DRONES: Raising the Bar for Facility Management and Maintenance

IBTTA
TOLLING. MOVING SMARTER.

RENÉ MOSER

EU & International Affairs Manager

ASFINAG

Presenters with us today…

MIKE DAVIDSON
Pennsylvania Turnpike Commission
Chair of IBTTA Working Group on Drones
Harrisburg, Pennsylvania

MANUEL CREW
Maryland Transportation Authority Police
Baltimore, Maryland

THOMAS STEINBRUCKER
ASFINAG
Vienna, Austria

LARS FUHR PEDERSEN
Sund & Baelt
Copenhagen, Denmark

Today's Logistics

- All participants on today's webinar are on mute.
- This webinar will last 75 minutes. We will post the slides and audio portion of this webinar on the IBTTA website within two days.
- Questions will be addressed after we have finished all presentations.
- If your question is for a specific panelist or you wish all panelists to address the question, please note that in your question.
- Please take the time to answer our brief survey at the close of the webinar.

MALIKA SEDDI

International Vice-President, IBTTA

Chair, IBTTA International Committee

Director of International Affairs and Customer Services, ASFA

MIKE DAVIDSON

Pennsylvania Turnpike Commission

Chair of IBTTA Working Group on Drones

Harrisburg, Pennsylvania

Drones – Raising the Bar for Facility Management and Maintenance
October 1, 2019

IBTTA WEBINAR

General Drones Overview and of the IBTTA Working Group on Drones

Mike Davidson, P.E., PTOE

Senior Traffic Operations Project Manager

Pennsylvania Turnpike Commission

mdavidson@paturnpike.com

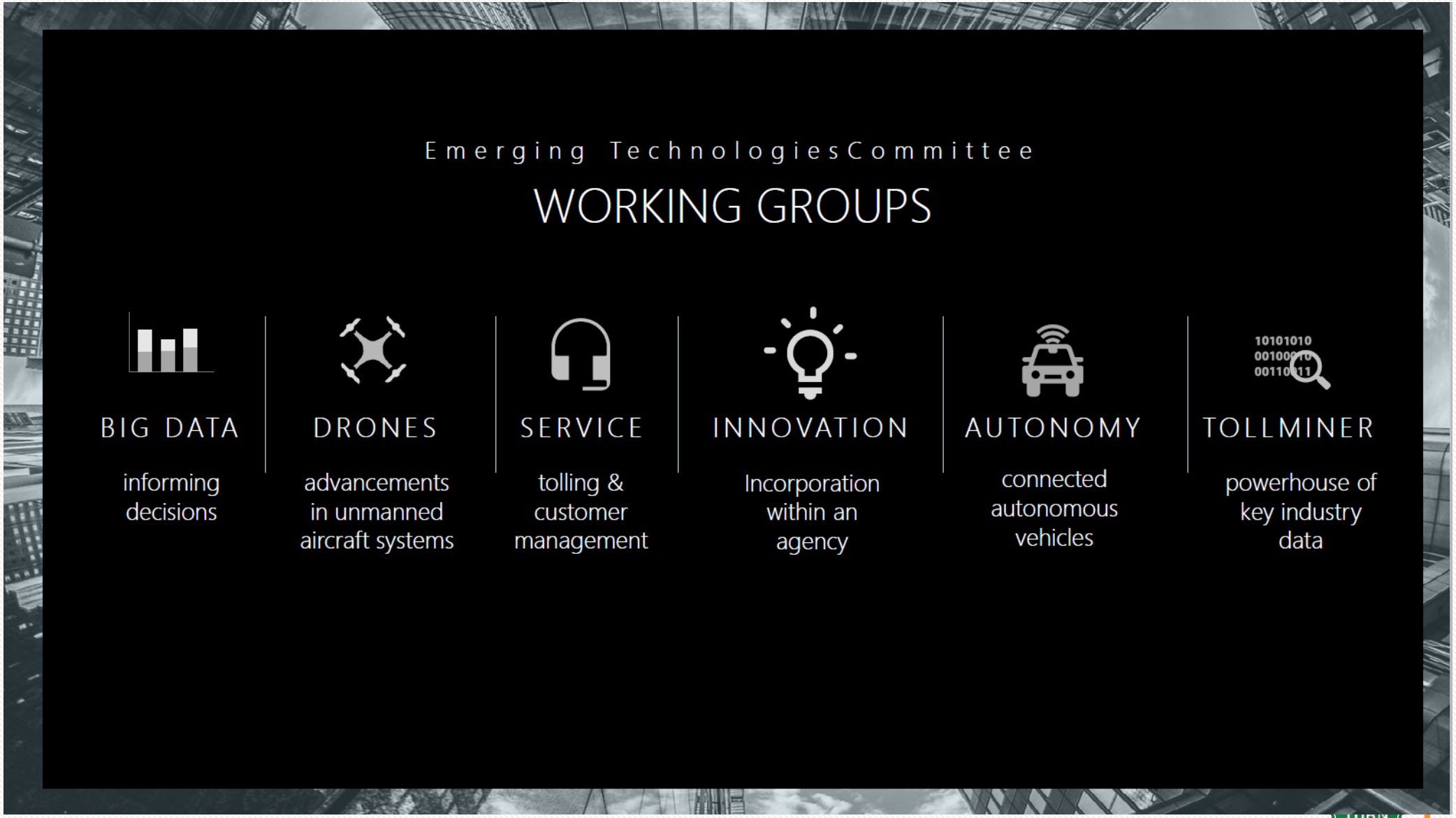
Overview of UAS/Drones

- Unmanned Aircraft Systems (UAS)
  - Three components:
    - Unmanned Aircraft/Unmanned Aerial Vehicle (UAV)
    - Controller
    - Communication system
- UAS are commonly known as “drones”
  - Aircraft controlled remotely
  - Can be autonomous (controlled by computer)
- Most common types
  - Multicopter
  - Fixed wing

Overview of UAS/Drones

- Drones are exploding in popularity due to their ability to enhance safety, save time, and reduce costs
- FAA predicts commercial market for drones to triple between 2019 and 2023
  - 835,000 commercial drones by 2023
- Within 20 years, the European drone sector is expected to directly employ more than 100,000 and have an economic impact exceeding €10 billion per year

Emerging Technologies Committee

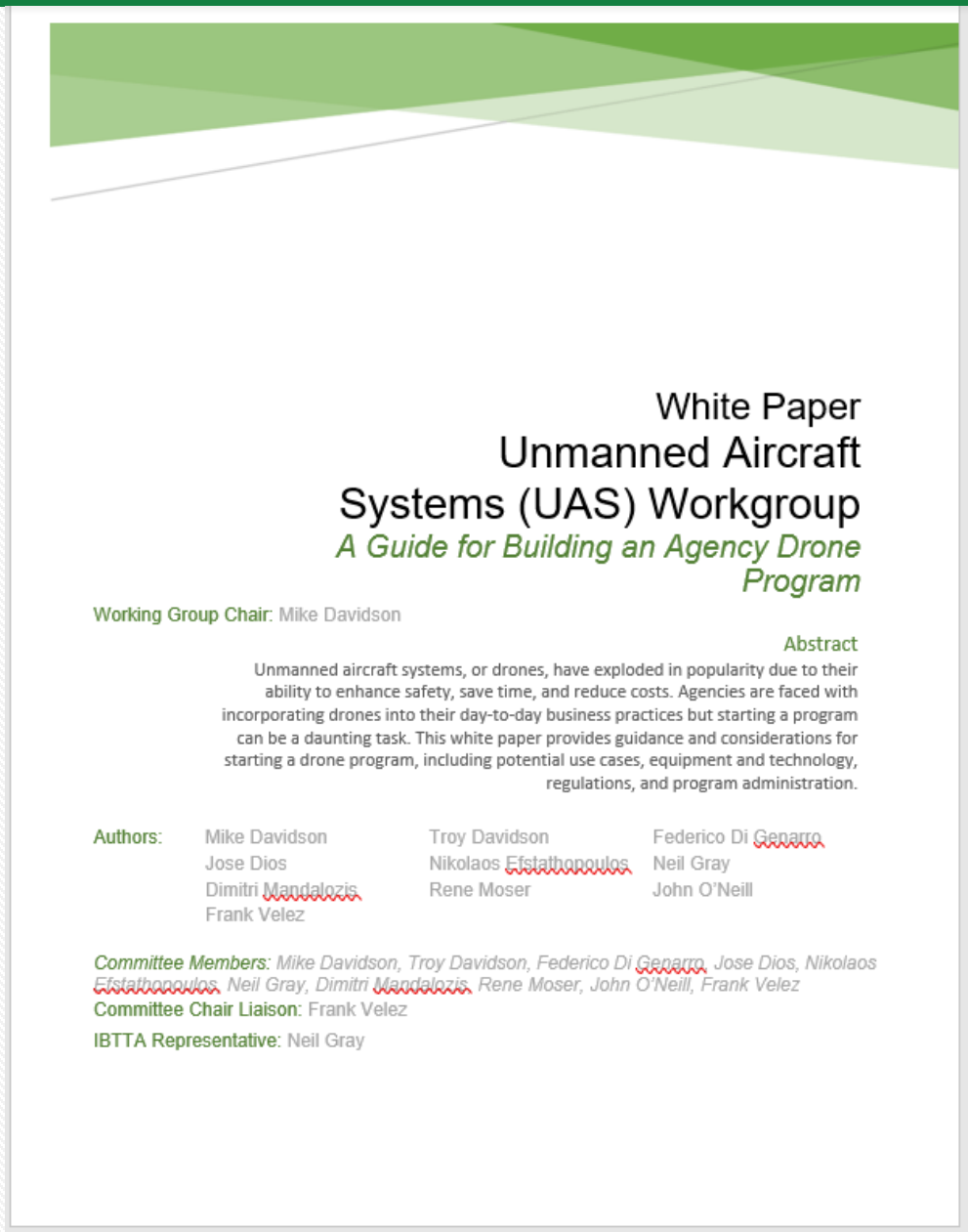


UAS Working Group

Committee Members	
Mike Davidson, PA Turnpike Commission	Troy Davidson, NTTA
Federico Di Genarro, AISCAT	Jose Dios, New Jersey Turnpike Authority
Nikolaos Efstathopoulos, IBI Group	Neil Gray, IBTTA
Dimitri Mandalozis, HELLASTRON	Rene Moser, ASFINAG
John O'Neill, Maryland Transportation Authority	Frank Velez, NTTA

