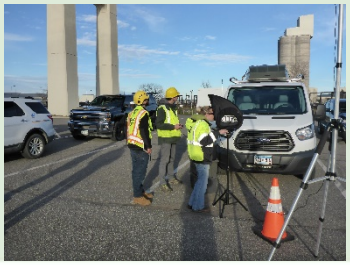


Utilizing Unmanned Aircraft Systems (UAS) for Bridge Inspections

Presented by:

Jennifer Zink, MnDOT

Barritt Lovelace, Collins Engineers

IBTTA 2016

Minnesota Department of Transportation




COLLINS ENGINEERS INC.

Phase I Project Background

- MnDOT Bridge Office identified Unmanned Aircraft Systems (UAS) as a potential useful technology
- Additional Research Dollars Available
- Project was scoped, funded and completed in two months

Minnesota Department of Transportation
COLLINS ENGINEERS INC.

Presentation Overview

- Project Scope
- FAA Rules
- Assessment of Current Practices
- Assessment of Phase I and Phase II UAS Technologies
- Project Planning
- Phase I Results
- Phase II Study
- Phase III
- Conclusions and Recommendations
- Public Response

Demonstration Project Scope

- Evaluate UAS safety and effectiveness as it applies to bridge inspection.
- Utilize UAS technology in the inspection of four bridges at various locations throughout Minnesota.
- Investigate UAS effectiveness in improving inspections and reducing inspection costs.
- UAS technologies were investigated to evaluate their capabilities as they relate to bridge inspection.
- Research report written for the MnDOT Research Services Office.

Flight Safety Restrictions

Current FAA Rules

- Licensed pilot is required to operate the UAS.
- UAS must be operated within line of sight.
- UAS must not be operated within 5 miles of an airport unless prior authorization from the airport operator ***and*** the airport air traffic control tower is received
- Cannot fly within 500 ft. of non-participants.
- Cannot launch or land within National Parks or National Wild and Scenic Rivers

Above and Beyond

- Notice to involved parties of operation
- Safety requirements

Minnesota Department of Transportation COLLINS ENGINEERS INC.

Assessment of Current Practices

Access Methods

- Aerial Work Platforms (AWP's)
- Rope Access and Structure Climbing
- Ladders

NBIS and MnDOT Requirements

- Hands On Inspection
- Non Hands on Inspection
- Measurements/Testing

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Assessment of UAS Technology

- Phase I Technology
  - Not capable of looking up
  - Unable to fly without GPS
  - Photo, Video and Thermal Imaging
- Phase II Technology
  - Inspection-specific UAS
  - Object Sensing
  - Capable of looking up
  - Fly without GPS, under bridge decks
  - Photo, Video and Thermal Imaging

