Using Unmanned Aerial Vehicles (Drones) in Facility Management:
Roof Inspections, Safety, and More

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Simplar Institute

- **Group of researchers and educators**

- **Integrated within the parties (clients/buyers and vendors)**

- **Developed tools, methods, & training to enhance:**
  - **Organizational Transformation**
  - **Procurement & Sourcing**
  - **Project & Risk Management**
  - **Operational Efficiency**
  - **Human Dimensions**
  - **Performance Measurements**
  - **Benchmarking & Workforce**
  - **Facility Management Professional Training**

What is a UAV?

"Unmanned Aerial Vehicle"

Drone

Quadcopter

Unmanned Aerial System (UAS)

Remotely Piloted Aircraft (RPA)

Remotely Piloted Vehicle (RPV)

Typically have a camera attached

Sometimes have other sensors attached

Small payload capacity

POLLING QUESTIONS

Who primarily does your roof inspections?

What are the main reasons that you do roofing inspections?

Has an employee at your organization ever been injured doing roofing-related tasks / work?

Industries That Use UAVs Regularly

Geographical Mapping (GIS)

Agricultural

Construction Project Management

Engineering Surveying

Real Estate

Search and Rescue

Hazmat Emergency Response

Facility Managers?

Common Questions:

Should I be using UAVs over my facilities?

In-house or contractor?

Cost to train my staff (or myself) to use equipment?

Cost range of a drone? Quality level?

Legal requirements to fly?

Will it actually save me money?

UAV Price Ranges:

Basic Simple: $10 - 180

F36 Mini

Mid-Level: $120 - 1,000

DJI Mavic Pro

High End $800 +

DJI Phantom 4 Pro

3 Parts to UAV Proficiency

- **Licensing - FAA 107 Licencing**
- **Piloting**
- **Flight Planning Software**

Licensing

Licencing: Exam Facts

FAA recent history in licencing exams

$150 - Taken at FAA approved airport sites

1.5 hrs time limit

3 Answer multiple choice - 1 correct, 1 dumb, 1 similar

Example Question

Under what condition would a small UAV not have to be registered before it is operated in the United States?

A. All small UAVs need to be registered regardless of the aircraft before, during, or after the flight

B. When the aircraft has a takeoff weight that is more than 0.55 pounds, but less than 55 pounds, not including fuel and necessary attachments

C. When the aircraft weighs less than 0.55 pounds on takeoff, including everything that is on-board or attached to the aircraft.

Liscencing: Study Time   +/-12 hrs

Flight Zones	Radio Lettering A - Z	Latitude & Longitude Measurements	Weather patterns	Airport Setups
Lift	Runway Patterns (Degrees)	Planes circle to the Left, Copters to the right	Upwind vs. Downwind	NODEMS
PIC (Pilot in Command)	.55-55lbs	13yrs old youngest pilot	400 ft above surface/structure	100 mph max speed
File report with FAA if +$500 damage	Air Space Rules A - G	90 days ahead to get waiver for A - D Zones	Stall speed	Load Pressure or Load Factor
Sectional Charts (Follow the Legends)	MSL (Mean Sea Level)	METAR	NOTEMS (Notices on current no-fly zones)	MTR (Military Training Routes)
VR (Military Training Routes)	2000 ft from side clouds or guy-wires	500 ft below vertical clouds	400 ft above or to side of structure	At Night, need anti-collision lights 3.5 Mile Visual
Alcohol - 8 hrs min after and 0.04 Blood Alcohol Level (BAL)	SM (Statute Miles)	Restricted Areas: National Parks, Airports etc.		

Licensing: What it does and doesn't do…

- **Does:**
  - **Allow one to commercially charge for services - (as a Contractor)**
  - **Help pilot to understand Laws, Safety and Regulations (in U.S.)**

- **Does NOT:**
  - **Make you a good pilot - no actual flight testing or hours of operation required**
  - **Teach you about industry software and uses of UAVs**

Piloting

Licensing vs. Piloting

Piloting: What does it take?

- **Hours of practice (20-40 hrs) - Cheap Drone first, then expensive one**

- **Not crash**
  - **Trees, power lines, structures, birds, battery life management**

- **Know when it is safe and not safe to fly**
  - **Weather conditions, lighting, etc**

- **Understand optimal camera settings (on UAV app)**
  - **Focus**
  - **Exposure (shutter speed)**
  - **Brightness**

Piloting: How/Where to Practice?