UAS Working Group

- Introduction and Quick Guide
- Use Cases
- Equipment and Technology
- Pilot Certification Overview
- Regulations
- Program Administration
- Research and Development Projects
- Conclusion and Recommendations



White Paper

Unmanned Aircraft Systems (UAS) Workgroup

A Guide for Building an Agency Drone Program

Working Group Chair: Mike Davidson

Abstract

Unmanned aircraft systems, or drones, have exploded in popularity due to their ability to enhance safety, save time, and reduce costs. Agencies are faced with incorporating drones into their day-to-day business practices but starting a program can be a daunting task. This white paper provides guidance and considerations for starting a drone program, including potential use cases, equipment and technology, regulations, and program administration.

Authors: Mike Davidson, Troy Davidson, Federico Di Genarro, Jose Dios, Nikolaos Efstathopoulos, Neil Gray, Dimitri Mandalozis, Rene Moser, John O'Neill, Frank Velez

Committee Members: Mike Davidson, Troy Davidson, Federico Di Genarro, Jose Dios, Nikolaos Efstathopoulos, Neil Gray, Dimitri Mandalozis, Rene Moser, John O'Neill, Frank Velez

Committee Chair Liaison: Frank Velez

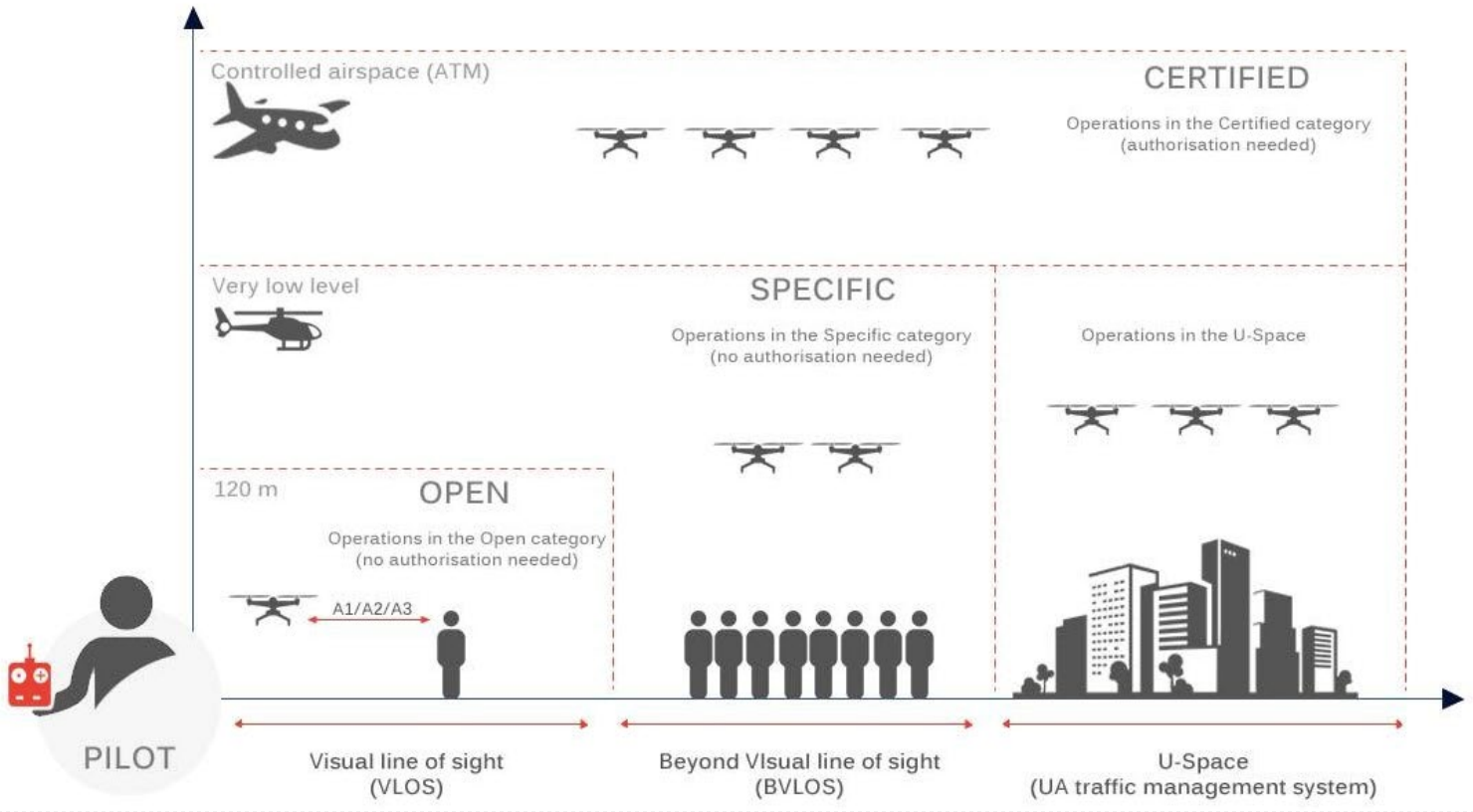
IBTTA Representative: Neil Gray

UAS Working Group

- Introduction and Quick Guide
  - Quick Guide provides some links for further reading
- Use Cases
  - Gives an overview how drones are being used at some agencies – asset inspections, traffic engineering studies, surveying, etc.
- Equipment and Technology
  - Discussion of different considerations when procuring UAS and cameras

UAS Working Group

- Pilot Certification Overview
  - Overview of knowledge areas for operating drones



Likelihood		Severity: No Safety Effect 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
No Probability Requirement	A	Low	Medium	High	High	High
Probable	B	Low	Medium	High	High	High
Remote	C	Low	Medium	Medium	High	High
Extremely Remote	D	Low	Low	Medium	Medium	High
Extremely Improbable	E	Low	Low	Low	Medium	High* / Medium

*Risk is high when there is a single-point or common cause failure

- Regulations
  - US Regulations
  - EU Regulations

UAS Working Group

- Program Administration
  - Staffing
  - Right of Way Infringement
  - Flight Planning
  - Insurance
- Research and Development Projects
  - Discussion of major projects in Europe and the U.S. to advance UAS technology, including drone traffic management
- Conclusions and Recommendations

UNMANNED AERIAL SYSTEMS @ ASFINAG

PROJECT „R2F - Ready to Fly“

Thomas Steinbrucker, BSc.

Asfinag - Asset Management

R2F-Ready to Fly
drone support in asset management

Project goal

- Establishing, analysing and evaluating the potential of **drones / UAS (Unmanned Aerial Systems)** in the field of asset management
- maximum SUPPORT AND ADDED VALUE for operative processes
- Becoming faster and more economical
- Risk minimisation thanks to better data quality and knowledge about objects
- Increasing occupational safety by avoiding the presence of staff in dangerous areas

Project duration

- December 2016 – August 2017 (8 months)

Potential applications which have been evaluated and established

Application Potential		Assessment
Bridge	Steel	B
	Ferroconcrete	A
	Prestressed Concrete	A
Tunnel	Air Supply and Exhaust Duct	C
	Air Supply and Exhaust Shaft	B
	Entrance	A
	Gallery	A
	Roof	A
Slope Stabilization	Hillside Movement	A
	Mudslide	A
	Hillside Slide	A
	Avalanche	A
	Protective Structures	A
	Rock Guard	A
Overhead Barrier	Ferroconcrete	A
	Prestressed Concrete	A
	Revegetation	A
Noise Protection Wall	Noise Protection Wall	B

Application Potential		Assessment
Roadway Frame Constructions	Direction Sign	B
	Overhead Direction Sign	B
	Toll Bridge	B
	Traffic Control System	B
ÖBB Tunnel	Ferroconcrete	B
Further Applications	Digitize Constructions	A
	Monitoring Terms	A
	Disaster Operations	A
	Field Documentation	A
	Topographical Survey	A

A= optimal area of application
B= limited and costly
C= application not recommended

Selected essential test applications 1/3

- **Arched bridge on the Pack Pass**
- **Pillar of the Europa Bridge**
- Focus: Photo documentation of the area which is difficult to access, data quality, repeatability, changes, evaluation, documentation,
- inside of the pillar: Lighting/quality/positioning