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Project Planning

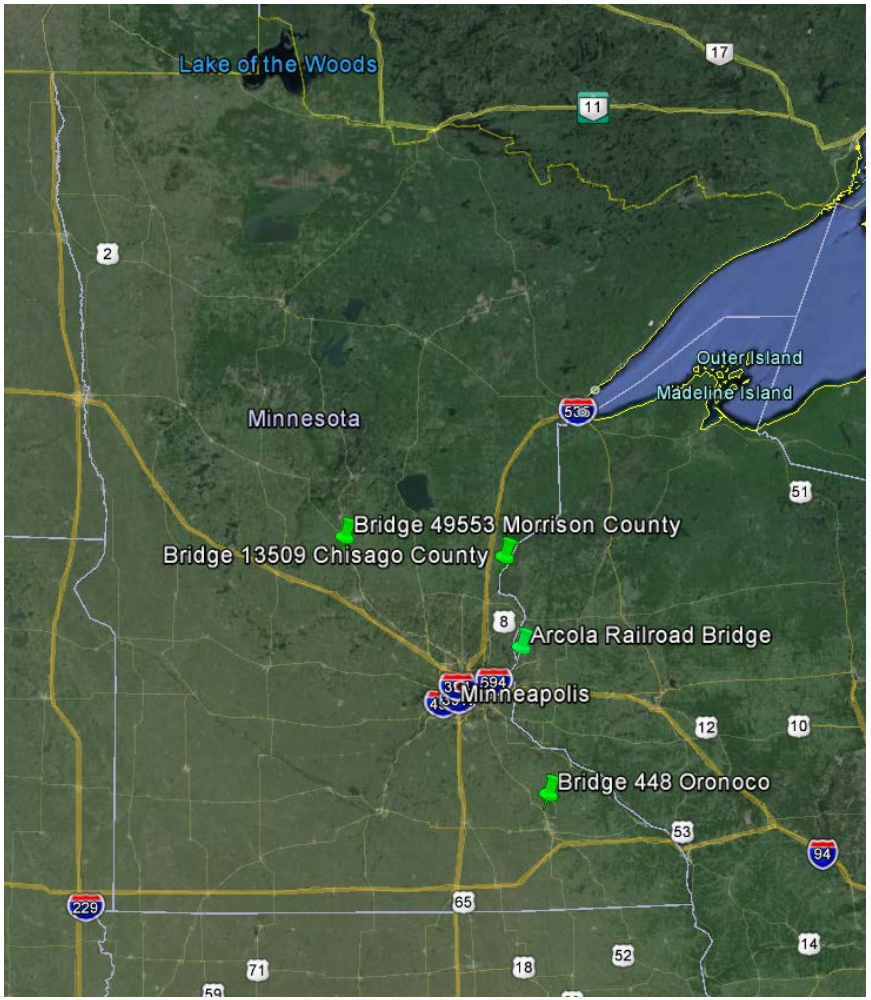
Approvals

- Governors Office
- FAA
  - 333 Exemption
  - Certificate of Authorization
- MnDOT Aeronautics
- National Park Service
- CN Railway
- Bridge Owners Coordination

Project Planning

Bridge Selection Criteria

- Rural vs. Urban
- Variety of Bridge Sizes
- Variety of Bridge Types
- Bridge Location
- Bridge Owner Cooperation
- Limit Public Contact



Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Bridge 49553 –Morrison County Pedestrian Bridge

- Large Steel Truss
- Difficult to access with UBIV
- Great detail in images
- Pack rust visible
- Concrete deterioration visible

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Table 5-3 Bridge 49553 Inspection Element Table

Bridge Element	Condition State	Previous Inspection Note	Discernable from UAV Video/Photo/IR Image
31 Timber Deck	8450 FT^2 CS 2	Constructed 13' wide x 4" thick x 650' treated timber deck and replaced 33 RR ties. Also placed 2" treated timber wear course.	Yes
407 Bituminous Approach	2 EA CS 1	Paved 2" bituminous in November, 2006. 8/28/13 - West approach failure repaired by MCHD. Good condition. Erosion on East approach repaired w/ quarry run riprap.	Yes
334 Metal Rail Coated	1299 FT CS 1	Placed 1,300' of coated chain link fence in November, 2006. 8/27/12 - Missing (1) end cap on East end.	Yes
117 Timber Stringer	3251 FT CS 1	Constructed 5- 4"x 8" treated timber stringers.	Yes, partially
131 Painted Stl Deck Truss	351 FT CS 2 299 FT CS 2	10/4/04 - All steel corroding & in need of rehab.	Yes
311 Expansion Bearing	1 EA CS 1 8 EA CS 2 1 EA CS 3	10/11/05 - Bearings show movement is possible. Significant corrosion is present, but bearings appear functional. 8/27/12 - Extensive crack in lower portion of bearing on South bearing on East abutment. 8/28/13 - Changed quantity to	Yes

