

Current State of Infrastructure Maintenance and Monitoring in USA

(ACECC TC-28 Meeting in Mar 2022)

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Outline

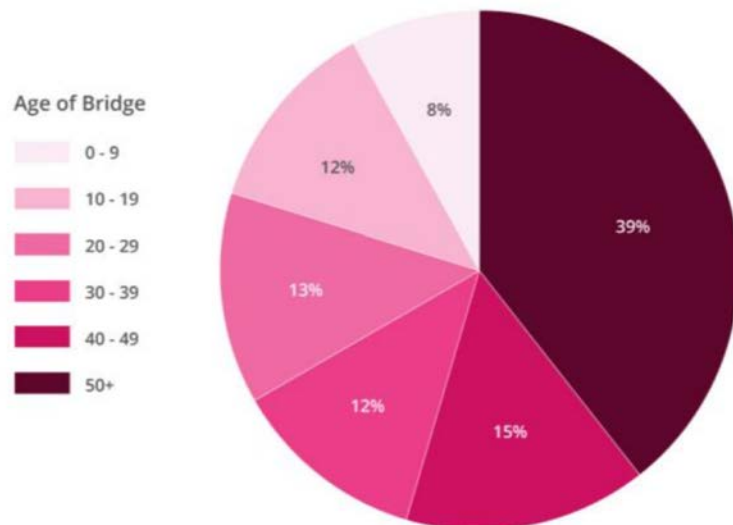
1. **Age of Bridge Infrastructures in US** (1 slide)
2. **Periodic Inspection Requirements in US** (3 slides)
3. **Monitoring Research Efforts in US** (3 slides)
4. **Needs and Challenges in Monitoring Efforts** (1 slide)

1. Deterioration of Bridge Infrastructures in US

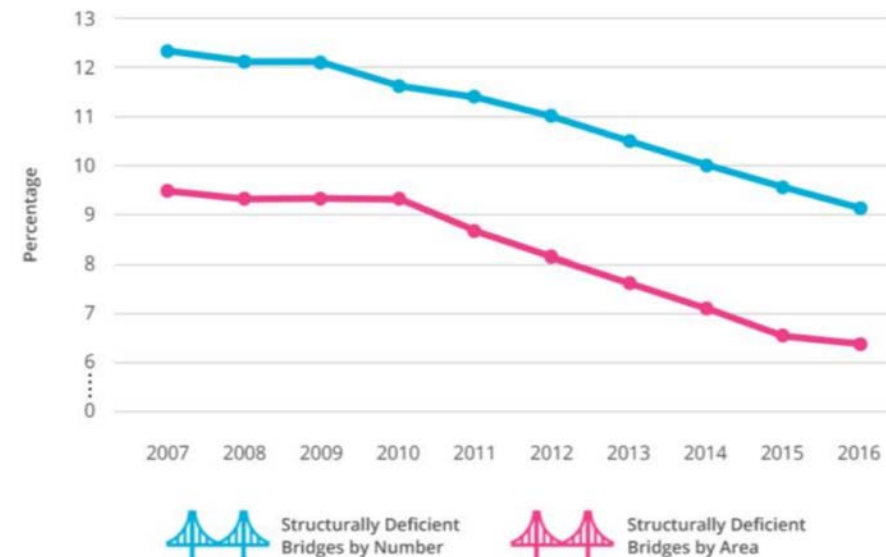
Graphical Data based on the ASCE 2017 Infrastructure report card and

- Of the 614,387 bridges in the National Bridge Inventory, 39% are over 50 years or older. (2017)
- Including the 15% with bridges between the ages of 40 and 49, the average age of US bridge is 43 yr old.
- With the past 10-15 years of efforts, the number of structurally deficient bridges is currently at 9% of the inventory.
- Most recent 2021 report card suggests with that there are now **42%** of the **617,000** bridges that are **at least 50 years old**, and **7.5% (46,154 bridges)** are considered as **structurally deficient**.

