OPTELOS

OPTELOS WHITE PAPER

8 Ways to Optimize Drone Asset Inspections: Optelos Puts Together Lessons Learned from Enterprise Clients

Introduction

UAV based inspections are becoming increasingly common-place in the energy and industrial manufacturing industry. Fueled by the evolution of drone hardware, sensor technology, and the expansion of Beyond Visual Line of Sight (BVLOS) certifications, the use of drones has become standard practice for performing applications such as oil well and tank inspection, pipeline inspection and monitoring, and safety and compliance inspections just to name a few.

And you don't need to look far to see the immediate benefits UAV inspections are yielding:

INCREASE WORKER SAFETY. Drone based inspections take Inspectors out of dangerous environments such as elevated, confined space and hazardous conditions. Inspectors and field crews are able to perform more frequent inspections while increasing overall safety.

COST SAVINGS. The time and expense to perform those elevated inspections are significantly reduced simply by putting drones to use in those applications, especially where expensive scaffolding or asset shutdowns are required.

FASTER AND MORE ACCURATE DATA CATPURES. Drones and robotics coupled with the right sensors provide large amount of inspection data. When combined with Beyond Visual Line of Site (BVLOS) capability, organizations can perform more frequent inspections in a shorter amount of time compared to manual inspections.

With those benefits in mind, its obvious UAV based inspections will continue to expand. However, these applications are only scratching the surface in terms of the possible benefits of UAV based inspections. ***The secret to unlocking the power of your UAV program and going beyond the images is the intelligent use of all that collected visual data!***

WHAT WE WILL COVER

1. **How to best manage your collected visual data**
2. **How to Operationalize that data**
3. **The best data collection practices**
4. **The best asset analysis practices**
5. **Putting it all together**

Go Beyond the Pictures to Drive Better Decisions

INSIGHTS BEYOND THE DATA

Drone based inspections yield massive amounts of high-resolution images and videos as well as other data sources like LiDAR, thermal and methane detection.

This data is key to critical inspection decision making. However, it is only through the effective management, collaboration and analysis of this data that sustainable improvements and breakthroughs are possible.

A common statement expressed by a number of senior energy and industrial manufacturing company leaders, who remain skeptical about the true benefits of broad UAV inspection deployments is ***"I see lots of great pictures of our assets, but I'm not sure we're seeing return on the investment."***

The most common challenges companies face in realizing maximum return on their drone programs investments are:

WASTED DATA	Drones are being used to collect vast amounts of visual data for asset inspection, but a high percentage of the data does not appear to be useful or often times goes unused.
LACK OF DATA INTEGRATION	Images, 2D and 3D models and Digital Twins are being generated but often times not integrated into a comprehensive view of the asset, reducing the effectiveness this data and the ability to identify asset conditions.
LIMITED INSIGHTS	The data collected is not being utilized to its full potential to provide contextual relationships between the visual data and the root cause of the problem.
DATA SILOS	Drone inspection data exists in a silos, making it difficult to use in conjunction with other data sources to create a more comprehensive view of the assets.
DIFFICULT TO COLLABORATE	Ineffective communication across stakeholders and organizations. For example, Mitigation teams do not have full access to the drone inspection data to improve time to repair.

Energy and Industrial manufacturing companies are looking to overcome these challenges. They want to go beyond the pictures and achieve meaningful results from their drone program.

This means using images and videos alongside 3D models, maps, panoramas, CAD drawings, and other documents. When implemented properly, this allows users to better see relationships to other data which is critical to driving maximum value and insights.

Let's look at the basic capabilities that need to be in place for any UAV based inspection program to generate the highest return on investment and overcome these issues.

1. ***Intelligently store and manage massive datasets.***

This means creating a single source of truth to allow data to be processed, correlated, easily accessed and shared across the organization.

One of the most critical issue is properly geo-locating all of this data so that it can ultimately be used to create a complete view of the specific asset, so that proper identification and mitigation actions can be performed.

2. ***Integrated data visualization.***

Organizations must provide all stakeholders with a way to visualize and act on all this data, including complex 3D models, maps, panoramas, videos, and other formats, all in a single location. This eliminates the need for disparate systems to view and analyze that data.