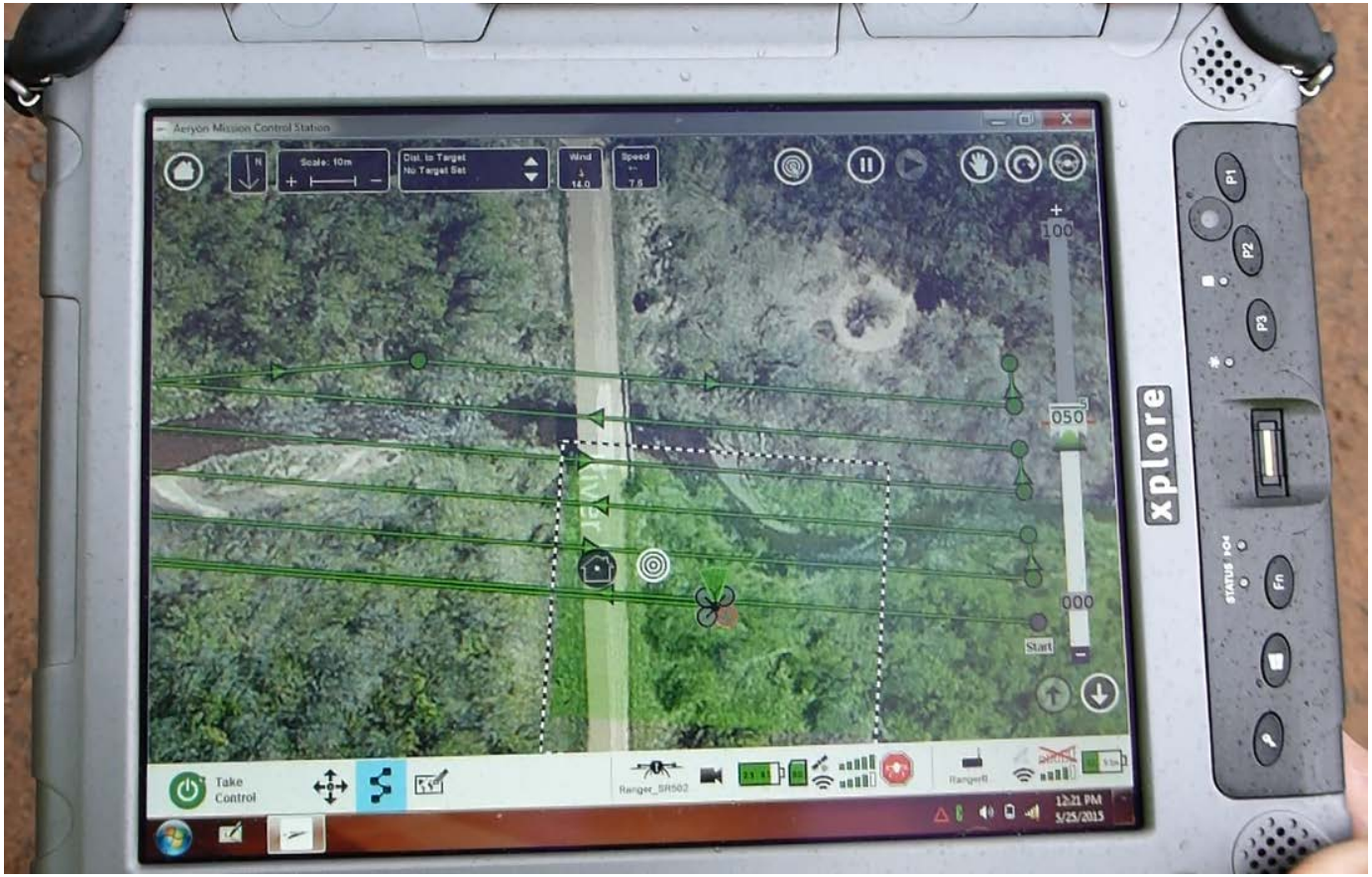
Bridge Element Comparison

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Bridge 49553 –Morrison County Orthographic Mapping