America's Bridges by Age



Structurally Deficient Bridges



2. Periodic Inspection Requirements in US

National Bridge Inventory

- FHWA requires bridges that are longer than 20 ft (6 m) on all public roads
- Requires inspection at least once every two years
- Data available for download between 1992 to 2021

317 NKA-MF-
0021420000000004500000Mirage
Flats Canal Lembke Rd
Approx 16 miles
southwest999900051170000000000000
422803791025218800073026909199002
0000005020105005000000000050000000
000A15101000002000099900049000107
000000005000509990N0000N000000664
6N232723274NN487381000000031224N
N N
0522000000000522002010 0 0
0N3 00000018001501Y80000082030
NY
1 06251

Information for Many Bridges

Required by FHWA for NBI



Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges

Report No. FHWA-PD-96-001



Office of Engineering
Bridge Division

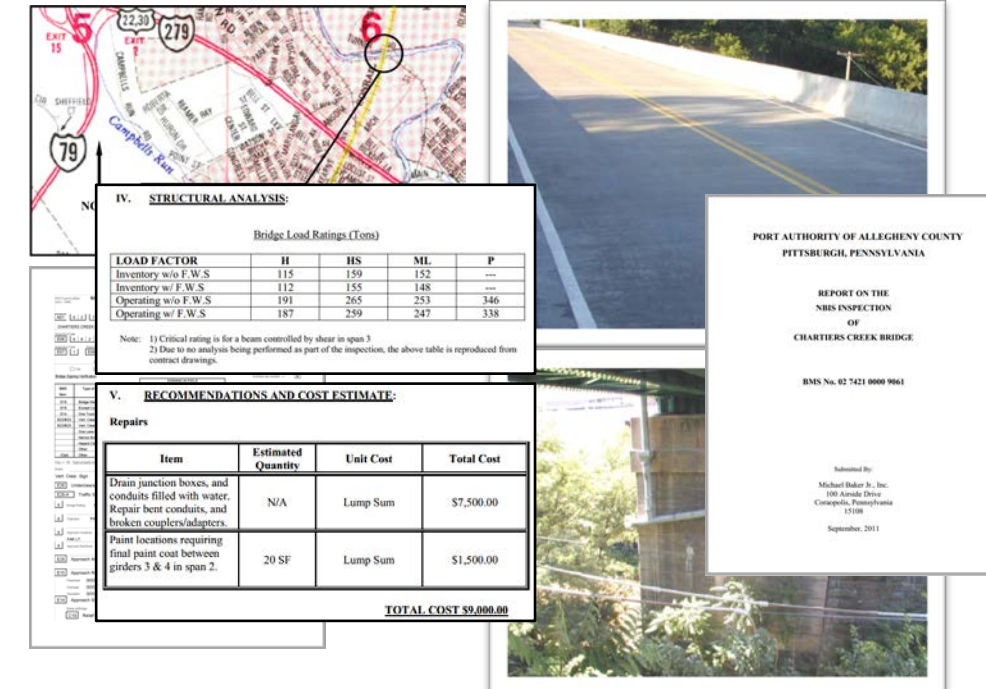
December 1995

92 Critical Feature Inspection	63
93 Critical Feature Inspection Date	64
94 Bridge Improvement Cost	64
95 Roadway Improvement Cost	65
96 Total Project Cost	65
97 Year of Improvement Cost Estimate	66
98 Border Bridge	66
99 Border Bridge Structure Number	66
100 STRAHNET Highway Designation	67
101 Parallel Structure Designation	67
102 Direction of Traffic	68
103 Temporary Structure Designation	68
104 Highway System of the Inventory Route	69
105 Federal Lands Highways	69
106 Year Reconstructed	69
107 Deck Structure Type	70
108 Wearing Surface/Protective System	70
109 Average Daily Truck Traffic	71
110 Designated National Network	72
111 Pier or Abutment Protection (for Navigation)	72
112 NBIS Bridge Length	73
113 Scour Critical Bridges	75
114 Future Average Daily Traffic	77
115 Year of Future Average Daily Traffic	77
116 Minimum Navigation Vertical Clearance	77
Vertical Lift Bridge	
GENERAL	78
APPENDIX A	Structure Inventory and Appraisal Sheet
APPENDIX B	Sufficiency Rating Formula and Example
APPENDIX C	National Bridge Inspection Standards
APPENDIX D	Commentary
APPENDIX E	NBI Record Format