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Football Camp	Wedding	Parade	Family Gathering
Kids playing at park	Hiking	Roof & Bldg Inspections	Public Events
Construction Sites	Gathering Events	Parks	Parades

Piloting: How/Where to Practice?

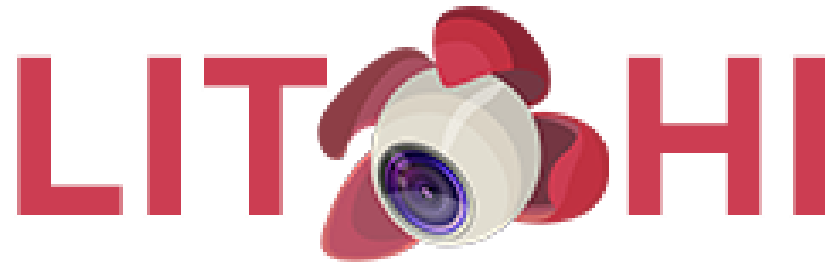# Piloting: How/Where to Practice?

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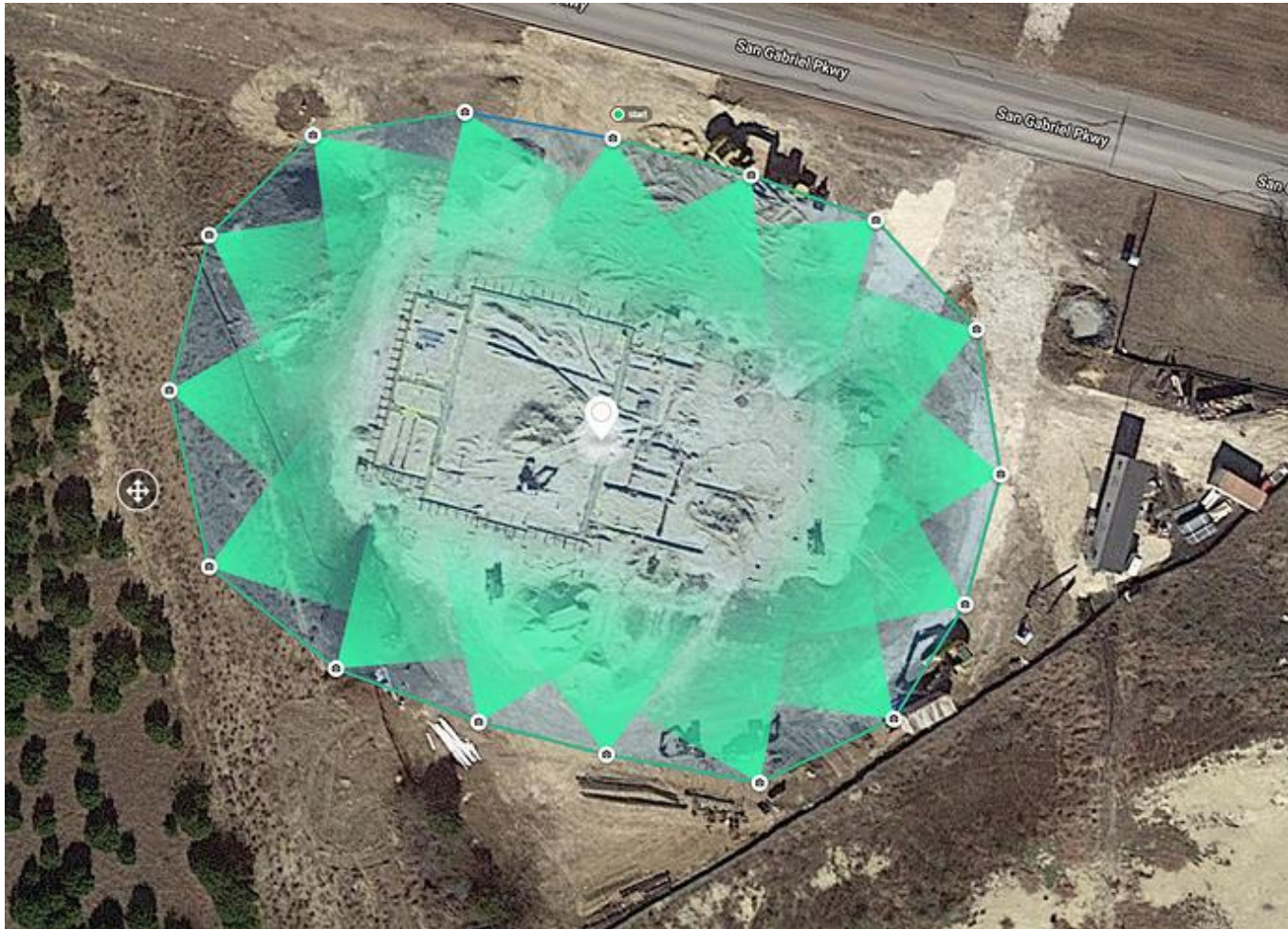
Piloting: How/Where to Practice?