Bridge Inspection Methods and Results

Bridge 49553 –Morrison County Orthographic Mapping

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Arcola Railroad Bridge

- Large Complex Bridge
- Normally inspected using rope access
- National Park Service Permission
- Difficult to access

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Arcola Railroad Bridge – Image Detail

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Arcola Railroad Bridge – Image Detail

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Arcola Railroad Bridge – Image Detail

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

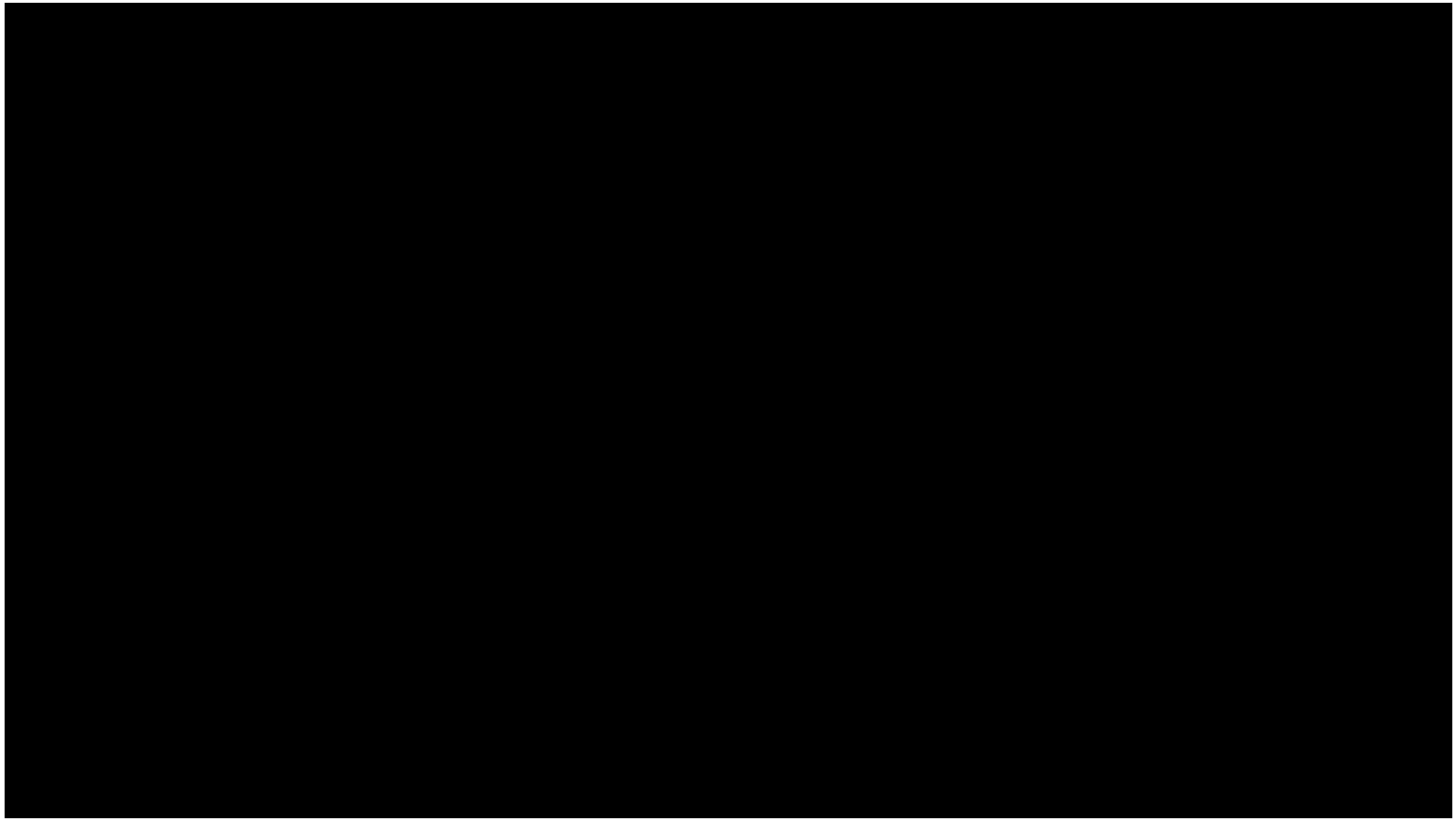
Arcola Railroad Bridge – Image Detail

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Bridge Inspection Methods and Results