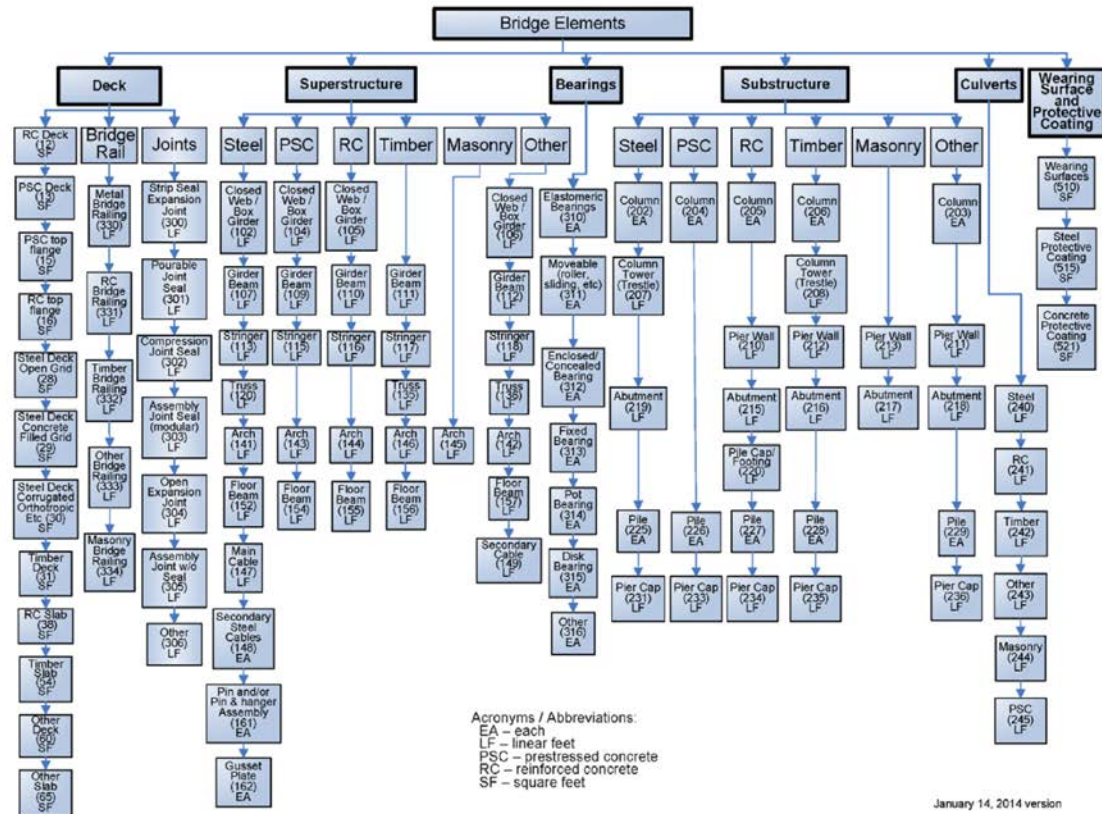
2. Periodic Inspection Requirements in US

National Bridge Element Data and State DoT Inspection Data

- Element level data available from 2015 to 2021
- State DoT manages photos, load ratings, drawings, inspection reports in their own repositories separate from NBI, NBE data



