

Blade Counter (v2.1)

User Guide for the Mentor Visual iQ+



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1. Introduction

Waygate Technologies' now offers artificial intelligence based feature detection technology for counting blades passing through the live scene during in-situ gas turbine visual inspections.

All of this is now made possible using Mentor Visual IQ+ borescope platform.

Based on the Inspection Works ecosystem, algorithms (analytics) can be deployed to the borescopes, placing enhanced technology capability at the point of inspection.

The ability to count blades during live video visual inspections enables the User and subsequent reviewers to identify individual blades without subjectivity or influence by human error.

Inspections become more objective; more consistent; more productive.

2. What is the Blade Counter Analytic?

Waygate Technologies has developed the ability to count and display the number of blades passing through the scene during live in-situ gas turbine visual inspections.

It has the ability to:

- Count up or count down (bi-directional).
- Dynamically track the blade so that probe movement is now permissible during the count.
- Dynamically track the blade so that the blade count label tracks the blade as it moves through the scene. This can be deactivated if required.
- Start the count with User-defined number (default set to '1'). This can be changed at any point during the inspection as required.
- Enter total number of blades within stage (if known). This can be changed at any point during the inspection as required.
- Customize location of 'blade count' label to coincide with specific User requirements.
- Operate on all rotating stages: compressor & turbine.

2.1 What's new in BC2.1?

Blade Counter version 2.1 includes general enhancements to the detection model, tracking capabilities and counting logic resulting in an even more robust tool to count blades during the live inspection of compressor and turbine blades within Gas Turbines.

This analytic is less sensitive to probe rotation. Counting blades even when they are up to 45 degrees from their standard vertical or horizontal orientation is now possible.

We also fixed a left bias, so that blade detection and tracking is now much more centered within the field of view.

3. Warnings

Analytic applications are intended to assist the User whilst performing in-situ visual inspections.

Results will vary depending on your application and the method employed during setup.

The User is responsible for following the appropriate procedures and standards.

Waygate Technologies cannot be held responsible for the accuracy and outcome of any inspections.

Users must review this user guide for its intended use and limitations prior to use.

4. Prescribed usage

This analytic is designed to operate whilst performing routine gas turbine visual inspection tasks using the Mentor Visual IQ+ borescope.

It has been developed based on a range of gas turbines from industry leading OEMs and trained to work on all rotating stages: compressor and turbine.

5. Dependencies

- Only operable on the Mentor Visual IQ+ (MViQ+) borescope
- Operating software version 4.11 or later
- Activated with MVIQ-BLADECOUNT Feature Key (free trial or purchased)

Blade Counter analytic will only function if MViQ+ is in the 'live' video state.

To prevent miss-counting, it is recommended engine rotation is stopped before entering other states e.g. Global Menu, Settings, Measurement or Freeze Frame etc. The analytic will resume operation once returned to the 'live' state.

Probe Movement: blade counter analytic continues to function if MViQ+ probe is moved provided the given blade remains within the scene. A function to reveal the 'tracking region' or Bounding Box is available. This can be activated to enable the User to help optimise the blade position to ensure consistent blade detection and tracking. Viewing the Bounding Box also helps to serve as an easy way to help the User identify the blade being counted if the Blade Count Tracking function is turned OFF.

Probe Rotation: blade counter analytic is optimized for images that present the blades in either the vertical or horizontal orientations. Angled poses can sometimes present challenges that can result in sporadic detection and counting performance.

Image Transforms: these are the functions available to Users that affect the appearance of the live video e.g. brightness, dark boost and distortion correction. There are however certain image transforms that are not permissible once the Blade Counter analytic is activated. As a result, they are deactivated whilst using Blade Counter. They are:

- Invert
- Single view
- Rotate.