Software Applications

Software Systems

GPS Path Sequences

Crop Inspections

Path Photos

Photo Stitching
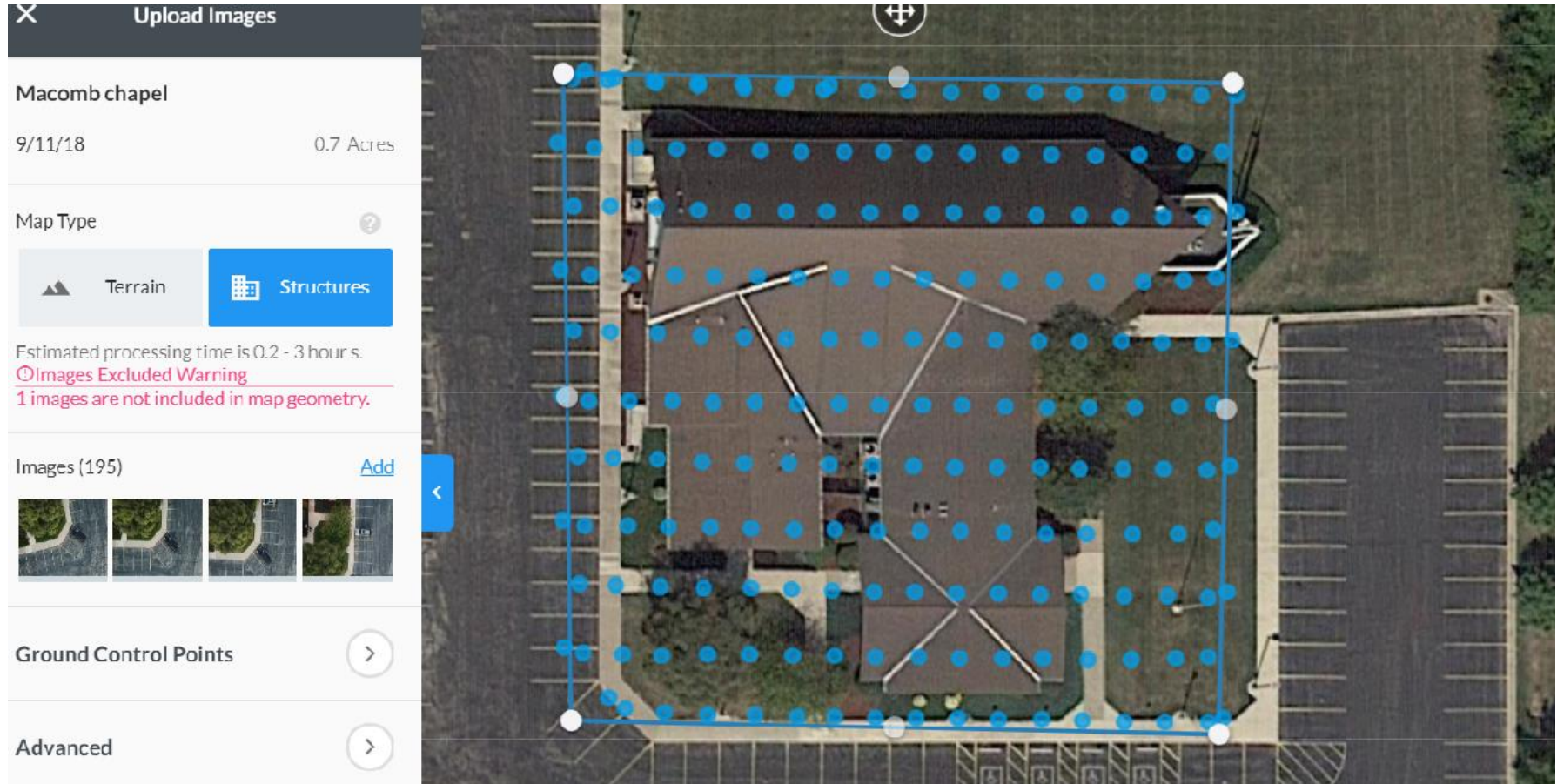
3D Modeling
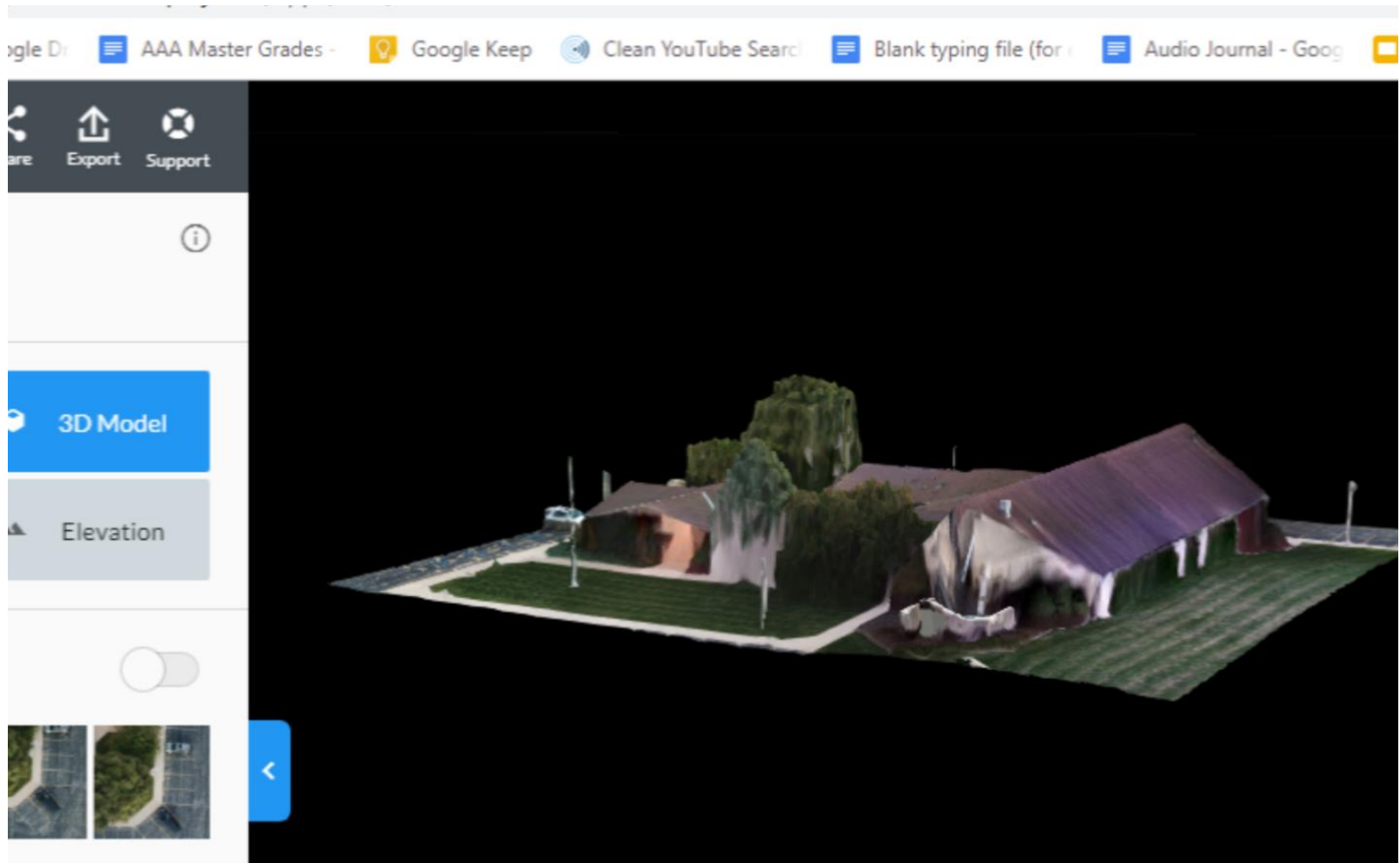
UAV Training? What are the costs?