Mapping of cracks in a pillar of the Europa Bridge

Arched bridge on the Pack Pass: Zirknitzgraben Bridge

Detail of the arched bridge on the Pack Pass

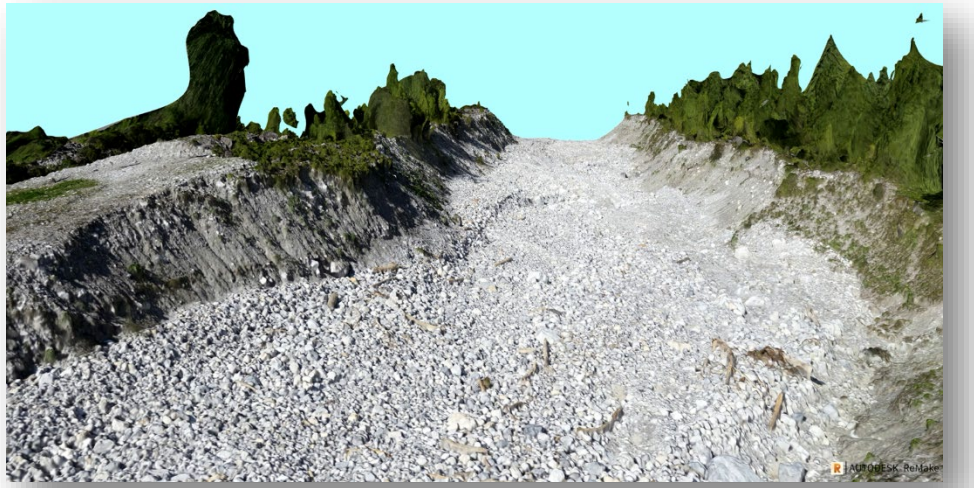
Selected essential test applications 2/3

- **Mudslide with rubble, A10 in Salzburg**

  Focus: measurement, data quality, analysis of change, repeatability, evaluation, documentation, integration into the inventory system

- **Rock face stabilisation, A10 in Salzburg**

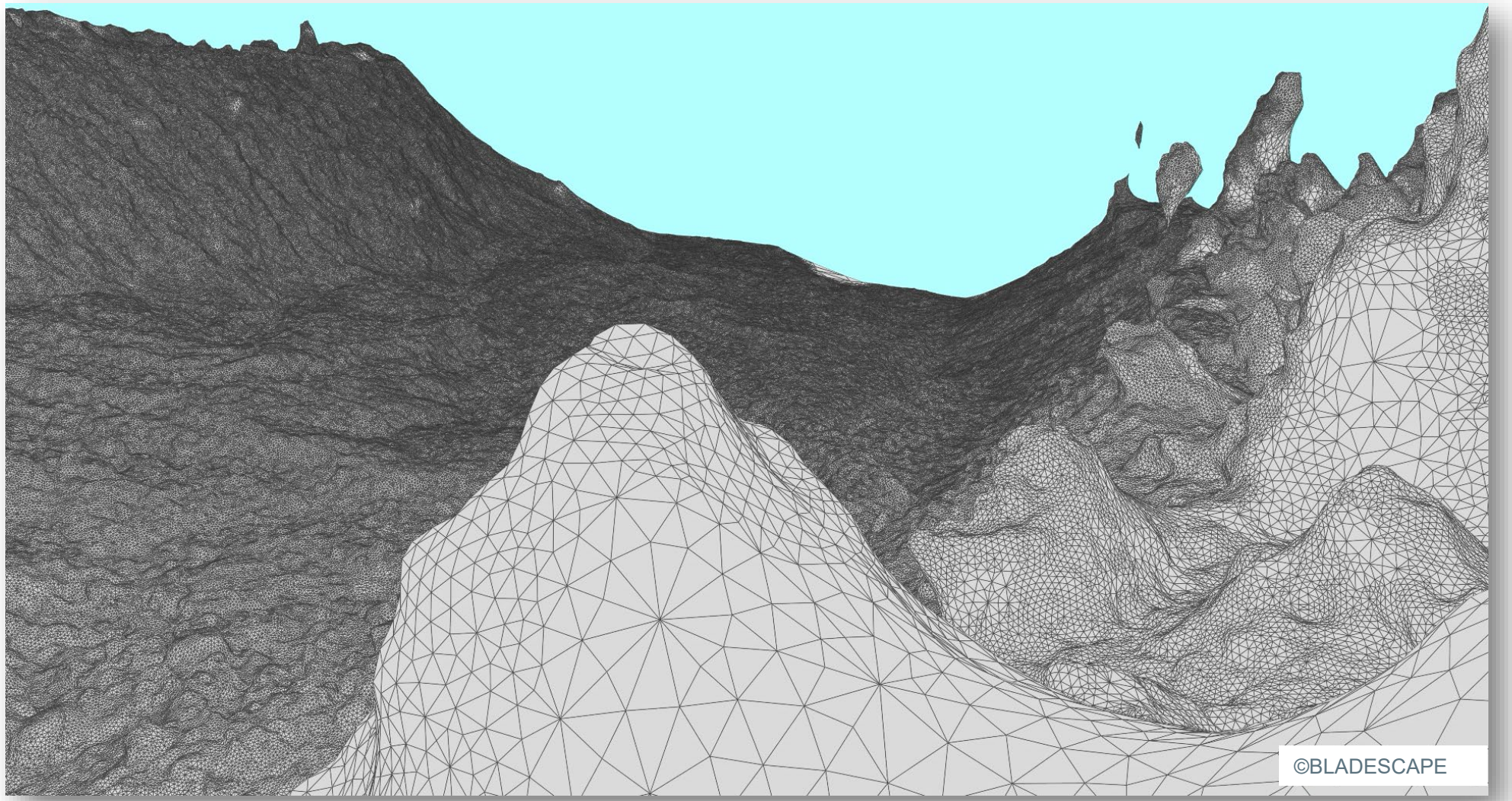
  Focus: photo documentation of the area which is difficult to access / Necessity of safety measures for the documentation work, data quality, repeatability, evaluation, documentation,
  integration into the existing IT system



3D visualization / model of the mudslide with rubble

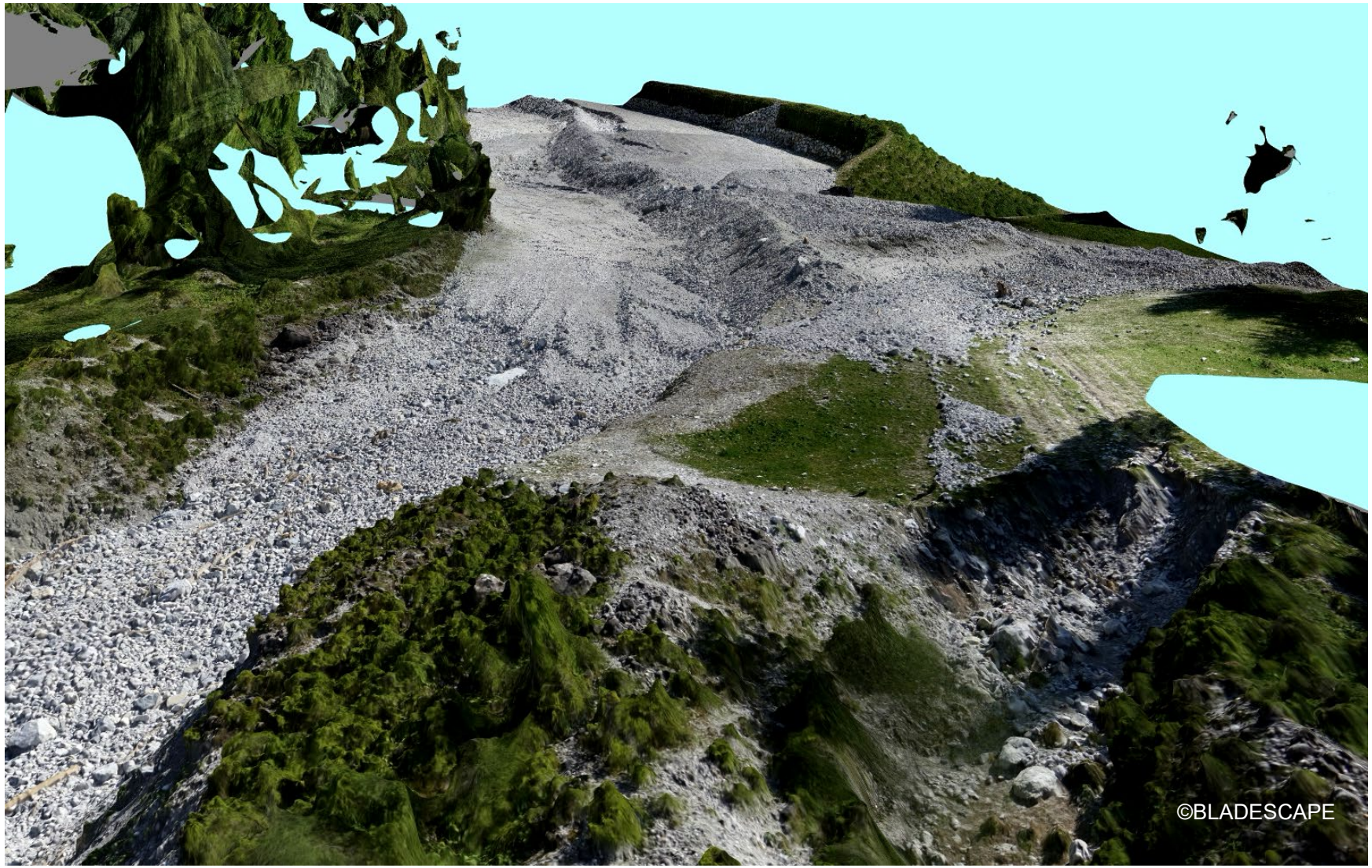
Schüttmure Salzburg

3D-Visualisierung - Berechnung Massenbilanz



Schüttmure Salzburg

3D-Visualisierung - Berechnung Massenbilanz



Selected essential test applications 3/3

➢ Enclosure A10 Flachau

Focus: data quality, repeatability, view from a bird's eye perspective evaluation, documentation, integration into the inventory system