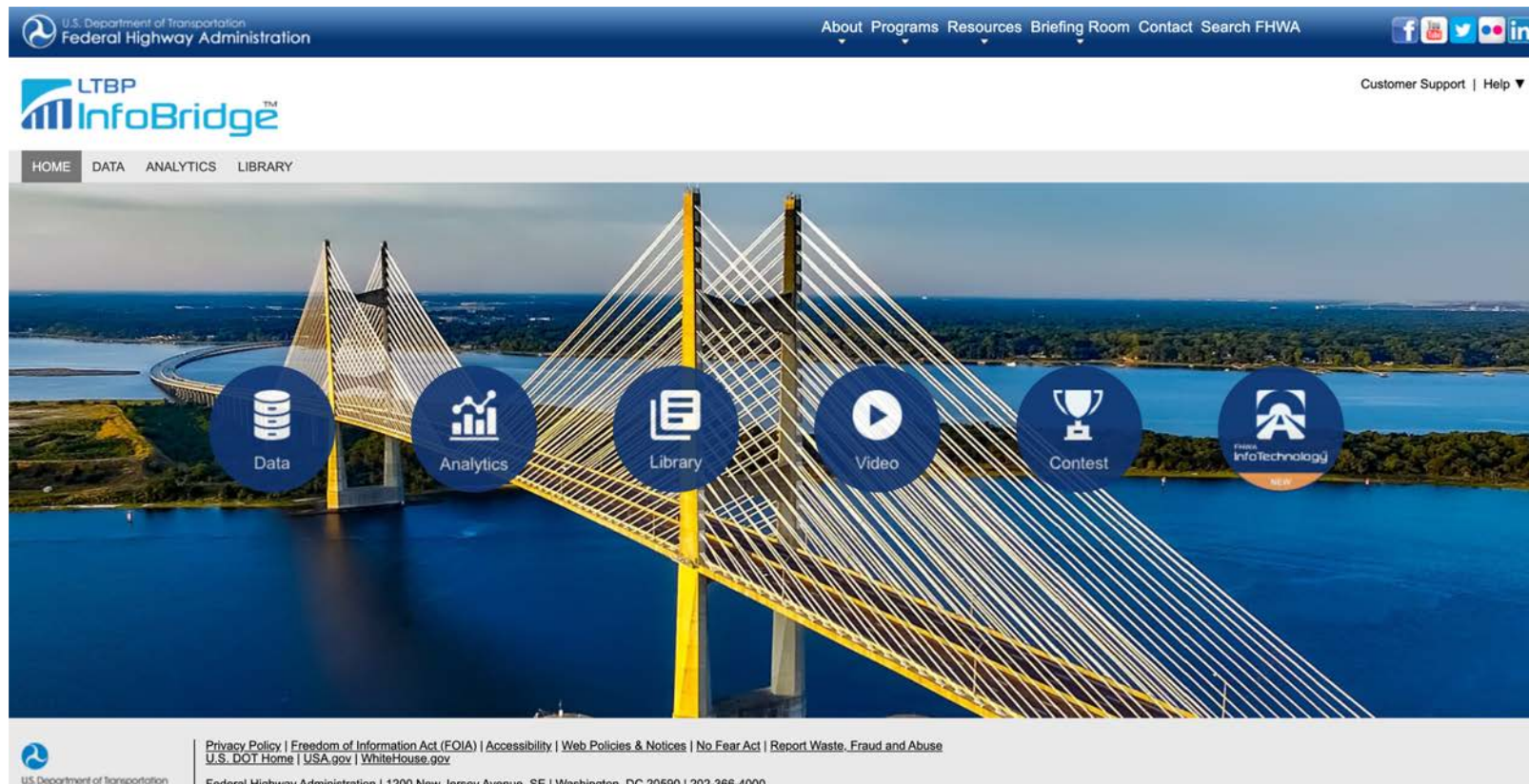
APPENDIX B – BRIDGE ELEMENTS



2. Periodic Inspection Requirements in US

Long-term Bridge Performance (LTBP) *InfoBridge*

- InfoBridge web portal started as one of the efforts of the LTBP program in 2019.
- Tries to archive, share, and allow analytics on web portal including NBI, NBE data of bridge inventory and some NDT data for limited number of bridges