Item	Cost	Description
DJI Mavic Pro Drone Basic	$850	Standard DJI Model with stock gimbal and lens filter.
UAV Storage and operation peripherals	$450	Hard-case storage containers, I-pad mini (used), extra propellers, 4-battery charging manifold, carrying pack.
FAA 107 UAV Licencing Test	$150	Taken at participating airports
Study Time for UAV Licencing Test	Approx 12 hours	FAA document and youtube training videos used as study guides. 70% accuracy for passing grade.
Inexpensive Practice Drone	$20-60	Drone with extra batteries and propeller protectors. Price range is between $20-60 for economic non-GPS models.
Flying Practice Time	20-40 Hrs	Recommended to practice at sporting events, weddings, hikes etc. Outdoors, not indoors.
Software Learning and Practice	20 hrs	DJI unit software, Dronedeploy, Pix4d, Litchi etc. Recommend using free software first, then free trial software period before deciding on a software to purchase. Must learn specifics in Flight Planning programing.
Total Cost & Time	**$1,510 72.5 Hrs**	

Case Study: Roof Inspections w/ Drone

Problem

Challenges

- **Infrequent inspections**
- **Inconsistent quality**
- **Inefficient**
- **Improper documentation**
- **Expensive**
- **Dangerous**

Steep-sloped roofs are difficult to inspect

RESULT: Premature roof replacement
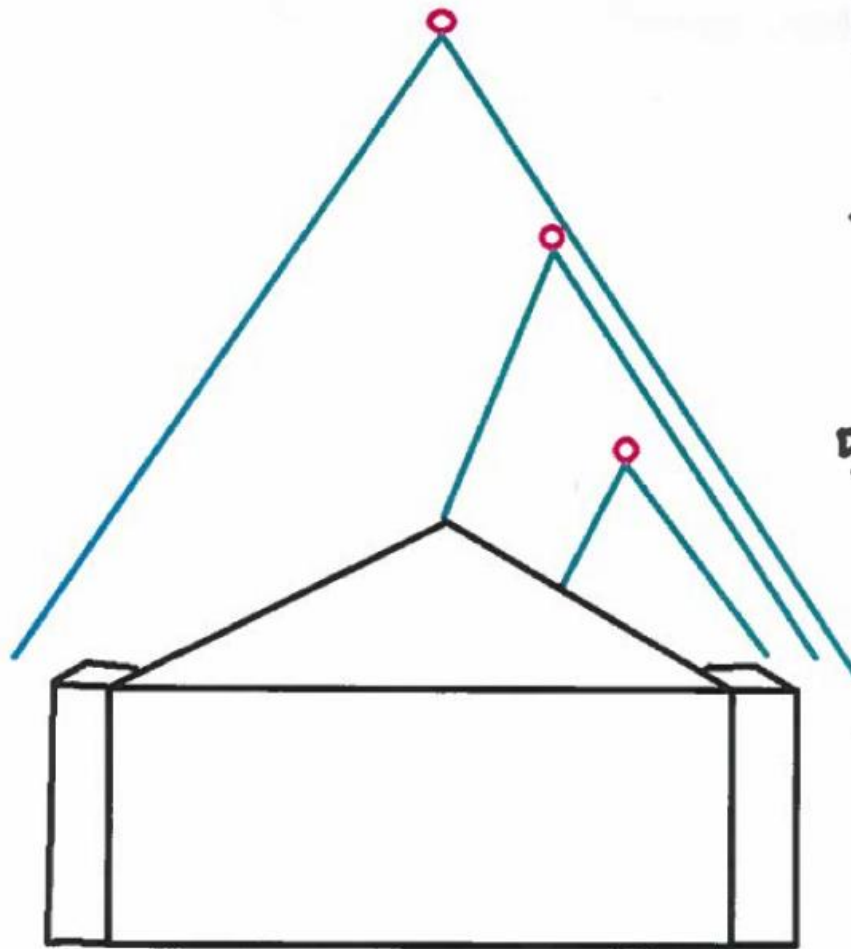
Solution: Drone Roof Inspections

