1

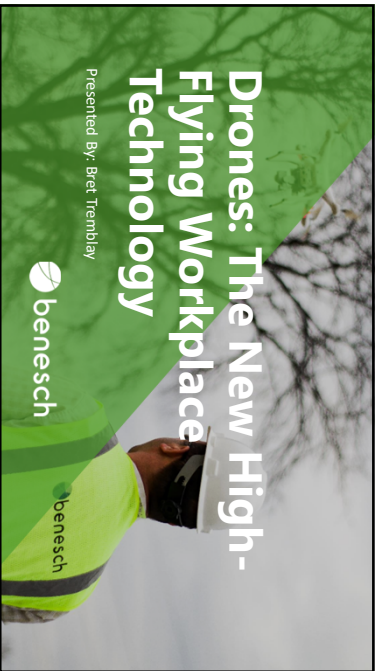# Drones: The New High-Flying Workplace Technology

Presented By: Bret Tremblay

benesch

2

Introduction

Bret Tremblay
Technical Manager

- 18+ Years Experience
- Land Development
- Aviation
- Civil 3D Tech Group Lead
- Drone Tech Group Lead
- 3D Modeling
- Augmented Reality Tools
- Implementation of A.I./M.L.

Benesch is a nationally recognized transportation, planning and design consulting firm with 1000+ professionals nationwide.

1,000+ EMPLOYEES | 46 LOCATIONS | 20 STATES | 1 TEAM

ENR #101

VALUE FOCUSED.
COMMUNITY MINDED.
QUALITY DRIVEN.

benesch

3

Agenda

- Benesch Drones
- Airport Surveys
- Thermal Inspections
- Disaster Response
- Bridge Scan / Digital Twin
- Augmented Reality
- Artificial Intelligence

benesch

4

Benesch Drones

5

Benesch Drones

Autel Evo II Pro

DJI Inspire 1

DJI Phantom Series

Skydio

DJI Mavic Series

DJI Matrice

Intel Falcon 8+
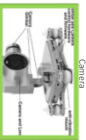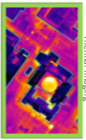
As of 2023:
26 Drones
30 Drone Pilots

Payload / Equipment:

Camera

Thermal Imaging

LiDAR

6

How Do Drones Benefit Benesch?

Possibilities are Endless!

- Enhanced Surveys & Inspections
- Create 3D Models
- Safe Access
- Fast & Cost Effective
- High Quality

benesch

Airport Surveys

What Are Airport Obstructions?

- Any object, natural or manufactured, that penetrates an imaginary surface that surrounds an airport, and which creates a potential hazard to airport operations.

Most Common Obstructions

- Trees
- Power Poles
- Towers
- Buildings
- Streets

benesch
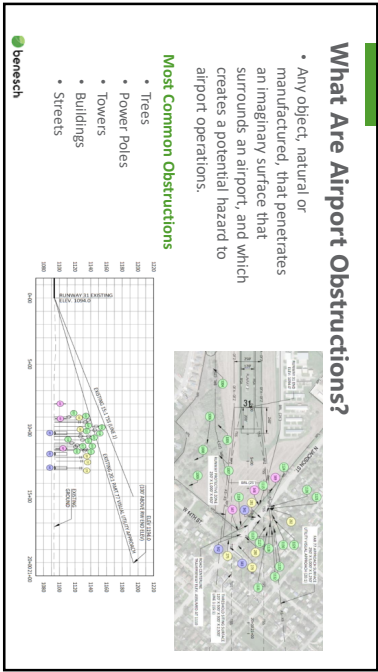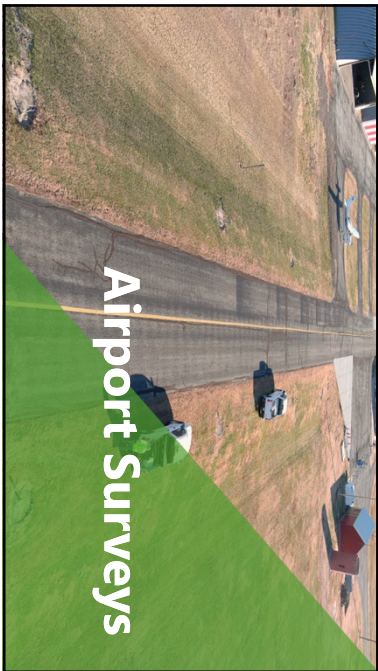
Benefits of Drones at Airports

- **Comprehensive/Full Coverage:** Able to get all obstacles that may exist, even if they weren't pre-identified before field investigation.
- **Clash Detection:** Obstruction Models & Mesh That Can Be Compared for Clash Detection w/ Design Models
- **Accurate:** Internal Studies have experienced accuracy w/ Drones ~ 0.20'
- **Speed:** Typical Data Collection in Hours, not Days
- **Data Set:** Collected information can be used for other projects.
- **Time Stamp:** Compare to Future Collections.