3. Monitoring Research Efforts in US

Active Structural Health Monitoring Research Groups in US

Institution	Project Investigator	URL
University of Illinois at Urbana Champaign	Dr. Billie F. Spencer	https://sstl.cee.illinois.edu
University of Illinois at Urbana Champaign	Dr. John S. Popovics	https://cee.illinois.edu/directory/profile/johnpop
Purdue University	Dr. Shirley Dyke	https://engineering.purdue.edu/IISL/
Purdue University	Dr. Mohammad R. Jahanshahi	https://web.ics.purdue.edu/~jahansha/
University of Michigan	Dr. Jerome P. Lynch	http://www-personal.umich.edu/~jerlynch/
Los Alamos National Lab	Dr. Charles R. Farrar	https://www.lanl.gov/projects/national-security-education-center/engineering/about-us/index.php
Rutgers University	Dr. Nenad Gucunski	https://cee.rutgers.edu/fac/nenad-gucunski
University of California, San Diego	Dr. Michael Todd	https://shm.ucsd.edu/
University of California, Los Angeles	Dr. Sriram Narasimhan	https://sri-lab.seas.ucla.edu
University of Nebraska-Lincoln	Dr. Jinying Zhu	https://nuengr.unl.edu/faculty/jzhu/

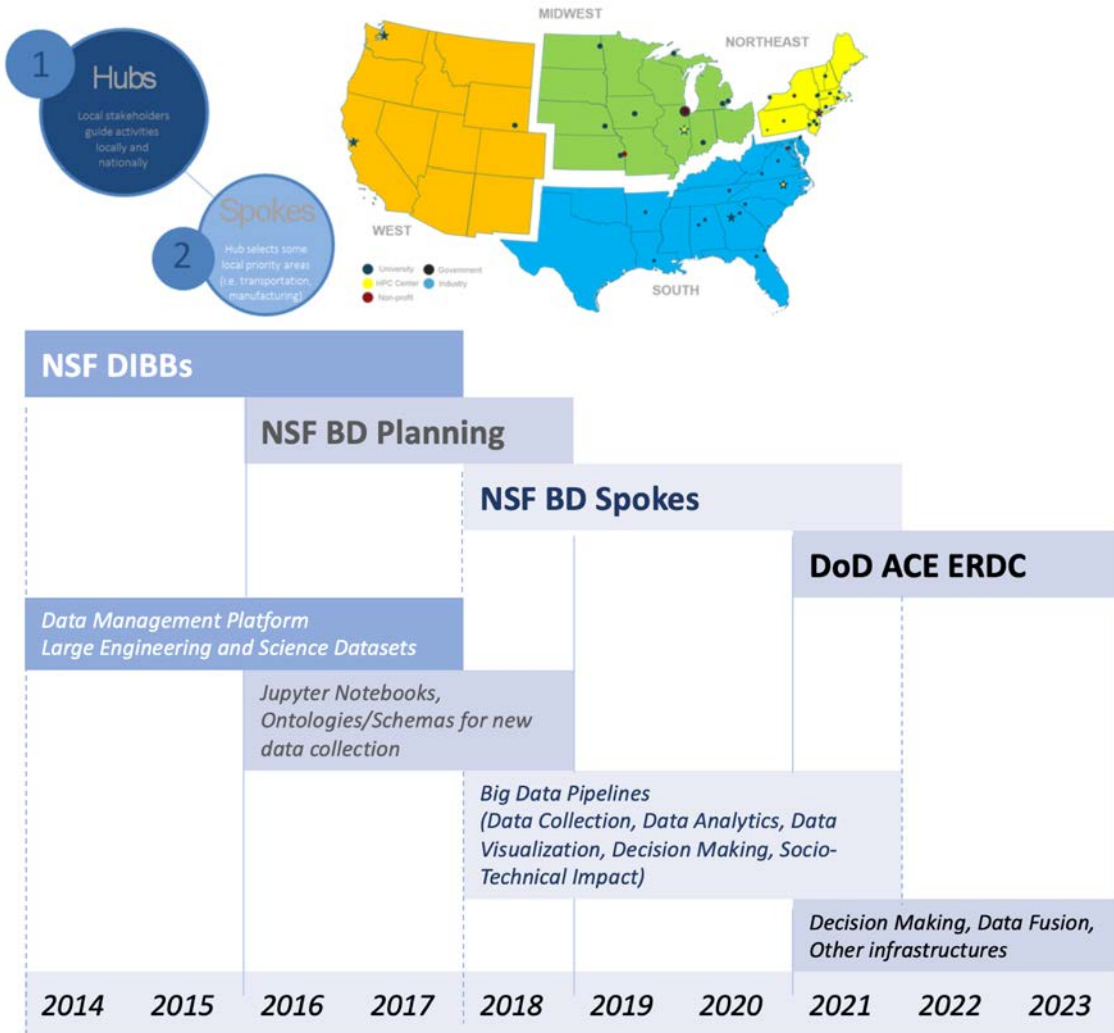
3. Monitoring Research Efforts in US

Active Structural Health Monitoring Research Groups in US and Canada (Asian Researchers)