Arcola Railroad Bridge



Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase II Study

- Cost comparison with UBIVs, traffic control
- Explore inspection specific technology including the Sensfly eXom
- Compile a best practices document
- Incorporate into an actual inspection
- Use UAS in the planning of an inspection
- Use a secondary display for bridge inspector
- Deck surveys with zoom camera
- Culvert and Box Girder Inspection
- IR Deck Delamination Assessment at Dawn
- Paint Assessment
- Data on how many hours UAS vs. other methods

Phase II Study

Blatnik Bridge Inspection

- Largest Bridge in Minnesota
- Crosses Duluth Harbor adjacent to Lake Superior
- Challenging wind and weather

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase II Study

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase II Study

Nielsville Bridge 5767

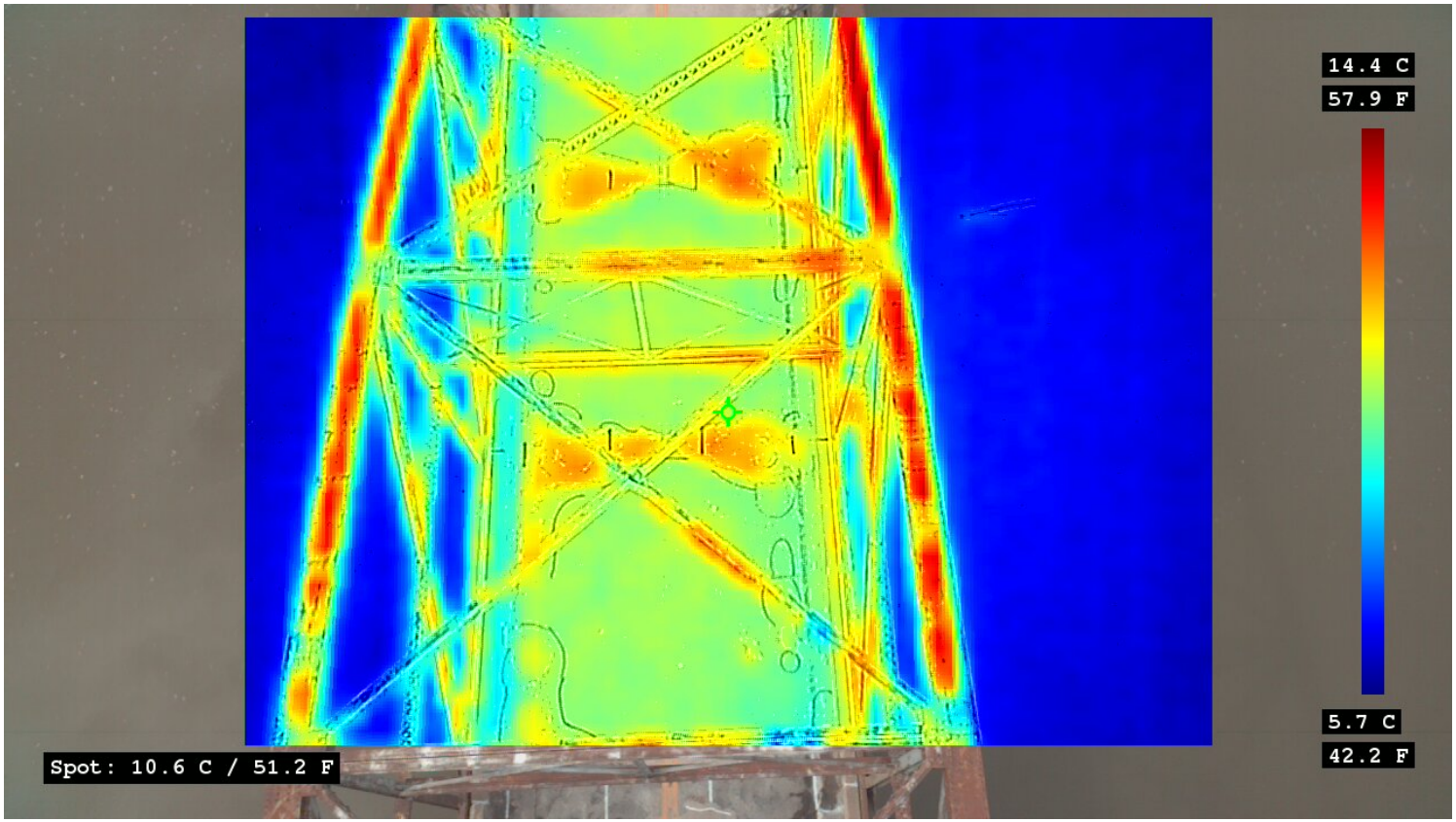
- Infrared Imaging
- Thermal Camera results were similar to high end Flir cameras
- Drone has the ability to map chain drag markings for quantities in CAD