Mapping of cracks in the surface of the terrain

➢ Vertical exhaust shaft in the Tauern Tunnel

Focus: preparation and solutions for flights and data recording in a shaft, data quality, repeatability, evaluation, documentation, integration into the inventory system

Test flight in the interior of the bridge pillar of the Europa Bridge

Advantages due to the use of UAVs

Extract from the final report

- **Maximum safety** due to **early detection** of anomalies and changes, also in parts of the building structure which are difficult to access
- **Opportunity for seamless surveying** and **documentation** and obtaining **valuable additional information** (overview thanks to the bird's eye perspective)
- **Exact repeatability** of the survey and analysis
- Improvement and completion of the quality of **inspections** and **documentation**
- **Decreasing the danger to staff** by reducing or avoiding their presence in dangerous areas
- **Reduction of the need for lane closures** due to the reduction or lack of need for the use of conventional climbing aids or ladders (e.g. BIG), and thus …
- **reduced costs for safety measures and climbing aids**

Limitations to the use of UAVs

- **Legal framework conditions**
  - **Currently no official permit** for flights directly above railway tracks
  - **Visual line of Sights-Flights only** (within a radius of 500m)
  - **No flights directly above** larger crowd of people
- **Environmental conditions**
  - **Very strong wind** (> 15m/sec) combined with a tight flying area
  - **Heavy rain**
  - **Very close proximity** (< 20m) **of moving traffic** (particularly heavy goods traffic)
- **Cost and effort involved**
  - If buildings and structures are easily accessible, the cost of a drone flight (preparation, execution and follow-up) is not always the most economical way.

Conclusion - ASFINAG Asset Management

- UAVs are proper tools to support our asset management staff by fulfilling their inspections and to get more detailled information about the inspected object.
- For standard objects (simple accsess, small objects) we usually don´t expect big economical benefits. Under certain circumstances are there some economical advantages due to smaller impact on traffic.
- For special objects (hard access) the biggest advantages are the detailed and comprehensive inspection options due to the new technical opportunities. Safety and availability are getting better.

Within the context of our following inspection and examination plans, **the initial deployments of drones has been established** for buildings/structures where an advantage can be expected.

On the basis of the practical experience obtained during the last year, actually our **internal processes** are going to be defined and/or adapted.

In the meanwhile other departments, also in different divisions of the company are involved and preparing to use UAV technology as well.

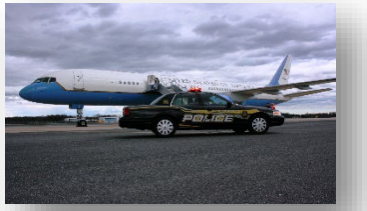
Thanks for your attention !

asfinag.at

Thomas.Steinbrucker@asfinag.at

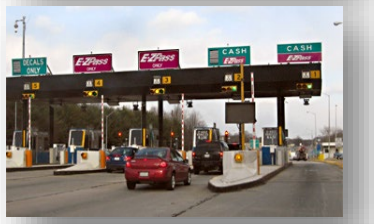
Maryland Transportation Authority Police
Small Unmanned Aircraft System Program

Who We Are?



The Maryland Transportation Authority **(MDTA)** Police is nationally accredited and is the seventh-largest law enforcement agency in the State of Maryland with more than 600 sworn and civilian professionals.

The **MDTA Police** are responsible for law enforcement at the MDTA's highways, tunnels and bridges. We are also contracted to provide services at the Baltimore/Washington International Thurgood Marshall Airport and the Port of Baltimore.



Challenges to Roadway Openings

- History has shown us that there are basically 3 areas that delay us in getting our roadways open quicker after a serious or fatal collision.
  - Treating the injured.
  - Processing the scene by our Collision Reconstruction Unit.
  - Removing the vehicles and cleaning up the debris from the roadway.

Our Program

- The primary purpose of our Small Unmanned Aircraft System (sUAS) or "Drone" Program is for efficient traffic management. Our Drones are used by our Collision Reconstruction Unit to document and collect evidence at serious/fatal collision scenes through the use of 3D mapping (PIX4-D).
- Our Program was fully implemented in November 2017 and to date we have processed numerous serious traffic collisions and or fatal collisions using our Drones. In each case we have significantly reduce the amount of time it takes to properly map a collision scene and regain the normal flow of traffic.
- Our Collision Reconstruction Unit trains monthly on the Drones to ensure everyone stays familiar with the program which allows us to be more efficient at a scene. The deployment of our Drones at a collision scene requires at a minimum a Pilot and a Spotter for all flights.

Accomplishments

- Approved Policy vetted through our Assistant Attorney General and our Senior Command Staff.
- Have COA's or Certificate of Authorizations from the FAA on our Drones.
- Waiver of Operation from the FAA which allows us to operate in controlled air space within 5 miles of BWI Airport
- Worked with the FAA at BWI/TM Airport and developed a working agreement to operate within the 1-mile radius.
- Worked with the American Civil Liberties Union (ACLU) of Maryland on our program.
- Two Drone Instructors and eight of our Collision Reconstruction Unit members have their FAA UAS Remote Pilots License.
- We currently have three Drones; a Dragonfly X4P and two DJI Phatom 4's and are finalizing the procurement of two new DJI Matrices to add to our fleet.

Sharing Our Vision

- Working with our partners on the challenges and rewards of having such a program for Collision Reconstruction.
- There is no perfect system and the sUAS or "Drone" does have its limitations in Collision Reconstruction.
- Proven Results.

Small Unmanned Aircraft Systems

- The primary purpose of acquiring the DraganFly XP-4 sUAS with PIX 4-D and our DJI Phatom 4 is to enhance the abilities of our Collision Reconstruction Unit.

- By conducting a mapping of a Collision or Incident scene using our Drones from the air, we have shown that we can capture the data faster and as accurate as our land-based mapping software.

- This method has resulted in a quicker CRU Investigation since mapping the area has always been one of our biggest delays in getting our roadways open quicker since we can not move vehicles until the scene is mapped.


UNMANNED AIRCRAFT SYSTEM PROGRAM
MDTA POLICE
MARYLAND
TRANSPORTATION
AUTHORITY
POLICE
Maryland Transportation Authority
Police
Unmanned Aircraft System Program
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QUESTIONS?

Manuel Crew
Executive Officer/Chief of Staff
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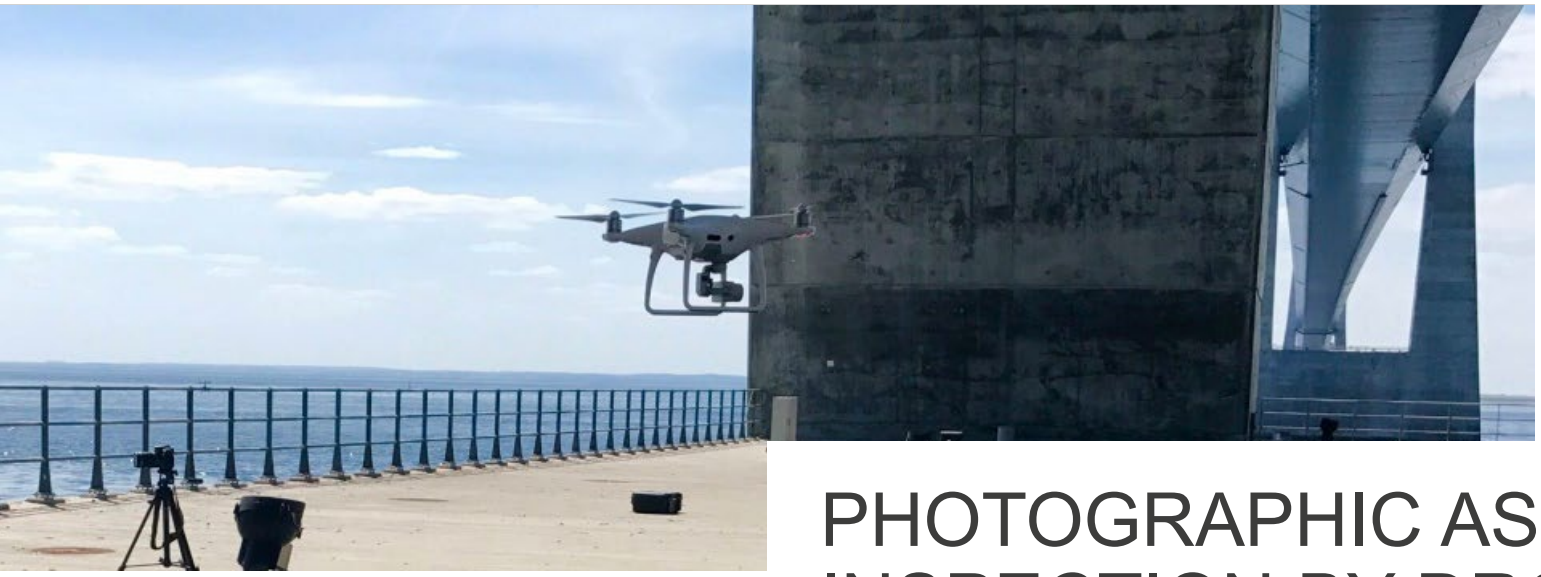
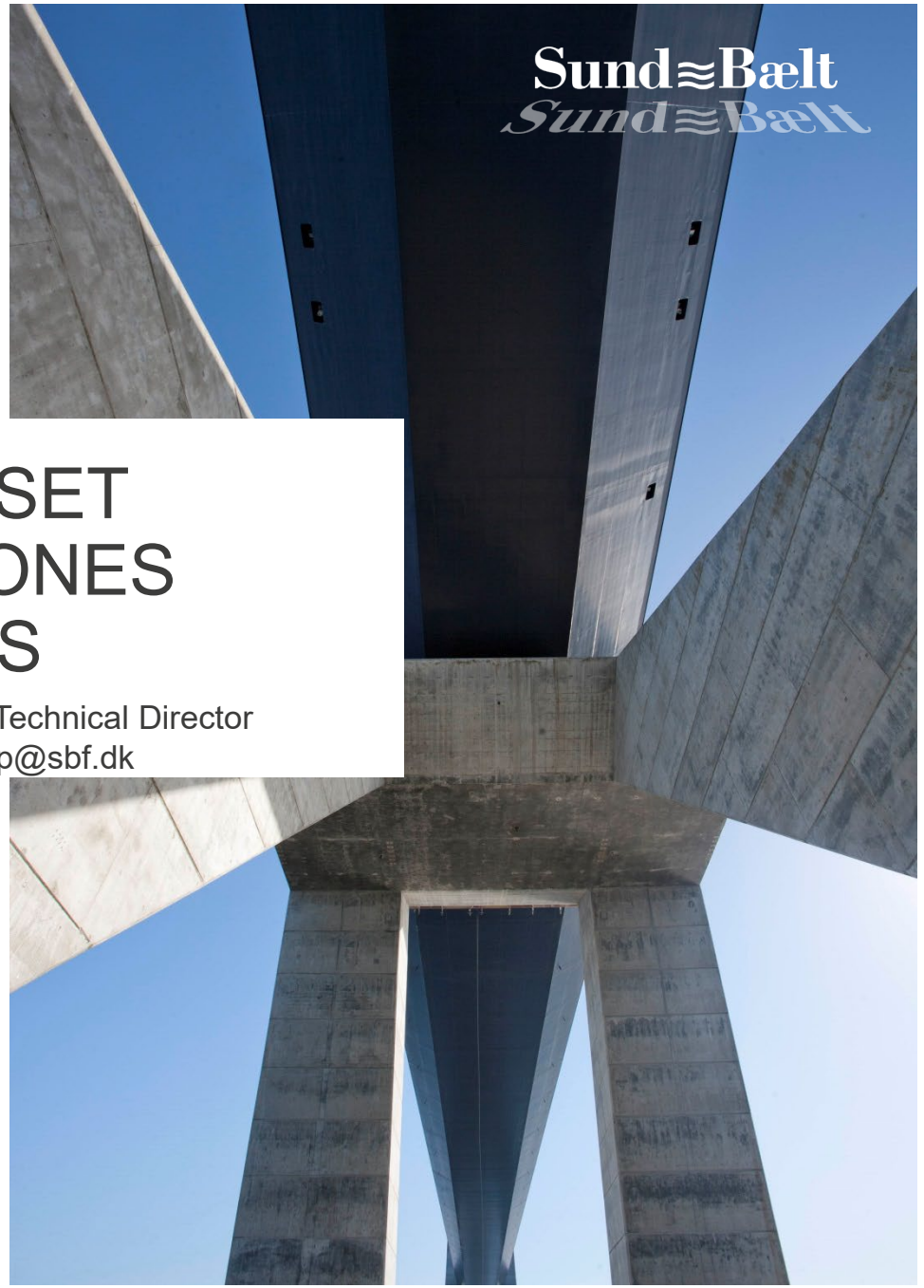




