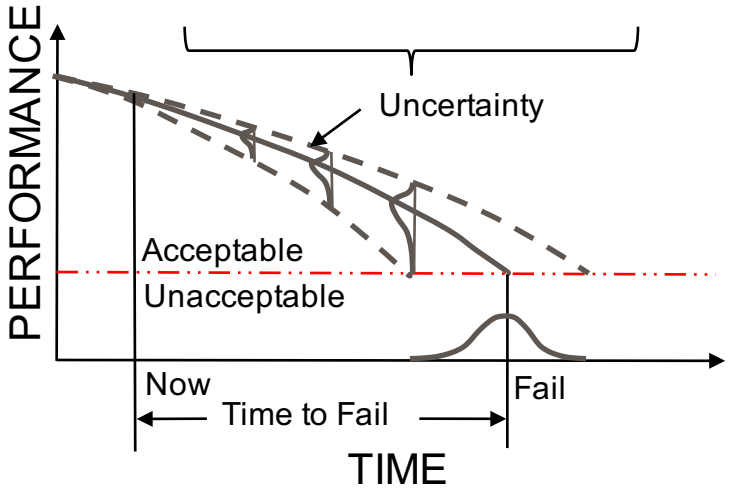
PERIODIC INSPECTIONS
- Visual
- NDT
- FEM

MONITORING SYSTEMS
- Sensors
- Cameras

ENGINEERING/STATISTICS MODEL
- Failure Modes
  - Corrosion
  - ASR
  - Cracking
  - Accidents
  - Natural Hazards
  - Levee Seepage
- Loadings/Usage/Environ.
- Uncertainties

SHM

PERFORMANCE METRICS (Mission Objectives)
- Navigation Tonnage
- Life/Property Protected
- Nonauth. Benefits
- Rec. Visitation
- Power Produced
- Wildlife/Environmental



Conventional Design vs. New Innovative Design

ERDC R&D

Example Decision Alternatives 1

Major Rehab. vs. Operate to Failure vs. Shut Down

Example Decision Alternatives 2

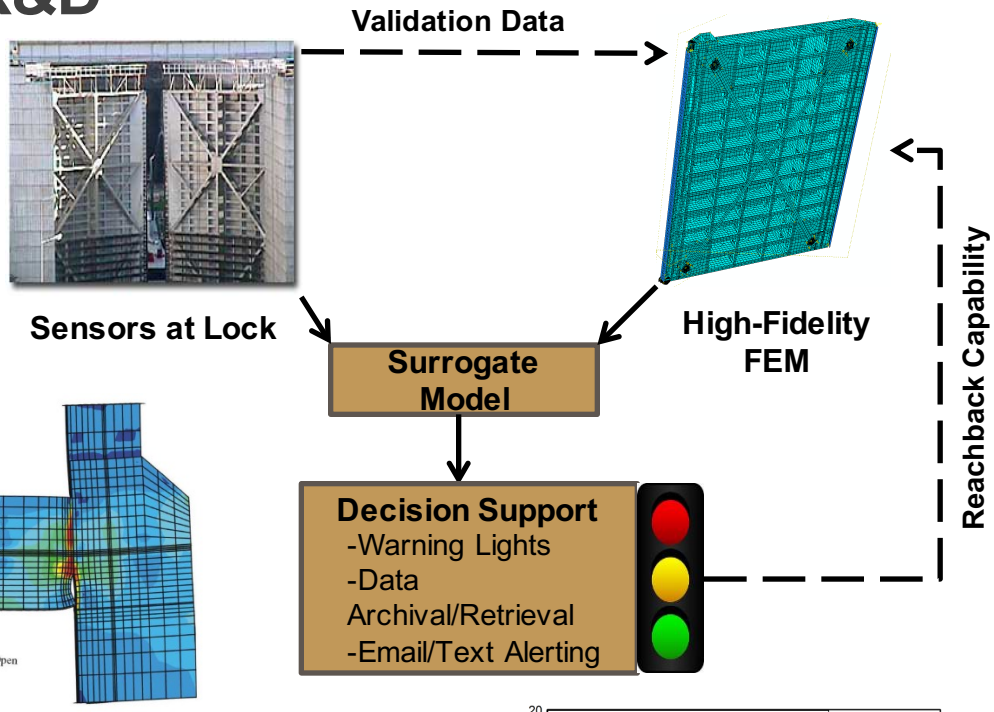
U.S. ARMY

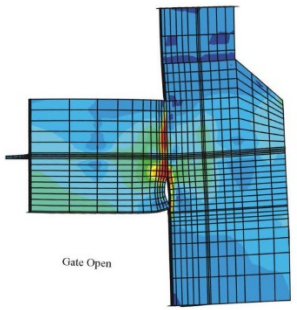
US Army Corps of Engineers®

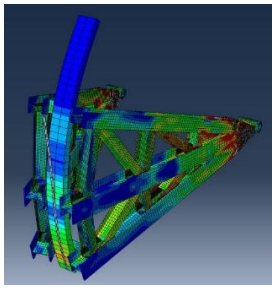
PREDICTING FUTURE PERFORMANCE
Used by A.M. (Budget Priority)
Used by Ops (Maint. Planning)
Used by E&C (Design Alternatives)
Used by R&D (Identify Gaps)