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase II Study

Nielsville Bridge 5767

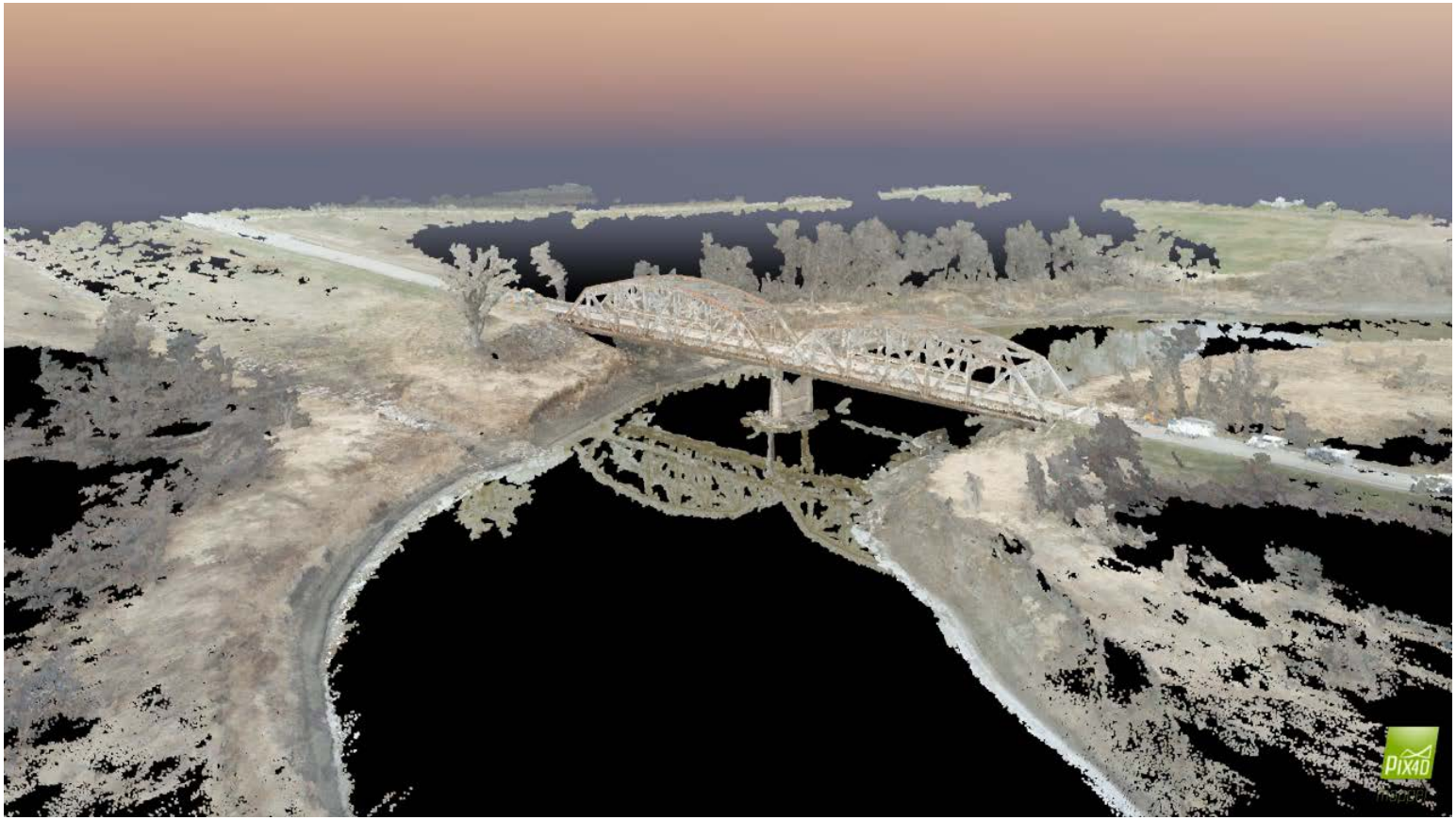


Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase II Study

Nielsville Bridge 5767 3D Point Cloud



Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase III – Project Goals

- Statewide UAS Inspection Contract – based on the MnDOT Bridge Access Inspection Policy list
- Overall Cost Effectiveness – at a statewide level for both District and local agency bridges
- Inspection Quality and Safety Improvements – close-up, 3D, and thermal imagery
- Identification of Sustainable Future Funding

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Phase III – Schedule & Cost

- **Task I** – Finalize Bridge Work Plans/Approvals
  - 9 months beginning **July 2016**
- **Task II** – Field Work and Evaluation
  - 9 months – **April to December 2017**
- **Task III** – Documentation/Final Study Report
  - 6 months – **Ending June 2018**
- **COST** - $100,000
  - Task I - $30,000
  - Task II - $50,000
  - Task III - $20,000

Minnesota Department of Transportation
COLLINS ENGINEERS INC.

Conclusions

- UAS can be used in the field during bridge inspections safely.
- Image quality allows for the identification of defects.