The power of the data lies in the ability of the organization to securely and effectively use it to solve problems. This means making the data accessible to inspectors, site managers, 3rd party contractors, EH&S personnel and others who can use it to their advantage.

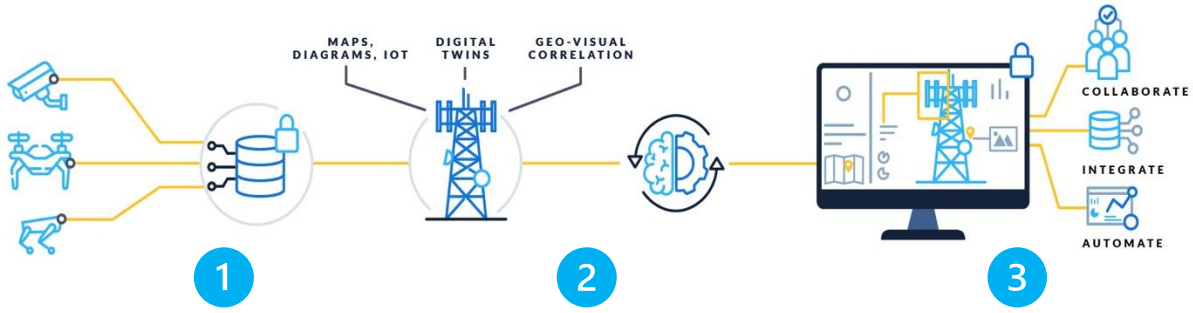
3. ***Operationalize this data***.

This is perhaps the most important step. Operationalizing the data ensures it is being used to identify and solve asset performance, reliability, inspection, or EH&S problems.

The ideal workflow is one that uses the collected data to automate or streamline a specific process. Then, through the analysis process, specifically identify service impacting, asset degradation, safety or inspection issues that need to be addresses.

The final step in the process is dispatch or trouble ticketing, providing the geolocated data required, so that mitigation crews can quickly resolve issues.

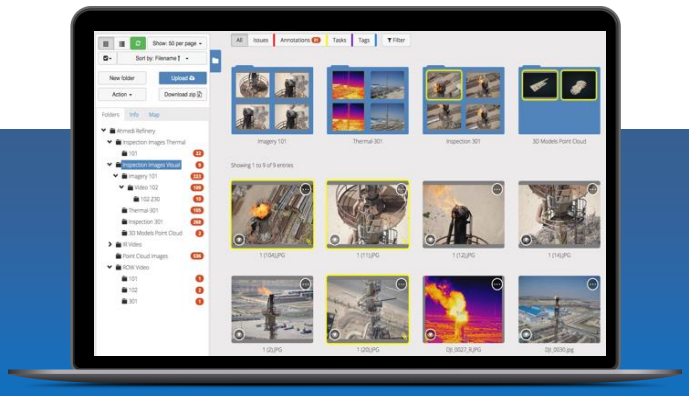
When combined, these three elements represent a process that looks like this:



1. Ingest and manage all the data associated with your UAV Program in one place

2. Provide the necessary visualization and analysis capability so that all stakeholders can access and utilize it to drive real outcomes.

3. Operationalize the end-to-end workflow by providing the right data to the right person at the right time and place so that rapid trouble resolution can occur.



Implementing these elements will provide the basis of a UAV program that can generate real operational improvement, reduce inspection costs and improve overall safety for years to come.

"The visual data collected by Legacy's aerial inspection helps gain valuable insight into assets, save inspection time, and reduce cost. But once we put our data management solution in place, we have been able to improve inspection accuracy and efficiency and provide our clients with the data they need to better manage their assets, their inspection cycles and make more informed decisions. Optelos has taken our program to the next level."

■ *Grey Johnson, Director of TSG, Legacy PSG*

Implement Best Practices to Achieve Optimal Results

Once a robust visual data management system is in place, the focus now shifts to ensuring that a series of best practices are in place, to ensure optimal results and repeatability. Following these steps will ensure optimal results for whatever your specific use case might be.