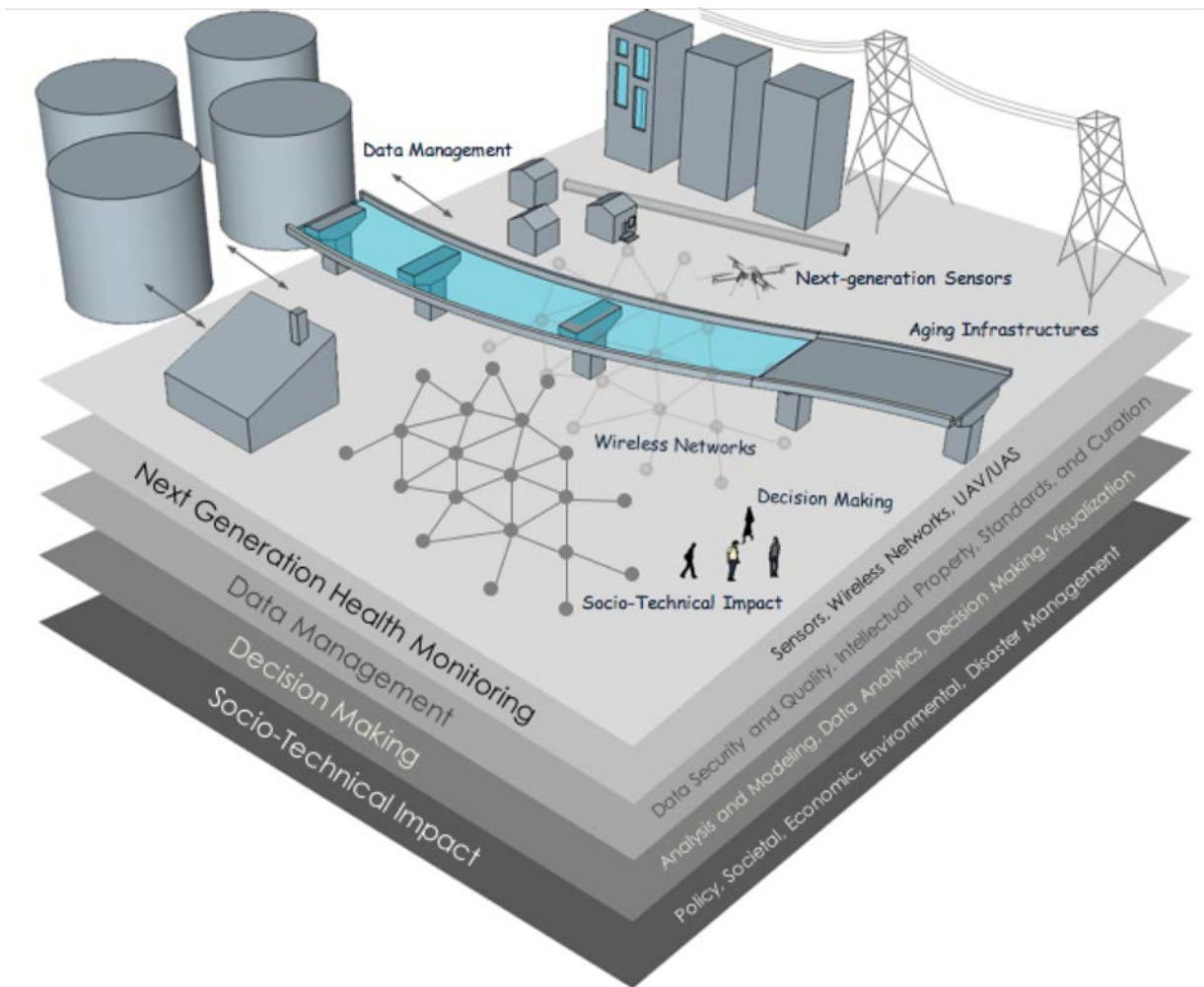
Institution	Project Investigator	URL
University of Central Florida	Dr. Hae-Bum Yun	https://www.cece.ucf.edu/hae-bum-yun/
Stanford University	Dr. Hae Young Noh	https://cee.stanford.edu/person/haeyoung-noh
University of Kansas	Dr. Jian Li	http://www.people.ku.edu/~j407l652/
University of Arizona	Dr. Hongki Jo	https://smartstructure.weebly.com
University of Connecticut	Dr. Shinae Jang	https://smart.engr.uconn.edu
Missouri University of Science and Technology	Dr. Genda Chen	http://web.mst.edu/~gchen/
University of Nebraska-Lincoln	Dr. Chungwook Sim	https://engineering.unl.edu/cee/faculty/chungwook-sim/
University of Manitoba	Dr. Young-jin Cha	https://www.youngjinch.com