- *Another Tool In the Toolbox.*

benesch

Case Study

Identified Area to Investigate Vertical Obstructions ~240 Acres

benesch

Case Study

Dots are Photo Locations ...Precise...Planned...Full Coverage

4 Flight Areas Covering ~ 240 Acres

benesch

Case Study

13

Photo

3D Model

Case Study

14

Photo

3D Model
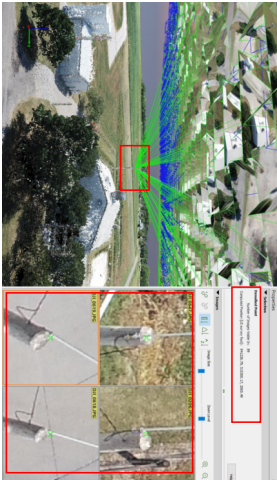
Case Study

15

Case Study

16

Case Study

17

Tree Canopy

Full Coverage

Full Coverage

18

Thermal Inspections

How Does It Work

Day / Sun

Night / Moon

Thermal Energy · Deck Delamination · Soffit Delamination · Reinforcing Bars

The drone infrared sensors detect the electromagnetic radiation and heat fluctuations that indicate anomalies in form of stress or damage.

Thermal Benefits

Benefits

Speed – Able to scan a bridge with minimal lane closures or traffic control

Safety – The bridge inspection takes place away from the bridge in a safe location, never needing to enter active traffic.

Accuracy – Sensitivity to even slight temperature variations.

Data Conversion – Software able to digitize areas making for quicker deliverables.

Case Study Results

Time = 35% less
Cost = 36% less
Deviation = 0.34%

Thermal Applications in Benesch

Current Thermal Use

- Bridge Deck Delamination
- Roof Inspections

Future Testing

- Bridge Steel Fractures & Stress
- Levee & Dam Leaks
- Utilities (i.e. Gas/Water Leaks)
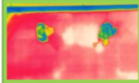- Environmental (i.e. Wetland Delineations)

TEMP

TIME

PRIME TIME

LEGEND
Warming
Cooling
Deck Normal Temp

Thermal Drone – Why?

CHAIN DRAGGING

PROS
- Simple
- Low Investment
- Tried & True

CONS
- Subject to Inspectors Hearing
- QC/QA Challenge
- Manual Reporting
- Time Consuming

THERMAL DRONE

PROS
- Digital Readings
- Full Electronic Record of Field Inspection
- Electronic Reporting
- Fast & Higher ROI

Thermal Setup / Specs

Drone:
- DJI Inspire 1
- DJI Matrice

Imaging Unit(s):
- 13mm DJI Zenmuse XT v2.0 336 @ 30 Hz
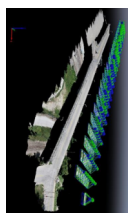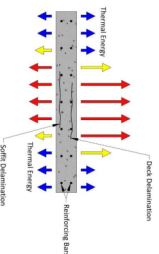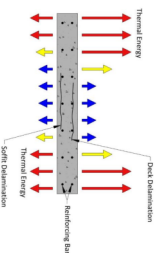- 13mm DJI Zenmuse XT v2.0 640 @ 30 Hz

---

Process START to FINISH

- STEP 1: Check FFA Authorization
- STEP 2: Flight Planning
- STEP 3: Flight Operation
- STEP 4: Process Data
- STEP 5: Analyze Data

25

26

STEP 1: Check FFA Authorization

27

STEP 2: Flight Planning

PRE-FLIGHT PLANNING
- Airmap
- Processes FAA Airspace
- PIX 4D CAPTURE
- Pre-Flight Programming