- **UAVs can be used to perform inspections quickly from the ground**
- **Numerous high-quality images can be taken to support the FM team's recommendation objectively**
- **Minimal cost**

Solution Details – The Drone Choice

- **Mavic (preferred)**
  - **Cost $1,500 w/ accidental damage plan & extra batteries**
  - **Smaller, more portable**

- **Phantom 4 Pro**
  - **Cost $2,400 w/ accidental damage plan & extra batteries**
  - **Larger, needs a case**
  - **Image quality no significant difference to Mavic**

- **Inspire**
  - **Cost $6,500 w/ accidental damage plan & extra batteries**
  - **Larger, needs a case**
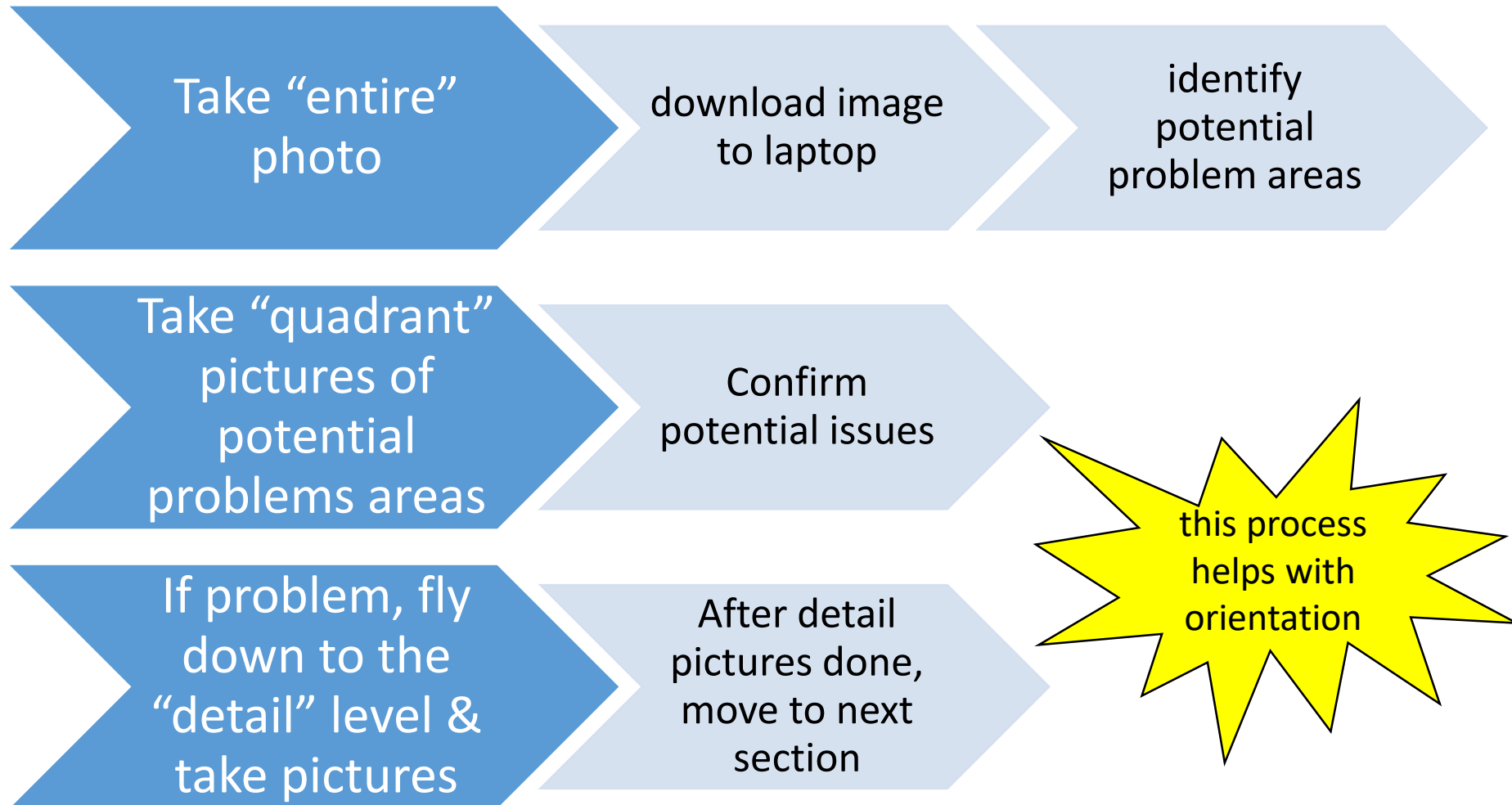 - **Image quality no significant difference to Mavic**