6. Operating instructions (4.11 Mentor Visual iQ+ Release)

6.1 Activating/de-activating the analytic

1. Enter MViQ+ Global Menu and select 'Analytics'
2. Review and accept disclaimer
3. 'Analytics' page is now displayed.
4. Select 'Blade Counter' tile and toggle from 'off' to 'on' state
5. Press 'Done' softkey

Note the appearance of the analytics icon positioned in the status bar. This remains visible when one or more analytic has been activated.

Repeat this procedure to de-activate the analytic albeit tap the tile from 'on' to 'off' within Step 4.

6.2 Using the Blade Counter Analytic

6.2.1 Setup overview

Upon activation of Blade Counter analytic (outlined within Section 6.1), the User is first presented with two simple questions:

- Enter the total number of blades for that given stage. This function enables the counter to return to blade number 1 at the appropriate point to ensure a complete revolution had been performed (Figure 8a). Maximum limit is 999 blades.
- Enter the blade number upon which the inspection begins. Number '1' is the default (Figure 8b).

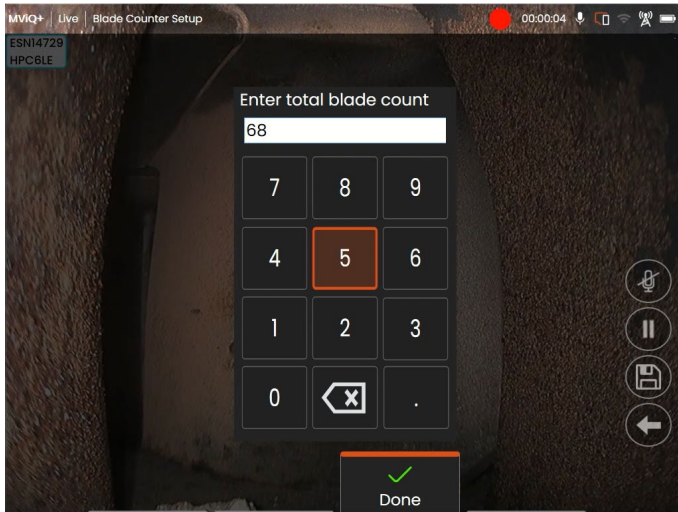


Figure 8a. 'Enter total number of blades' prompt

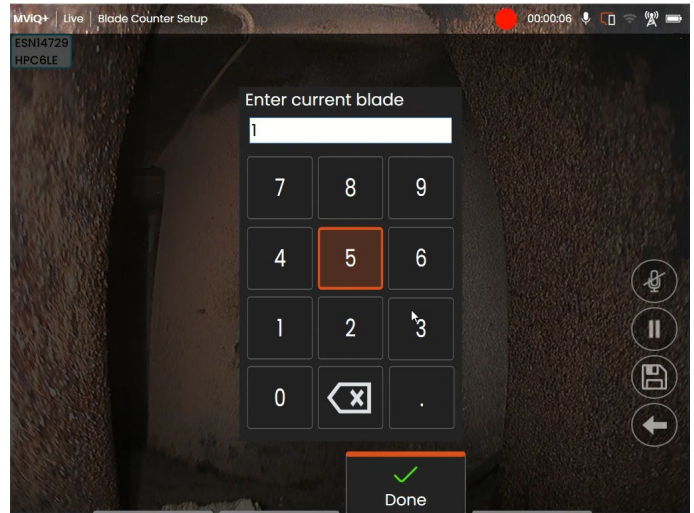


Figure 8b. 'Enter current blade' prompt

Now press 'Done'. The analytic immediately starts and will attempt to detect a blade within the scene.

Some minor probe movement or blade rotation may indeed be required if a blade is not immediately detected.

Once detected, the blade count label immediately relocates to the detected blade (Figure 9) and the inspection may begin.

The label or text box can be treated like any other text box and so can be moved to suit the User's preference. Note: the label can only be moved within the confines of the Bounding Box (whether it is visible or not).



Figure 9. Blade Counter active showing blade number text box.