PHOTOGRAPHIC ASSET INSPECTION BY DRONES & AI IMAGE ANALYSIS

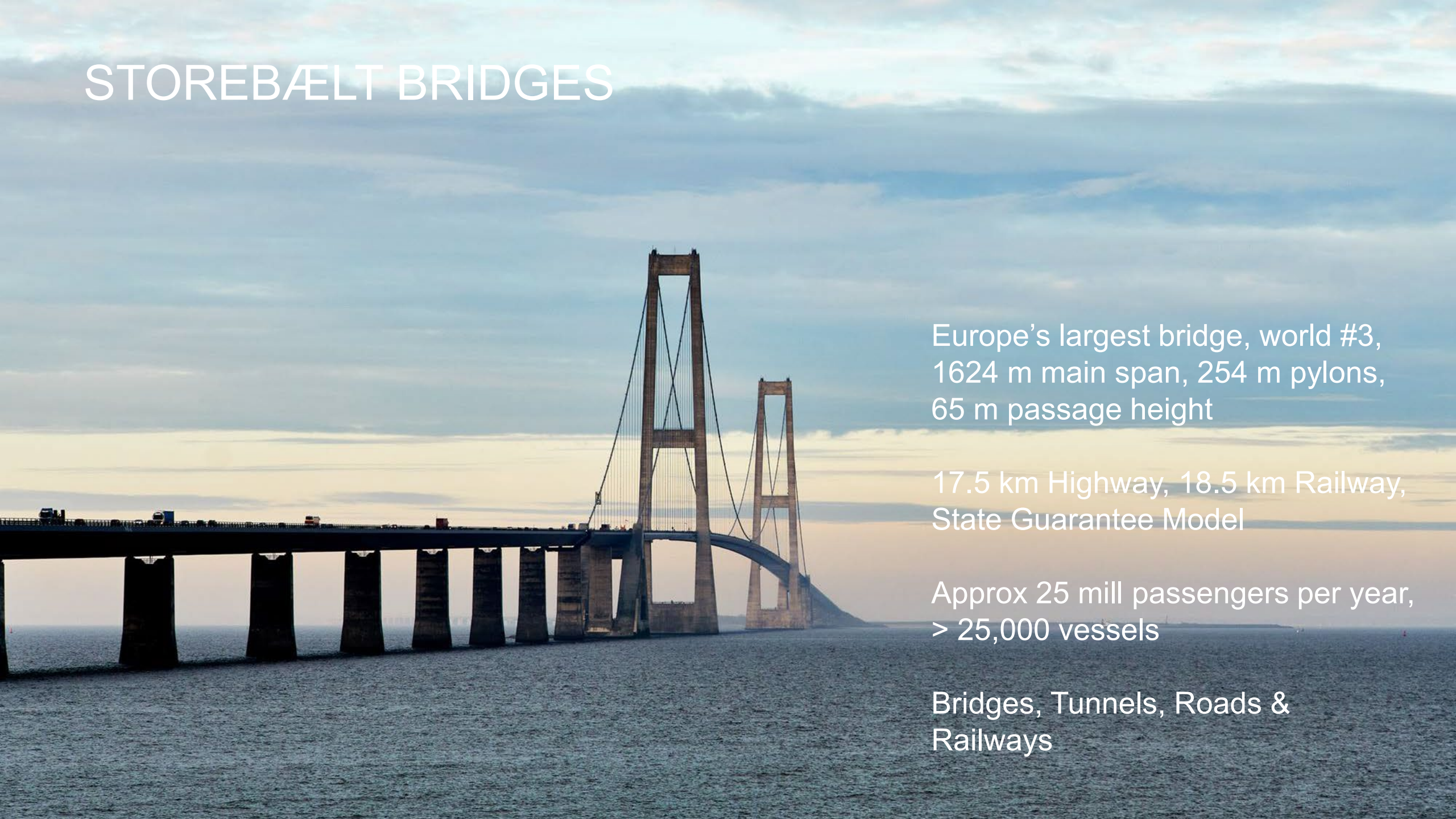
Lars Fuhr Pedersen, CTO, Technical Director
Sund & Bælt Holding A/S, lfp@sbf.dk


Norway
Sweden
Denmark
The Storebælt Link
The Øresund Link
The Femern Link
United Kingdom
Netherlands
Germany
Poland
Belgium

AGENDA

- The Storebaelt Bridge
- Sund & Bælts approach
- Drones, PAI & Image Analysis with AI
- Results

STOREBÆLT BRIDGES



Europe’s largest bridge, world #3,
1624 m main span, 254 m pylons,
65 m passage height