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5
Identify the specific objectives of your Visual Inspection Program	Select the corresponding sensor type and data collection method	Generate the data type best suited for the objectives	Employ the data analysis methods that aligns with your objectives	Integrate Dispatch our Trouble Ticketing into overall workflow

Let us take a look at these steps in detail.

STEP 1:

Identify the Specific Objectives of your Visual Asset Inspection Program

Too many organizations implement a drone based Visual Asset Inspection program based on the perceived benefits it will bring in inspector safety and reduced inspection cost, but fail to dive one step deeper to identify the specific improvements they are trying to achieve.

This is a critical first step, since every asset type or targeted improvement requires unique program elements in order to achieve optimal results. It is also critical to ensure that there are measurement mechanisms in place to ensure improvements are occurring and enable ongoing adjustments to be made to the program.

The following are some common examples of inspection initiatives where a UAV Inspection Program can yield significant improvements.

Flare Stack Inspection. Turnarounds, inspections, and repairs of Flare Stacks cost millions of dollars, in labor, capital equipment and downtime. Improving any of these elements yield significant financial benefits, in addition to the obvious safety benefits.

Corrosion and Corrosion Under Insulation (CUI) a major source of asset degradation in oil and gas facilities is corrosion. Monitoring the progression of corrosion and detecting corrosion under insulation can yield significant savings by eliminating future service impacting defects.

Methane Leaks. Methane leaks are typically early indications of more severe asset degradation. Effectively detecting these leaks can yield significant savings in repair and asset downtime.

Facility Planning. Facility Turnarounds are expensive, time consuming and often require additional capital investment in equipment to perform inspections. Effectively mapping the facility through the use of accurate 2D and 3D models yields significant financial savings and increase quality.

Once the specific program initiatives are Identified, the next step is identifying the appropriate drone hardware, sensor type, data collection and analysis methods are then selected to achieve optimal results for that specific objective.

STEP 2:

Select the corresponding drone sensor type and data collection method

There is no "one size fits all" when it comes to data collection. Images need to be collected in a manner consistent with the desired outcome and asset type being inspected.

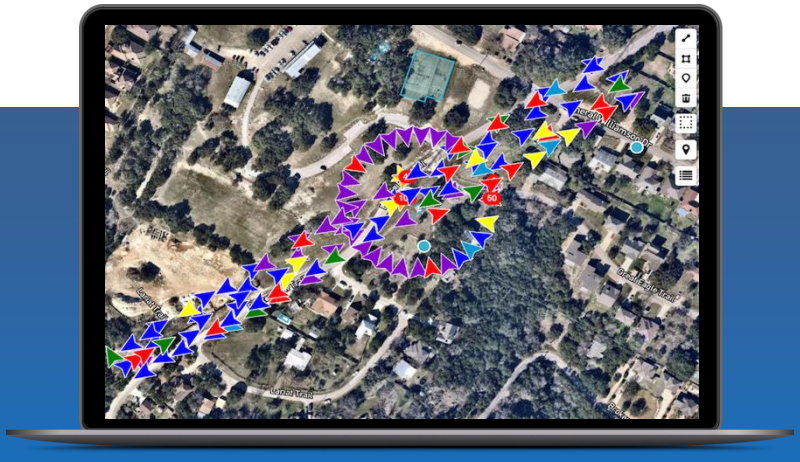
For example Flare Stacks and other vertical assets require different flight paths than Pipelines and other horizontal assets. Using the optimal flight path and technique based on asset type will yield optimal results. For example:

- Pipelines and other horizontal assets will typically require images be collected over a designated area using a "lawnmower" pattern with images collected at 30°, 70° or 90° from the asset in order to build the best 2D Orthomosaic and most accurate 3D model.
- A Flare Stack or other vertical assets such as towers or tanks, will require an orbital flight path at a fixed distance from the asset to collect the best imagery. Multiple orbits should be used, with images collected at various angles, looking directly (90°) at the asset and additional orbits looking 30° up and down at the asset. This imagery is used to build a highly accurate 3D models, which can be used to perform detailed inspections and highly accurate measurements to pinpoint specific asset conditions for geolocation and mitigation.