Note however, as stated in Section 5 (‘Dependencies’), the analytic will pause when the borescope enters a different state. For example, when editing or adjusting position of the label or text box. An amber banner is temporarily presented to warn the User of this risk. It is best practice to pause engine rotation should it be needed to enter into a different state. Returning to the ‘live’ state will reactivate the analytic and counting will resume.

Upon completion of an inspection of one given stage of blades, it is best practice to stop and then restart the analytic once the probe is repositioned to view the next stage of blades.

6.2.2 Blade Counter Bounding Box: On/Off

Each detected blade is labeled by both a text box and a bounding box. The text box is always visible when the analytic is in operation. The bounding box however can be turned ON or OFF dependent on User preference.

Viewing the Bounding Box can help the User visualize how the blade is detected as it passes through the scene.

It can be turned ON or OFF at any point during its use.

From the ‘live’ state, press ‘Image’ softkey and press the ‘Blade Counter Bounding Box’ tile to re-reveal the tracking region (Figure 10a, 10b, and 10c).



Figure 10a. Blade Counter active showing ‘live’ state.

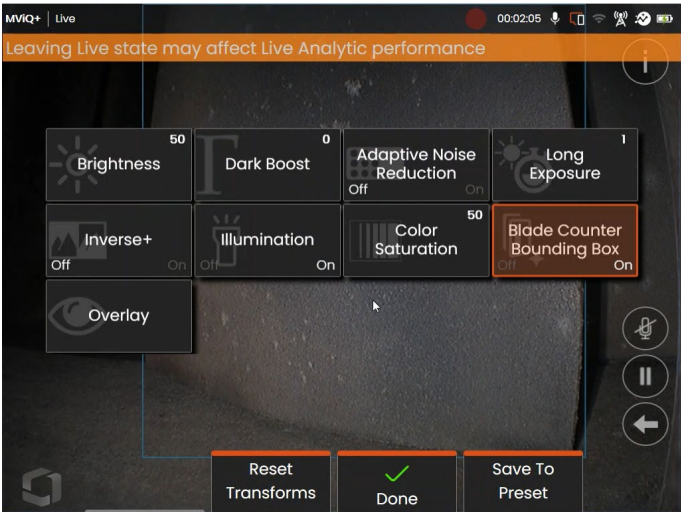


Figure 10b. ‘Image’ sub-menu showing all image transforms. This view differs dependent on MVIQ+ model.



Figure 10c. Blade Counter active Bounding Box

Repeat this process to de-activate the Bounding Box at any point during the inspection. Remember however to pause engine rotation to ensure the analytic does not miss-count.

Note: unlike the label or text box showing the blade number, the Bounding Box is not saved nor therefore visible within saved images. It is however visible within saved video.

6.2.3 Blade Counter Settings

Additional functionality can be exploited by accessing Settings > Analytics page as shown in Figure 11.



Figure 11. Blade Counter settings page

The following functions are available within the Settings page:

- ‘Current Blade’ – change the blade count label at anytime during the inspection. For instance, when needing to reset the count back to blade ‘1’.
- ‘Total Blades’ – change the total blade count for the stage being inspected here.
- ‘Counting Direction’ – the counter is designed to count-up when the first blade rotates in a given direction. This option allows the User to change the direction of count at any time during the inspection.
- ‘Blade Count Tracking’ – provides the ability to enable or disable the blade count label. If turned OFF, then it is recommended to turn ON the blade counter Bounding Box (see Section 6.2.2) to help identify which blade corresponds to the label.

7. Technical Support

Technical Support contact information follows:

Global Phone: 1-866-243-2638 (Mon – Fri 8:00 AM – 5PM E.S.T. North America)

Waygate Technologies Remote Service

email: RemoteService@BakerHughes.com

Please also provide the following important details:

- Handset model number
- Handset serial number

8. Revision history

Revision number	Date issued	Reason
1.0	January 2024	Launch of Blade Counter v2.1 for MVIQ+
1.1	April 2025	Reflect the introduction of Blade Counter version 2.1 with improved counting performance as part of the MVIQ+ v4.11 release.