17.5 km Highway, 18.5 km Railway,
State Guarantee Model

Approx 25 mill passengers per year,
> 25,000 vessels

Bridges, Tunnels, Roads &
Railways

SUND & BÆLTS APPROACH

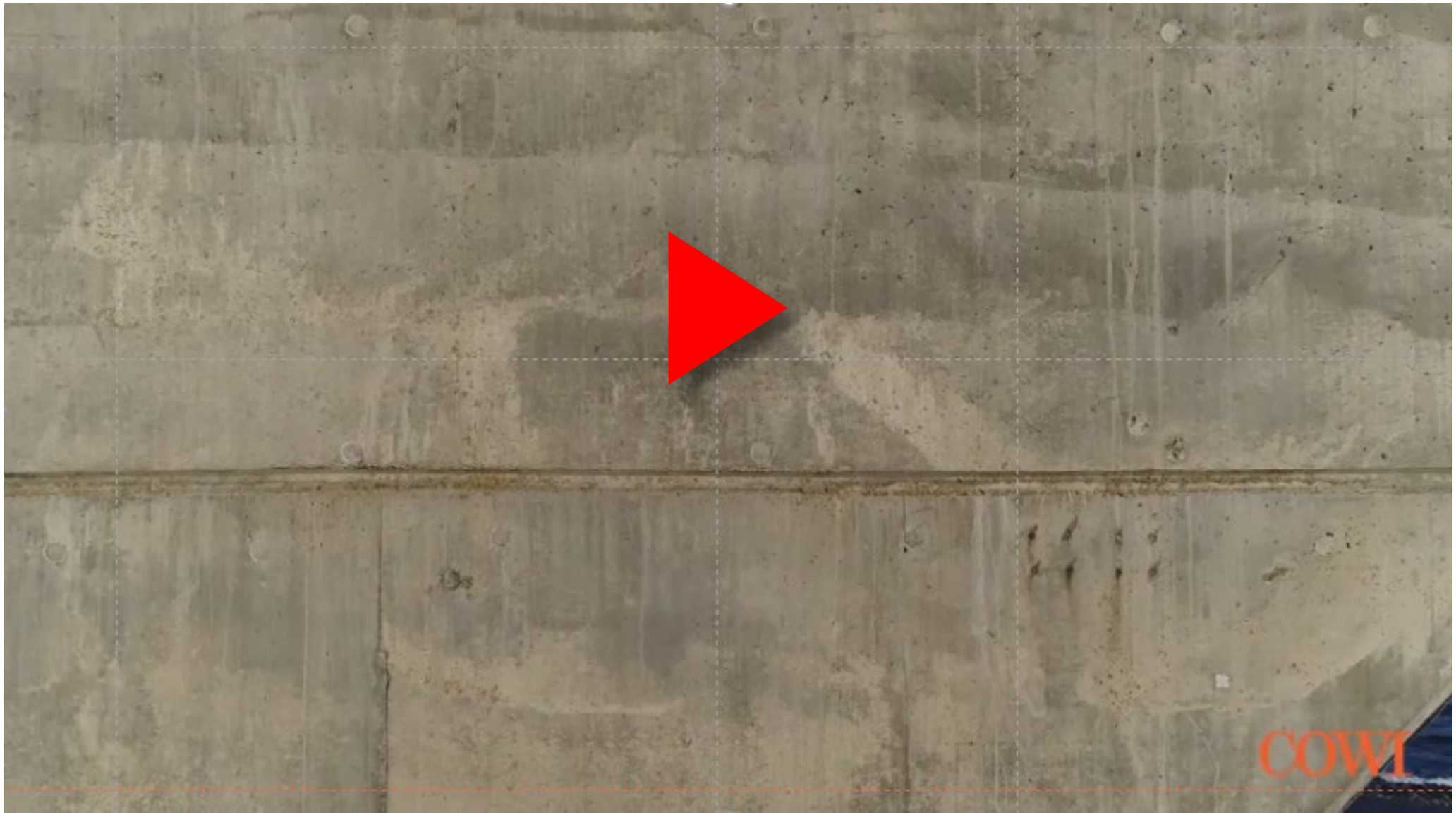
New technologies bring greater efficiency

- Ensure 2% annual productivity
- High quality standards & high accessibility/safety levels for our customers
- Ensure optimal TCO for new constructions
- Sharing knowledge through cooperation

Data from Drones, Sensors & Robots

- Increased Digitisation of our maintenance
- Big Data & Analytics, AI (Artificial Intelligence)
- New data sources; robots/drones/sensors
- Digital models: GIS, BIM, AR

DATA FROM DRONES / ROBOTS


COWI

WHY? BEFORE AND NOW

WHY ?

Digital Inspection

Improvement of inspection methods

- Mowing from mountain climbers to drones
- Easy access to unreachable surfaces
- Less time consuming
- Photographic materials keep track of the history

Improvement of data assessment

- Mowing from subjectivity to AI objectivity
- Keeping track of damage progression
- Assesment can be shared with more experts
- Compare real time evolution with original construction models
- Prediction of expected lifetime

Photographic Asset Inspection

Store, analyze, review and get insights from your photographic data

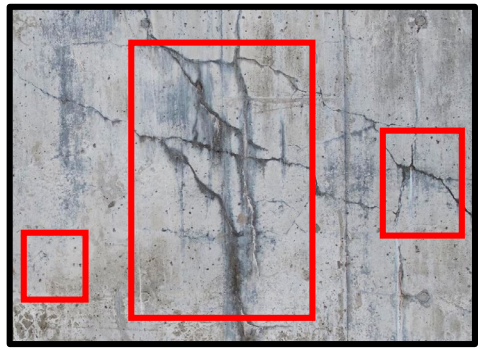
Capture photos

Any way you want

Import and organise

Thousands of images

Automatic damage detection



Using our computer vision algorithm

Human validation

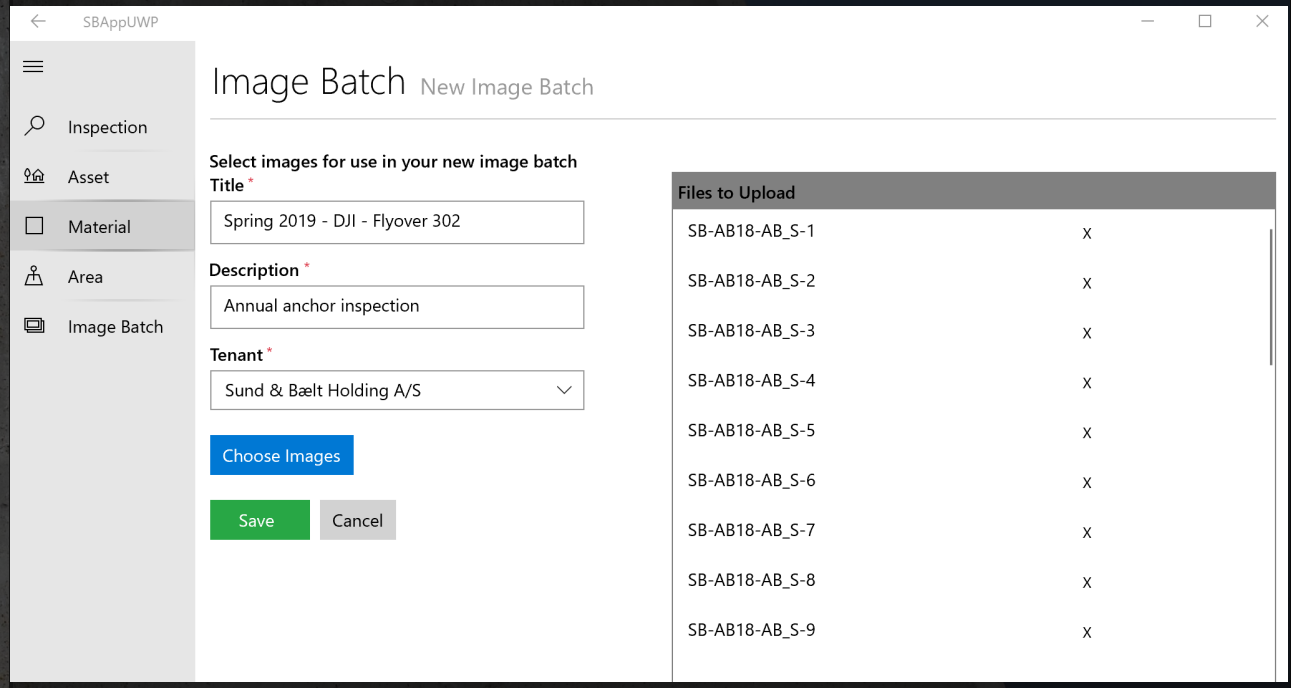
Following the "human in the loop" principle

Monitor trends & create reports

Export data to other systems

- **Easily store thousands of images**
- **Reduce manual review time with automatic damage detection**
- **Spot trends in your growing dataset**
- **Export your data to your own systems**

Import unlimited photos



- Capture from ground or with drone
- Include GPS information
- Overcast weather preferred
- Store as many images as you have
- Organize them in batches