In addition, images also need to be collected with a high enough resolution camera and at a high enough density so that detailed inspections can take place either through AI assisted inspection or human-in-the loop visual inspection of the asset data.

The table below provides examples of best practices for performing drone data collection based on different inspection objectives.

	Flight Path	Sensor Type	Analysis Methodology
Flare Stack Inspections	Lawnmower pattern for 2D Orthomosaic and multiple orbital paths for photogrammetry to produced detail and accurate 3D Point Cloud	Hi-Res 20-30MP Camera; Thermal sensor	Detailed mechanical measurements using 3D Point Cloud (Digital Twin) and Thermal profile analysis
Corrosion and COI Identification	Flight pattern varies by asset type	Hi-Res 20-30MP Camera, and LiDAR Camera	Changes over time analysis using high resolution images or LiDAR
Methane Leak Detection	Asset Flyover using Methane Sensor	Thermal or Infrared Methane Sensor	Detection through assessment of Thermal of Infrared images or threshold detection
Inspection and Turnaround Planning	High density lawnmower pattern for 2D Orthomosaic and high accuracy 3D Point Cloud	Hi-Res 20-30MP Camera, and LiDAR Camera	Detailed mechanical measurements using 3D Point Cloud (Digital Twin)



Arrows represent flight path, location and orientation of the collected images.

Be sure to know the best flight path required based on the type of asset being analyzed and the type of results required. When the incorrect flight path, proximity to the asset, or camera angle are not optimized, inferior imagery will be captured making proper asset inspections impossible.

STEP 3:

Utilize the Data Type Best Suited for the Objective

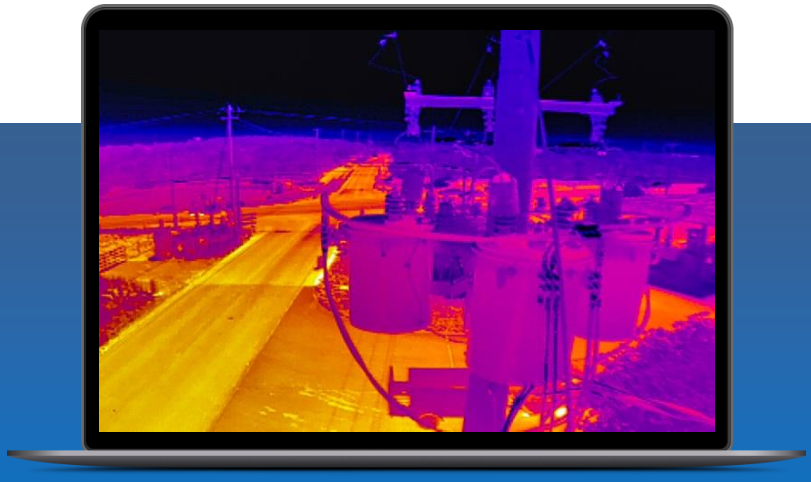
It is important to use the data type that provides the most meaningful results for the desired inspection outcome.

Different data types are best suited for a particular type of analysis. Standard photogrammetry, LiDAR, thermal all have their specific use cases. In cases where temperature variations can identify emerging non-visual defects, then thermal imagery is the best choice for identifying such conditions.

Based on the sensor type, thermal imagery can be used to detect pipeline or tank leaks as well as various hydrocarbon leaks, in addition to thermal variations. Other data source can be used in similar ways.

When inspecting pipelines, flare stacks or other assets for corrosion or dimensional variations, standard photogrammetry using a high-resolution camera or LiDAR are often the best choice.

From these images and assuming the correct flight path is used, highly accurate measurements and visual recognition can be performed. Additionally, Computer Vision AI can be applied to these images to automate the inspection process.



Use of Thermal images can be useful to detect degrading asset conditions. This method works best when changes in thermal profile are leading indicators of emerging issues, such as material leaks or Insulation breakdown.

STEP 4:

Employ the Data Analysis Methods that align with your Objectives

It is important to use the data type that provides the most meaningful results for the desired inspection outcome.

Once the images have been collected using the correct flight path and the sensor best suited for that asset, there are a variety of analysis methods that can be utilized to identify changes in asset condition.