University of Alabama	Dr. Wei Song	https://eng.ua.edu/eng-directory/dr-wei-song/
University of Waterloo	Dr. Chul Min Yeum	https://cviss.net

3. Monitoring Research Efforts in US

C.Sim Lab at UNL



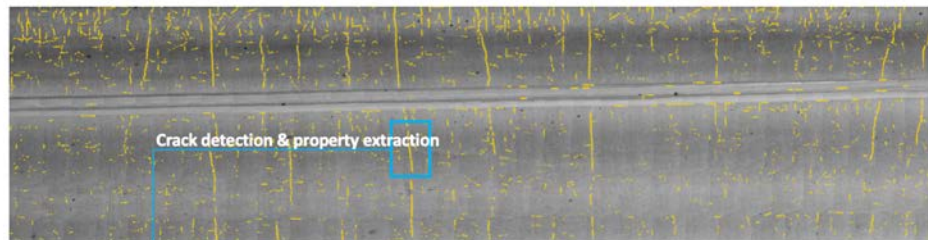
SMARTI Framework



3. Monitoring Research Efforts in US

C.Sim Lab at UNL

- Nebraska bridge dataset available at datacenterhub.org
- Bridge schemas for Big Data pipeline available at <http://bridgingbigdata.github.io/bridgehealthschema/schema/crack.schema.json>
- Created transverse crack mapping image pipeline, GPR pipeline, and load test data pipeline, examples available at datacenterhub.org (SMARTI datasets)
- Autonomous UAV control, on-board processing, corrosion on steel connection members pipeline
- Data fusion, and other infrastructures