9. Frequently Asked Questions (FAQs)

Q: How do I obtain this Blade Counter analytic?

A: Dependent on the MViQ+ model, Blade Counter v2.1 is either available as a 90-day free trial or included within a 1 or 2 year Enhanced or Pro package. After the given period of time has elapsed, contact your local Waygate Technologies sales representative.

Q: Is it possible to modify or enhance this Blade Counter analytic for other engine variants; other components or scenes?

A: Yes. Waygate Technologies are committed to delivering Inspection Solutions to the industry. Please contact your local Waygate Technologies sales representative to discuss your needs.

Q: What is 'artificial intelligence based feature detection technology' within the Blade Counter analytic?

A: This analytic has been trained to detect an extensive range of blades found within the typical aviation based gas turbine. It automatically detects, tracks and labels blades.

Q: Why should I consider using the Blade Counter analytic?

A: Provides ability to display a blade number during a live visual inspection.

A: Reduces human factors associated with engine inspections. No more mis-counting, mis-labeling or missed blades.

A: Reduces inspection time by not having to perform manual annotation.

A: Improves consistency and reliability of inspection tasks.

A: Reduces the probability of missing blades during visual inspection tasks.

A: Increases the overall quality of inspection output. Blade Count output can be preserved within i) live video recording or ii) still image capture(s) and therefore embedded into an inspection report.

Q: Which engine components is it designed to operate on?

A: Designed to work on all gas turbines albeit largely tested on commercial aerospace engines.

Q: How was this Blade Counter analytic validated?

A: Extensive testing on a variety of aero-derived gas turbine architecture. This analytic has not been validated by any gas turbine OEM but extensively tested by Waygate Technologies.

Q: Which tips or Optical Tip Adapters (OTA's) are needed for this Blade Counter analytic to function?

A: The analytic is not dependent on tips or Optical Tip Adapters. Stereo measurement OTA's are also compatible provided the 'single view' image transform is not activated.

Q: Will this Blade Counter analytic work for all MViQ+ probe diameter options? i.e. 4mm, 6mm and 8mm

A: Yes.

Q: What factors affect the performance of the analytic?

A: Excessive blade rotation speed.

A: Excessive probe movement.

A: Probe twist or rotation. Best practice to present probe in the correct orientation.

A: Target distance from probe.

A: Illumination settings.

A: Significant damage on blade edges resulting in local disruption of edges entering tracking region.

A: When probe is removed or rotated from the original set of blades to view another set. It is best practice to reset the analytic during each stage.

Q: Will this analytic work on the MViQ 'Grey' or MViQ 'Flame' handsets?

A: No.

Q: Can I use this Blade Counter analytic whilst inspecting non-aerospace gas turbine variants?

A: Yes although very likely to function, Waygate Technologies is unable to guarantee its performance on Gas Turbine within other applications.

Q: Does the MViQ+ need to be digitally connected in some way e.g. to the internet, in order for this analytic to work?

A: No. Once the analytic is installed on to the MViQ+ handset, it does not require internet connectivity to function.

Q: Can I use the Blade Counter analytic post-inspection on the MViQ+ device?

A: No. This analytic operates on live images only within the MViQ+ device.

Q: Can this Blade Counter analytic be accessed and operated from within Waygate Technologies Inspection Manager software?

A: No. This analytic operates on live images only within the MViQ+ device.

10. Glossary

AI based Feature Detection Analytic	Algorithm trained to recognize blades within the typical aviation based gas turbine. When rotation is detected, the algorithm tracks its location and begins to count when additional blades enter the scene.
Scene	The scene or sometimes known as, Field of View, is the image presented to the borescope probe.
Bounding Box	A box encapsulating the component or blade when counting has begun. Can be toggled to view ON or OFF.