Photogrammetry or LiDAR generated 3D Point Clouds, create a "real world" Digital Twin of an asset. These Digital Twins allow highly accurate measurements to be performed and a variety of asset conditions to be identified and monitored.

When 3D point clouds are generated over a fixed timeline and compared, variations such as dimensional changes, and corrosion can be easily identified and mitigated before they are service impacting or create safety or compliance issues. With centimeter level accuracy, 3D Point Clouds also serve the basis for performing any detailed measurements on the asset for material and repair planning.

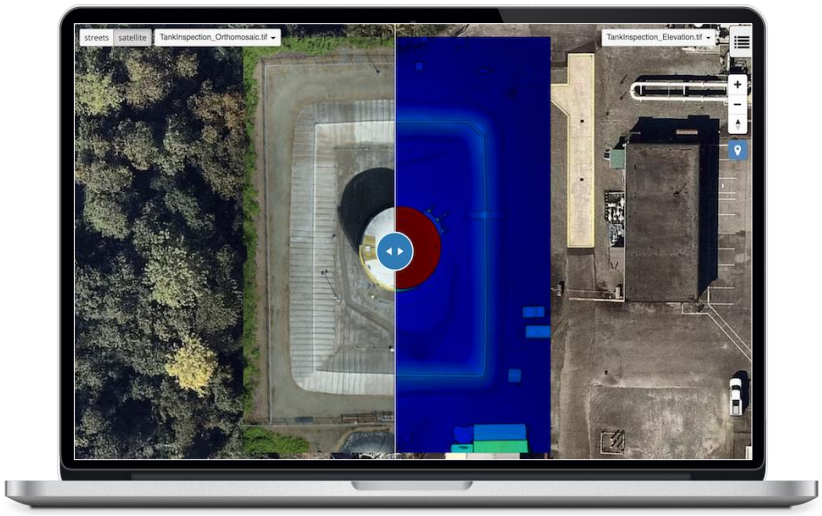
3D Point Cloud / Digital Twins
3D Point Clouds are particularly useful for Inspection planning during facility turnarounds. Accurate 3D models can replace the need for scaffolding or cranes, saving tens-of-thousands of dollars per day, as well as eliminate the need to put inspectors in elevated locations, providing tremendous safety benefits.

3D models, specifically 3D point clouds tend to work best when accurate measurements of assets need to be performed. Measuring cracks or separation conditions or areas of damage for calculating material needs are all examples where using a 3D point cloud can be used.

2D Orthomosaic Model

2D Orthomosaic maps are typically used to provide detail mapping of overall sites, buildings or larger geographic areas that need to be analyzed.

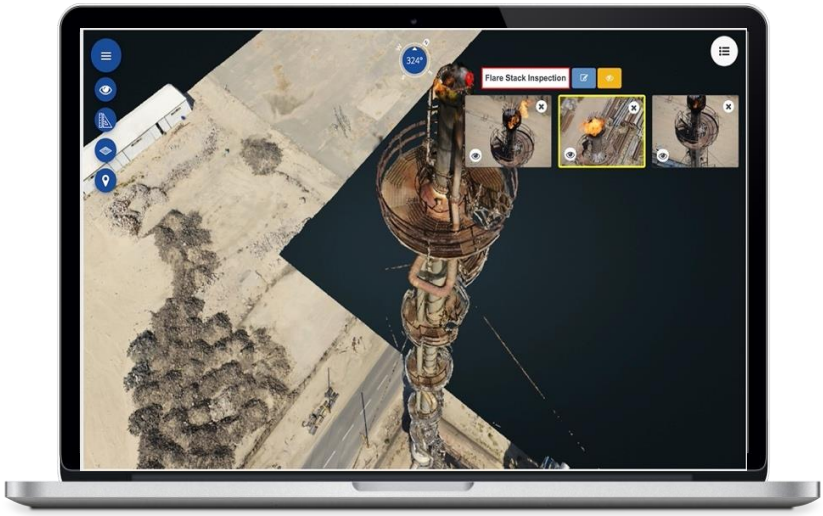
Orthomosaic maps can also be used for detecting elevation changes and vegetation encroachment.