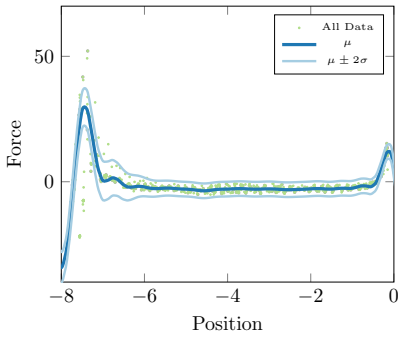
SHM CAPABILITIES AND R&D

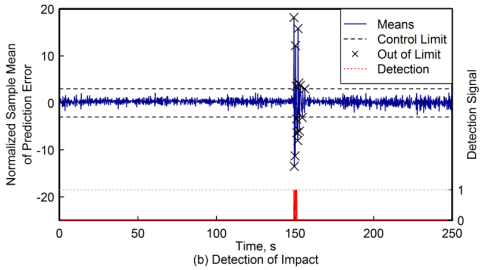
- Barge Impact – Lock Gates
- Dragging/Trapped Debris
- Degrading Contact Blocks
- Remaining Fatigue Life
- Miter Gate Diagonal Tension Limits
- Trunnion Friction in Spillway Gates
- Uneven Hoisting
- Sensing Paints/Films
- Bayes Net Based Inspection Models
- Computer Vision Techniques – Baseline and Dynamic
- Impedance Based Crack Sensors
- Tension and Flaw Detection in Trunnion Anchor Rods
- Corrosion Protection Monitoring
- Bridge Pier Scour Sensors
- Remote I-Wall Monitoring
- Underwater Wireless Sensor Communications











U.S. ARMY
US Army Corps of Engineers®

ERDC

MISSION

The Sensor Integration Branch:

- researches, develops, fabricates and integrates sensor, communications, electronic and electro-mechanical components and systems in support of direct and reimbursable research for military and civil work.
- provides instrumentation, data collection and measurement methodology expertise in the areas of structural monitoring, and physical phenomenology measurement.
- provides technical and operational supports for various software and hardware integrations and developments across the U.S. Army Corps of Engineers and other Department of Defense (DoD) entities.

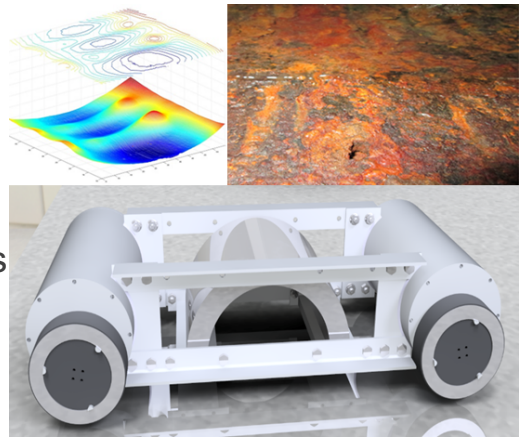
U.S. ARMY

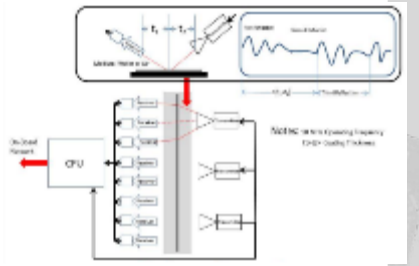
US Army Corps of Engineers®

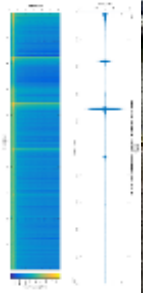
ERDC

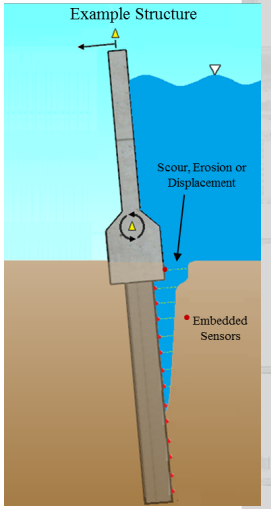
REPRESENTATIVE SHM EFFORTS-FY17

- Field Instrumentation, Data collection and Data Management
- Determination of Plate Corrosion and Thickness of Anti-Corrosion Coatings for Above and Below-Water Metal Structures
- Automated Underwater Corrosion Inspection System
- Structural Monitoring and Analysis in Real Time for Gates (SMART Gate)
- Underwater Wireless Communication
- Real-Time Monitoring of Structural Stability due to Scour, Erosion and Structure Displacement
- Trunnion Rod Defect Detection









U.S. ARMY

US Army Corps of Engineers®

ERDC

Innovative solutions for a safer, better world