- Tactile functions cannot be replicated using UAS.
- UASs can be cost effective.
- UASs can provide a very efficient way to collect infrared images
- Safety risks could be minimized with the use of UASs.
- UASs can be utilized to determine channel conditions.
- UASs can provide important pre-inspection information.
- “Off the shelf” UAS’s have limited inspection capability.
- Current FAA rules are onerous.

Public Response

- Almost 100 news articles and stories
- Overwhelmingly positive
- Safety, reduced closures and cost efficiency valued by public

Minnesota Department of Transportation

COLLINS ENGINEERS INC.

Questions/Contact Information

Jennifer L. Zink, P.E.
Bridge Inspection Engineer
MnDOT Bridge Office
3485 Hadley Avenue North
Oakdale, MN 55128-3307
Phone: 651-366-4573
jennifer.zink@state.mn.us

Barritt Lovelace, P.E.
1599 Selby Avenue, Ste. 206
St. Paul, MN 55104
Phone: 651.646.8502
blovelace@collinsengr.com
www.collinsengr.com

Minnesota Department of Transportation
COLLINS ENGINEERS INC.

Drones – More than Just an Irritating Buzz!

MODERATOR

Trey Baker, Texas A&M Transportation Institutue

PANEL

Barritt Lovelace, P.E., Collins Engineers, Inc.

Jennifer Zink, P.E., Minnesota Department of Transportation

Ian Ray and Jon Budreski, Media Wing LLC