2D Orthomosaic models provide the best way to view a location in a highly accurate top-level view. The Optelos Ortho-Overlay™ tool provides the capability to easily see changes over time or across different spectrums or data types. This is a great way to track the progress of construction activity, expansion of water reservoirs, leak activity and changes in elevation.

Geolocate Detailed imagery and Other Data Sources Directly to the Digital Twin

Ultimately the best results are obtained when multiple data sources can be geolocated to a given asset. The ability to utilize a 3D model ("Digital Twin") and assign and geo-locate additional data sources to it is critical in rapidly identifying issues and generating new and intelligent outcomes from the data. Videos, 360° cameras and thermal imagery are all great examples of additional data sources that can assist inspectors in rapidly diagnosing asset conditions and speeding trouble mitigation.



Geolocating all relevant data sources to a 3D point cloud is the best way to ensure that all decisions are based on the most current data associated to a given asset. Flare stack repair history, engineering drawings and service reports can all be correlated and geolocated to the specific asset for improved analysis and resolution.

Utilize computer vision AI to help automate the inspection process. Once the Data Management platform is in place to properly run and manage the overall visual asset inspection program, and the proper data collection and data analysis methods are in place, the next logical step is to employ AI to either augment the manual inspection process or automate the identification of specific asset conditions.

AI is great for processing large amounts of visual data, but it's important to keep in mind, it is not meant to full replace human inspection.

The best deployments of AI will have the AI processing large volumes of images in order to present the images most likely to contain fault conditions to the inspector. This can save significant time and manpower in identifying and mitigating critical asset conditions.

AI can be used to automate the identification of critical asset failures and map it to a specific geolocation. With this information the inspection team is able to schedule the repair activity, identify material needed to perform the repair, saving significant time and expense.

When AI is properly utilized, it can lead to a greater that 60% reduction in inspection and mitigation expenses.

STEP 5:

Integrate Dispatch or Trouble Ticketing into the overall workflow

Sustainable improvements are not fully realized until this new visual data and the inspection results are part of an end to end workflow that puts the right data in the hands of the right people at the point of impact.

This mean employing a system that that allows the pertinent inspection data, geolocation information and any other pertinent repair and asset data to be associated with the specific dispatch event or generated trouble ticket. In that way the repair technician and inspection teams have all the data they need to appropriate plan for the repair activity and more rapidly mitigate the issue.

This provides significant improvement in repair time and can also provide significant improvement in inventory of repair materials.

Bringing It All Together

In order to get the most out of your UAV program and turn the collected data into actionable insights and sustainable results follow these guidelines.

1	**Implement a robust Data Management platform –** Every UAV program must be built on the base of a solid visual data management platform that facilities management of all data sources, supports collaboration and analysis capabilities.
2	**Identify the Specific Objectives of your Visual Asset Inspection Program.** Make sure you start with clear understanding of your inspection needs.
3	**Select the corresponding sensor type and data collection method.** How you collect the data is as important how you analyze it.
4	**Utilizes the Data Type Best Suited for the Objective.** Determine the data formats such as images, videos, thermal, Orthomosaic maps, or 3D models that best aligns with your inspection goals.
5	**Employ the Data Analysis Methods that align with your Objectives.** Employ the right data analysis methods and reality models to best identify desired asset conditions.
6	**Geolocate Detailed imagery and Other Data Sources Directly to the Digital Twin.** Geolocate all relevant data source to create a more complete view of inspection assets.
7	**Utilize vision AI to Automate the inspection process.** Incorporate AI where a high volume of images need to be processed or to automate defect detection.
8	**Integrate Dispatch or Trouble Ticketing into the overall workflow.** Use the outcomes from the analysis to equip field personal to rapidly mitigate issues.

ABOUT OPTELOS

CONTACT US:
info@opteos.com

Optelos is leading the way companies think about Asset Inspection and Management.

Let us help you take your Drone Inspection program to the next level. We'll show you how to employ the best practice and put a system in place that will finally allow you to achieve real cost improvements and get the ROI you've been looking for.

Contact us to today and let us assess your current drone program and show you how to get the most value out of all your collected data.