PROCESSING & ANALYSIS
- FLIR Tools
- Analysis of Individual Photos
- Pix4D Mapper & Context Capture
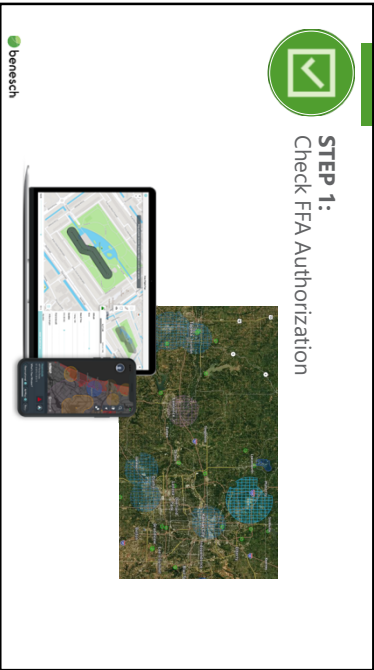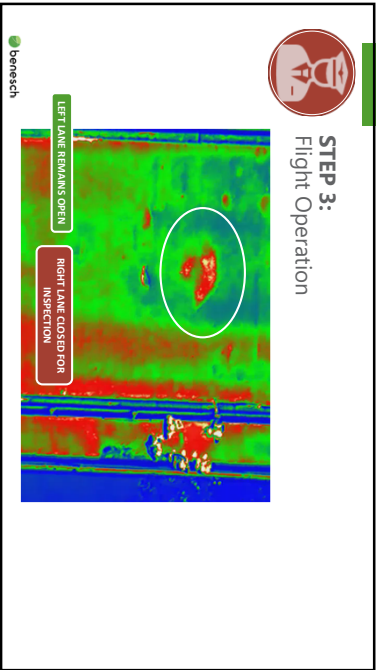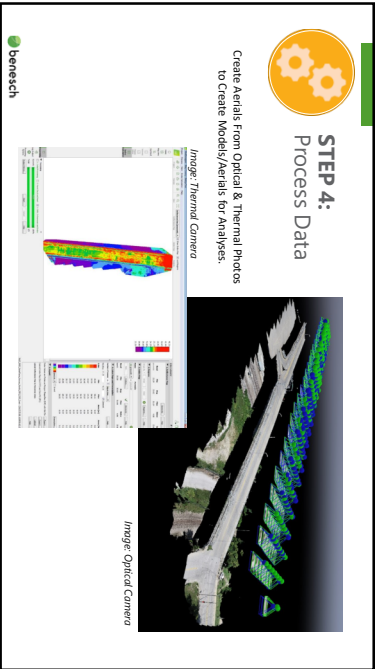- Orthomosaic Aerial - Stitches Together Thermal Images by Photogrammetry
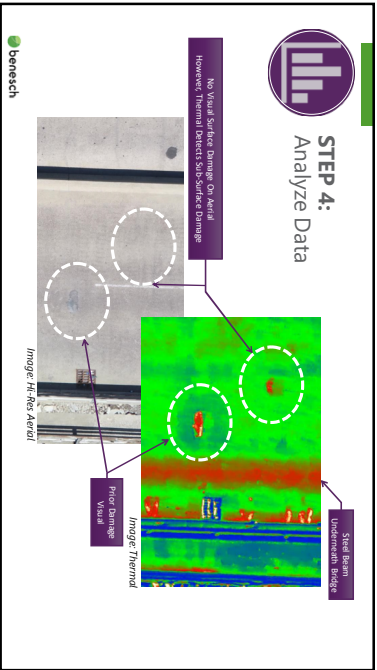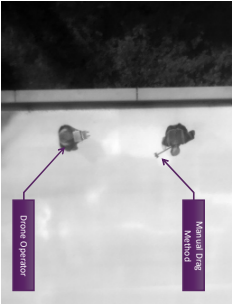
---

28

STEP 3: Flight Operation

LEFT LANE REMAINS OPEN

RIGHT LANE CLOSED FOR INSPECTION

29

STEP 4: Process Data

Create Aerials From Optical & Thermal Photos to Create Models/Aerials for Analyses.