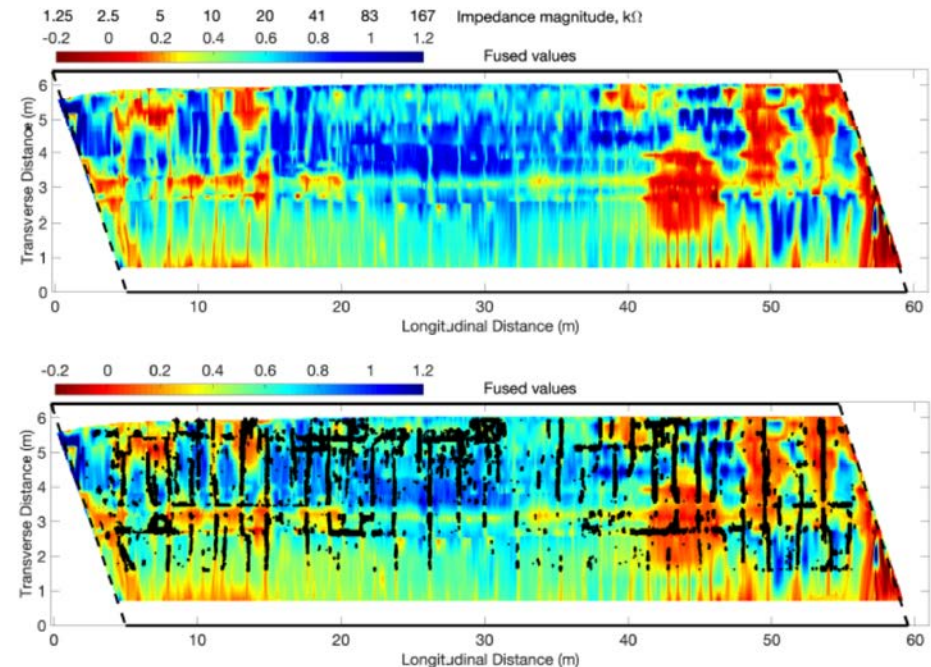
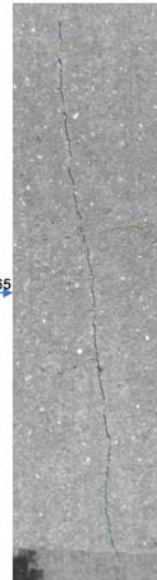
Output .yml file

```
crack_x84486_y10936_651: // ID
  "orientation": "T",
  "widthAverage": 0.06732,
  "widthMax": 0.12585,
  "length": 24.38,
  "geo": [842.26, 127.54],
  // bounding box (bridge
  coordinates)
  npts: 914 // # of detected crack
  pixels
```

Crack object
by crack schema v0.1



```
{
  "structureNumber": "83rd & Western Ave.",
  "deficiencyName": "Crack_x84486_y10936_651",
  "mediaURLs": [
    "CrackSegments_x84486_y10936.bmp"
  ],
  "onStructuralMember": "Deck",
  "orientation": "Transverse",
  "momentRegionType": "N.A.",
  "widthAverage": 0.067,
  "widthMax": 0.126,
  "pointWidth": [],
  "length": 24.38,
  "geo": {
    "coordinates": [
      41.270542,
      -96.040959
    ],
    "type": "Point"
  },
  "closestElement": { "N.A." },
  "label": "uri:50711f77bcf86cd799439011"
}
```



4. Needs and Challenges in Monitoring Efforts

DHS Report (2010)



Two issues are paramount

*What is the **present condition**?*

***How urgent is it** to expend significant public funds to effect its **repair, replacement,** and management **improvement**?*