SBAppUWP

Areas Level2

New Area

Inspection

Asset

Material

Area

Image Batch

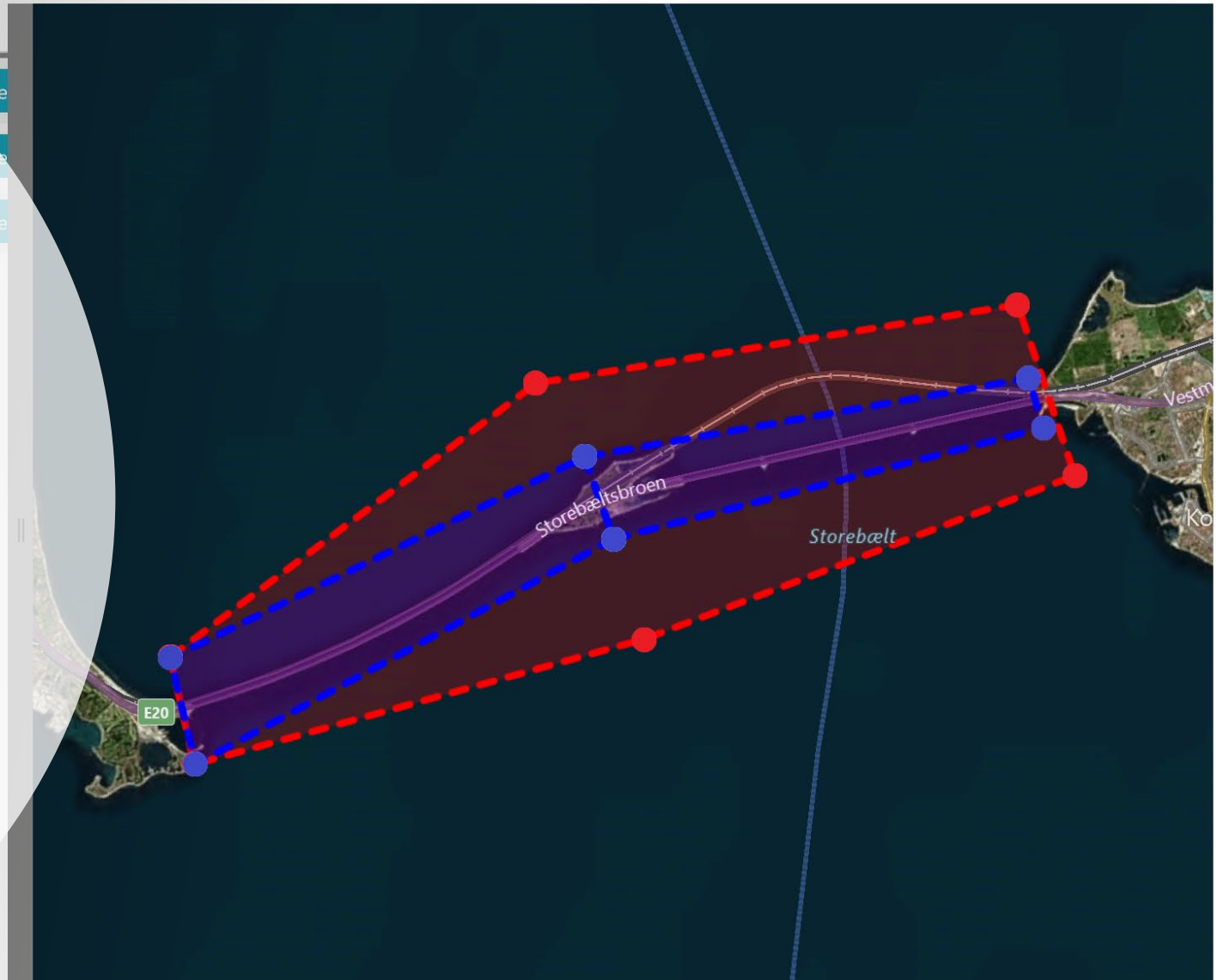
Overview / Great Belt Link

TITLE	START HEIGHT	END HEIGHT	
East Bridge	0	300	Next Leve
West Bridge	0	300	Next Leve
Sprogø	0	300	Next Leve

Test User

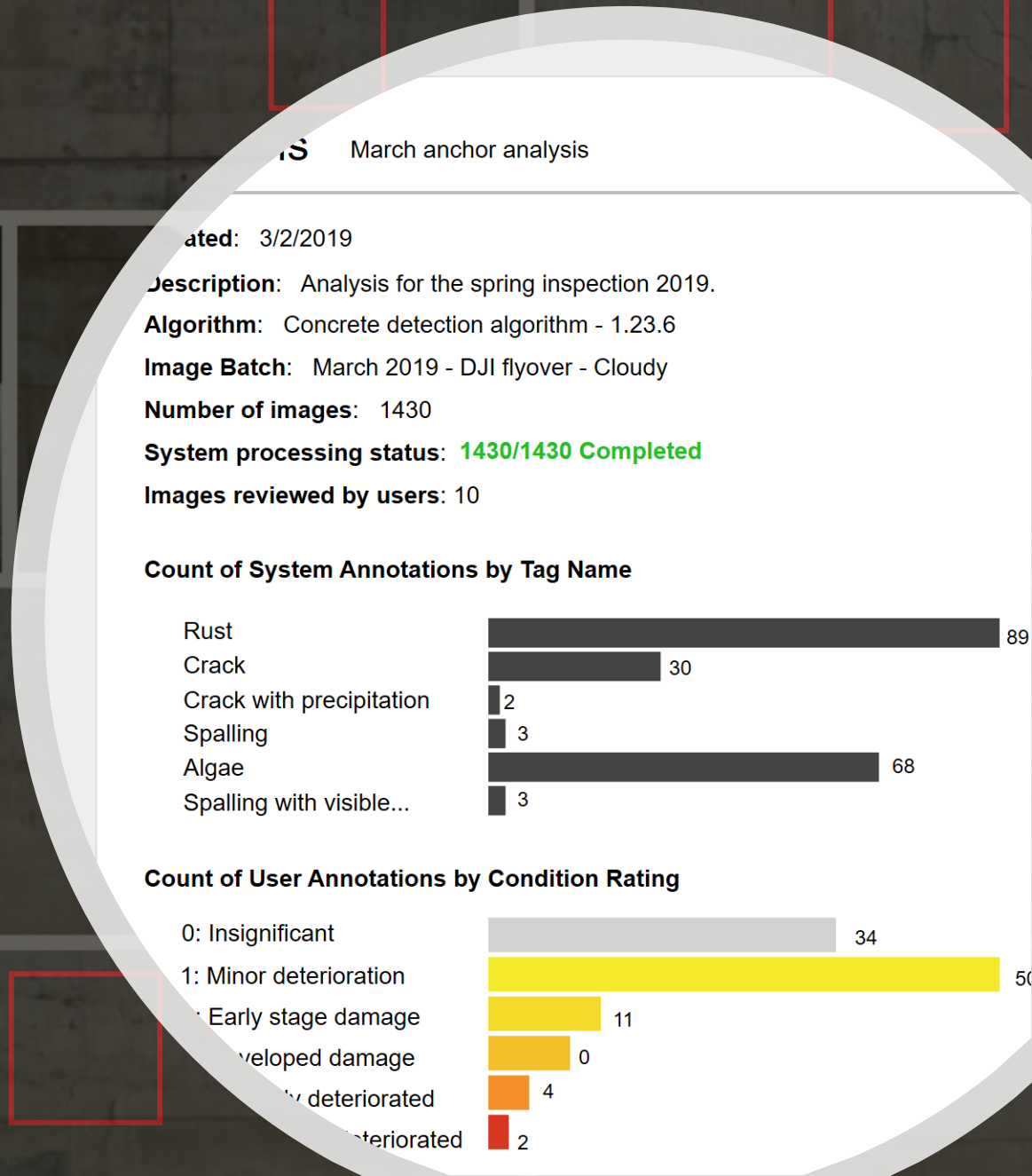
Photos are automatically organized by area

- PAI uses the GPS location to automatically organize images in the areas they belong to
- Finding images is easier, especially when browsing multiple large dataset
- Areas hierarchy can be customized in up to five levels



Our computer vision algorithm analyzes your images

- Quickly get an overview per category
- Filter the results based on the automatic analysis to reduce the amount of manual work
- Approve and modify findings following the “human in the loop” principle
- Algorithm gets more accurate over time

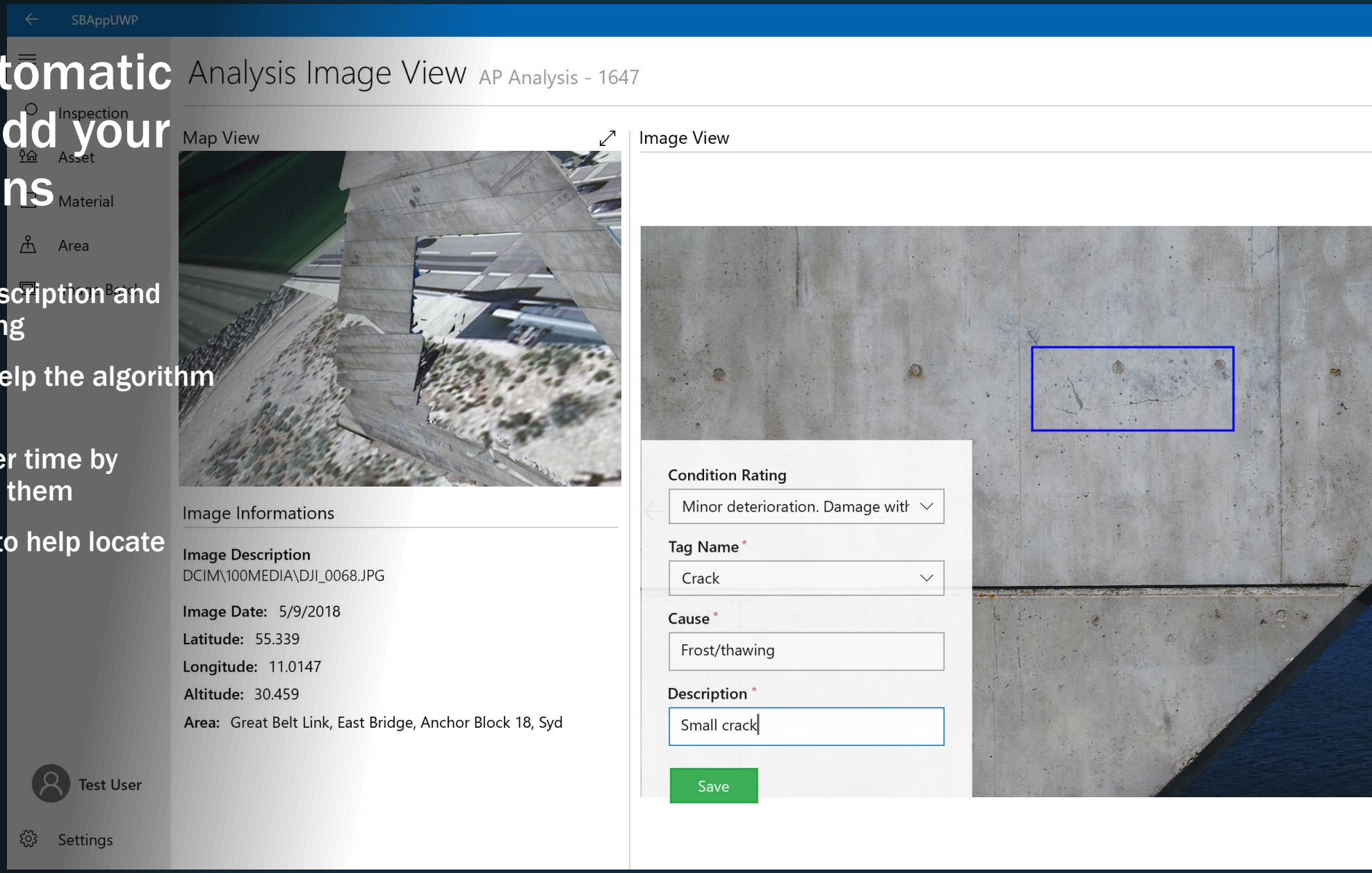


The computer vision algorithms are trained by concrete experts

- **Photos of damage are used to train the algorithm**
- **Training material is selected and validated by Sund & Bælt employees**
- **Multiple categories are used for the training:**
  - Crack
  - Crack with precipitation
  - Spalling
  - Spalling with visible corroded rebar
  - Algae
  - Rust