Image: Thermal Camera

Image: Optical Camera

30

STEP 4: Analyze Data

No Visual Surface Damage On Aerial However, Thermal Detects Sub Surface Damage

Image: Hi-Res Aerial

Image: Thermal

Prior Damage Visual

Steel Beam Underneath Bridge

STEP 4:
Analyze Data

31

Raw Photo

Drone Operator

Manual Drag Method

STEP 4:
Analyze Data

32

°F
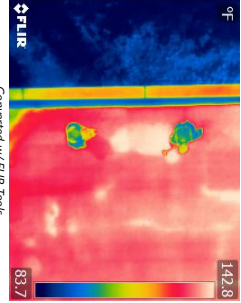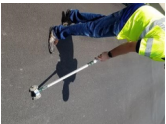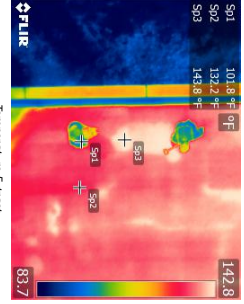
Converted w/ FLIR Tools

FLIR

83.7   142.8

STEP 4:
Analyze Data

33

FLIR

Sp1   101.8 °F
Sp2   133.2 °F
Sp3   148.8 °F

°F

Temperature Extract

83.7   142.8

STEP 4:
Analyze Data

34

FLIR

Sp1   135.8 °F
Sp2   144.2 °F

°F

Damage Isolation

83.7   142.8
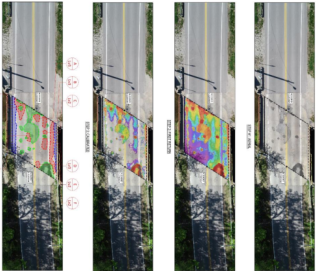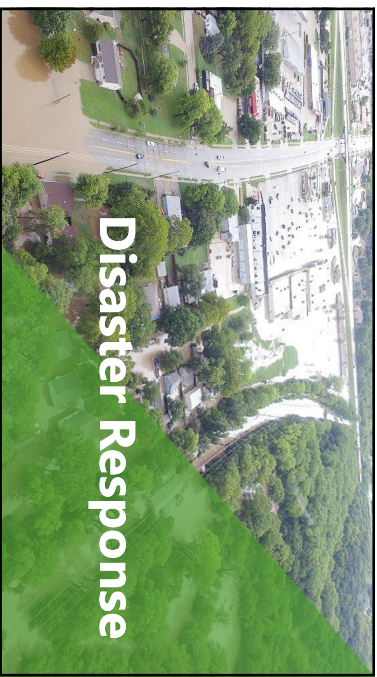
STEP 4:
Analyze Data

35

Disaster Response

36

---

37 — Benesch Service: Disaster Response

Natural Disaster / Emergency Management

Damage Assessment
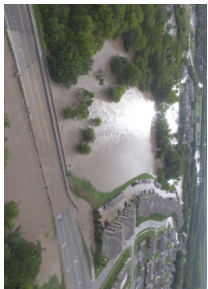
38 — Benesch Service: Disaster Response

Bridge washed away from its foundation

39 — Benesch Service: Disaster Response

Actual drone photograph of flooded highway and bridge.
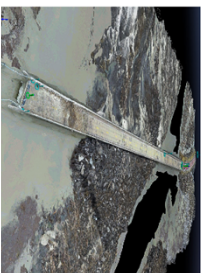
3D model generated from drone flight.

40 — Twin Modeling

41 — Digital Twin: Bridge & Inspection

42 — Digital Twin: Bridge & Inspection

Digital Twin Screenshot

Camera Photo

43

Twin Inspection – Live Demo

44

Augmented Reality

45

Digital Twin Inspections Using Augmented Reality

- Safety
- Efficiency
- Pre-planning for inspection
  - Traffic control
  - Snooper or man lift access
  - Location of key defects prior to field work
- Minimize/eliminate field time for preservation inspection

46

47

Augmented Reality – Visualize & Collect

48

49

A.I. // M.L.

50

Drones & Artificial Intelligence (A.I / M.L)

Manual Crack Measurements

Automated Detection

51

Drones & Artificial Intelligence (A.I / M.L)

Crack Linework

Bridge Deck Crack Detection

52

Drones & Artificial Intelligence (A.I / M.L)

Concrete Spalling

53

Drones & Artificial Intelligence (A.I / M.L)

Original

Rust A.I./M.L. Detector

54

THANK YOU

Bret Tremblay
btremblay@benesch.com

benesch