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Vertical Approach to Still Images

Picture Taking Flow Chart

Take "entire" photo → download image to laptop → identify potential problem areas

Take "quadrant" pictures of potential problems areas → Confirm potential issues

If problem, fly down to the "detail" level & take pictures → After detail pictures done, move to next section

this process helps with orientation

"Entire" view

"Quadrant" view

"Detail" view
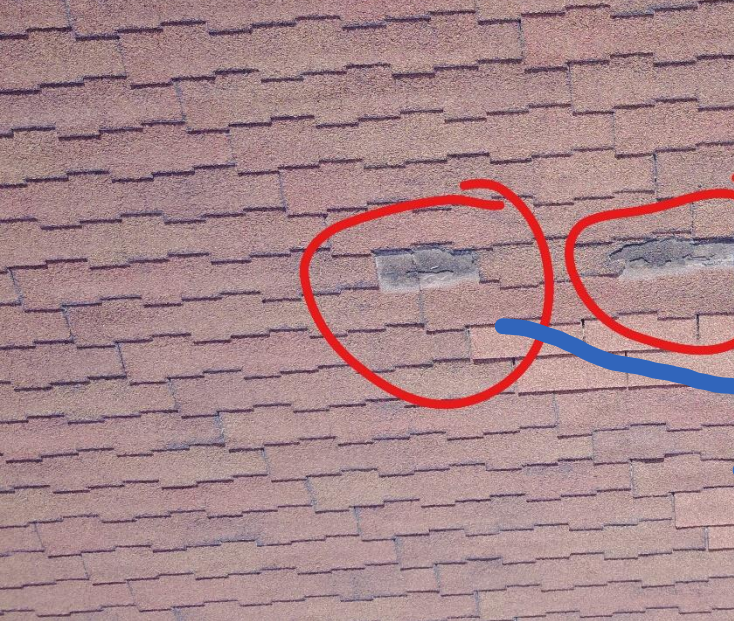
Blowup of Same Image

Other parts of the roof still have some life left

5 feet

10 feet

15 feet

20 feet

Pilot & Spotter Skills

- **The pilot (ideally) or the spotter (at a minimum) needs to have FM experience to be able to judge roof quality**

- **Flying the drone for the inspection is more complicated due to the need to avoid obstacles and concentrate on the roof quality**

- **Drones are fairly symmetrical, so at a distance it is hard to tell which direction is which (forward vs. backward, right vs. left)**

- **Spotter needs good eyesight to be able to see the drone without the aid of the camera's video image (which the pilot can see)**

- **Older pilots with reasonable technical skills have needed about 10 hours of flying time to become comfortable with the drone in this context**

Timing & Environmental Hassles

- **Need about an hour to take pictures of a normal chapel, maybe 15' more for a large chapel**
  - **Plan for a second hour to download images and review them during the process**
- **Drone battery life is just under 30'**
  - **three batteries are needed**
- **Inspection needs to be done on a reasonably sunny day**
- **Inspections should not be done in heavy wind and or rain/drizzle**

Suggested Image Numbering Scheme

- **A photo numbering scheme may be helpful to organize images**
- **Region # - Bldg. Local ID # - Facility ID # - Date - Photo Number**
- **424069-001-5512344-2017.03.24-i001**
- **424069-001-5512344-2017.03.24-v001**

Streaming Video

Process

1. Fly a pattern to record entire building (probably manual control for variable elevations)
2. Stream the video (Skype) to FM

Pro's

1. Still images possible with small file size (5-10 Meg)
2. Live images to roofing expert

Con's

1. Quality may be poor depending on internet connection
2. No record of video stream

POLLING QUESTION

How serious are you considering using drones for FM purposes?

Summary

- **Drones are a relatively inexpensive tool that drastically reduces safety risks for facility managers**

- **They take PRACTICE!**

- **But… there are some drawbacks:**
  - **Time consuming**
  - **Training is needed**
  - **Organizational culture / local rules & regulations**

- **Have a good plan in place when you start; stay organized**

Questions?

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