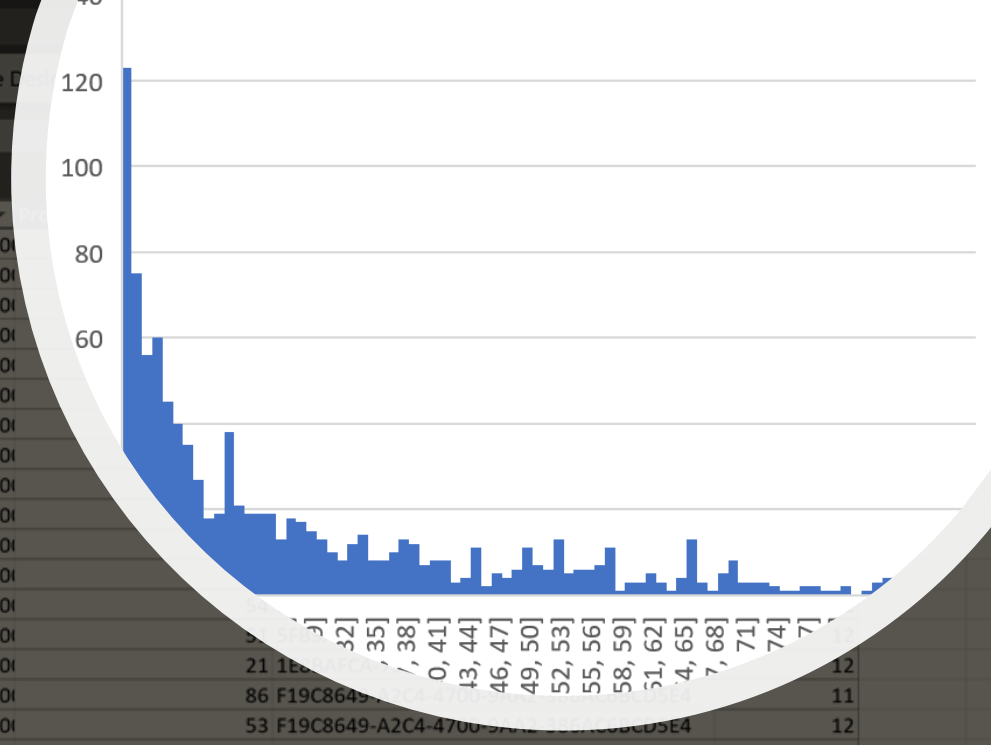
Review the automatic analysis and add your own annotations

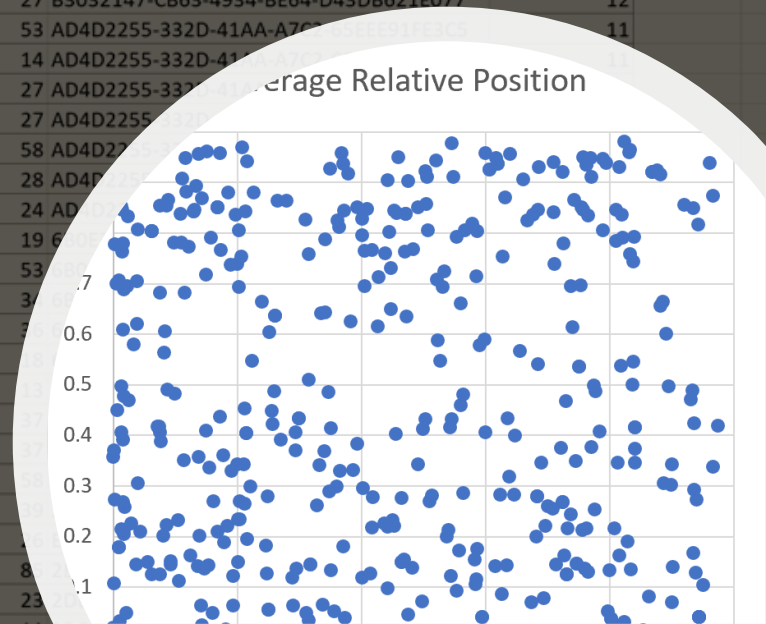
- You can add cause, description and assign a condition rating
- Correcting errors will help the algorithm improve
- Track the damages over time by creating links between them
- See your assets in 3D to help locate damages

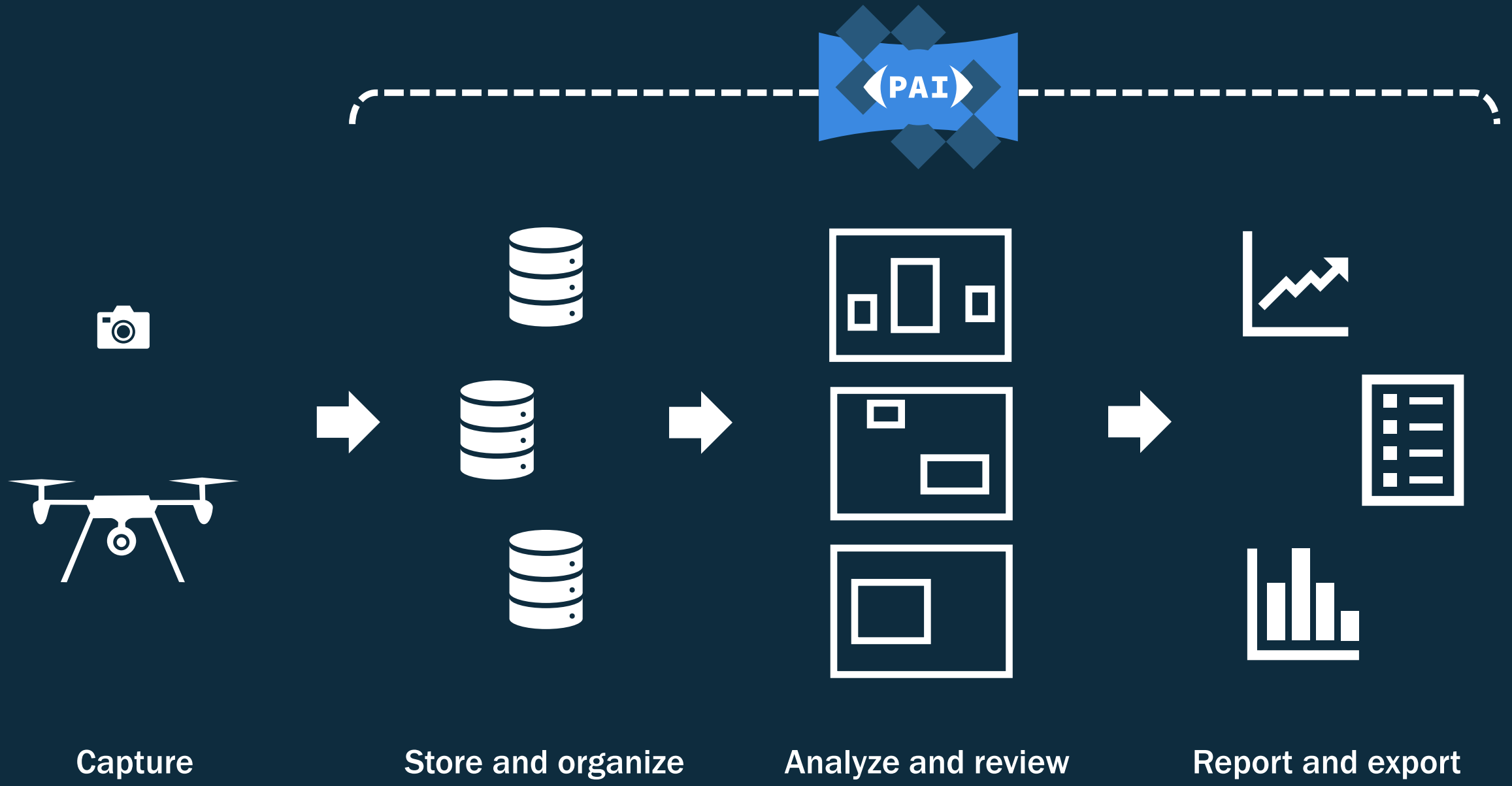


Create PDF reports with images & export your data

- Generate reports for PDF or CSV
- Filter your data by
  - Damage type
  - Area
  - Condition rating
- Import data to own system
- Share PDF with contractor






PAI
Capture
Store and organize
Analyze and review
Report and export

OUR RESULTS FROM BETTER DATA

OPEX

- Reduced maintenance & operation cost – target 10% in 5 years – more than on track
- Higher quality – prolonged lifetime & better asset conditions
- More knowledge from data & models

CAPEX

- Reduced renewal cost – budget index
- Better TCO in new projects with data models

THANK YOU – QUESTIONS ?

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QUESTIONS?

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THANK YOU.

FEEDBACK

We value your feedback, please take a moment to fill out the survey that will appear on your screen after exiting the webinar.

FINAL MEETING OF 2019

2020 EVENT SCHEDULE

SAVE THE DATES
www.ibtta.org/events

GET INVOLVED
Join a Meeting Planning Group
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www.ibtta.org/louisville
www.ibtta.org/austin
www.ibtta.org/globalsummit

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DRONES: Raising the Bar for Facility Management and Maintenance

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