

Applications of Artificial Intelligence in Flight Inspection and Procedure Validation

Larry Brady

Airfield Technology, Inc.
Olathe, Kansas USA
Lbrady@airfield.com



BIOGRAPHY

Mr. Brady is president, managing director and co-founder of Airfield Technology, a US company that designs and manufactures Flight Inspection Systems.

In 1983 he graduated from Ohio University with a degree in Electrical and Computer Engineering. During his career Mr. Brady has worked at King Radio Corporation, Ohio University Avionics Engineering Center, and Aviation Systems, Inc. In 1991, Mr. Brady and others founded Airfield Technology.

Mr. Brady has served as a member of the ICASC committee since 2004.

ABSTRACT

Artificial Intelligence (AI) is expected to influence many areas of aviation, but its future in the specialized fields of flight inspection and procedure validation has received limited discussion. By examining both opportunities and constraints, this paper seeks to provide a structured perspective on what the future of AI in flight inspection may realistically entail and to inform ongoing discussion, research priorities, and standards development within the flight inspection community.

INTRODUCTION

Artificial Intelligence (AI) has recently emerged as a powerful analytical capability with rapidly expanding applications across many technical disciplines. The rate of development and adoption of AI-based tools has been exponential, with new methods and use cases being introduced on a continual basis. In many engineering and operational environments, AI is already being used to assist with data analysis, pattern recognition, and decision support.

At the same time, it is recognized that current AI technologies are still in an early stage of development. While capable of producing useful results, they are also known to exhibit limitations, including the generation of incorrect or non-validated information, sensitivity to input data quality, and lack of inherent understanding of the physical systems being analyzed. These characteristics require that AI outputs be carefully evaluated and not accepted without appropriate verification.

In the context of flight inspection and procedure validation, these considerations are particularly important. These disciplines are based on precise measurements, well-defined tolerances, and established operational and regulatory frameworks.

The results of flight inspection activities directly support the certification and continued operation of air navigation systems and instrument flight procedures, and therefore must be reliable, traceable, and defensible.

While it is possible to speculate on a wide range of potential future applications of AI, the more immediate and practical question is how such capabilities may be used appropriately within the existing framework of flight inspection and validation. This includes not only identifying areas where AI-based tools could provide useful analytical support, but also defining clear boundaries to ensure that their use does not compromise established processes, responsibilities, or levels of safety.

Accordingly, this paper considers the potential role of AI as a supporting analytical capability within flight inspection and procedure validation, with particular attention to what such systems may reasonably be used for, and equally important, what they should not be used for.

SCOPE

This paper considers the potential applications of AI as a supporting capability within the fields of flight inspection and procedure validation.

It is provided as a reference commentary from the author's unique perspective, formed over more than four decades of first-hand engineering and operational experience in the flight inspection and validation fields.

The intent is to examine where AI may be useful, recommend some clear limits and boundaries, and to emphasize the importance of protecting the integrity of existing processes which maintain a human-in-the-loop.

AI is not considered as a replacement for existing processes or personnel. It is treated solely as a tool to support analysis and improve understanding of complex system behavior. All operational, evaluative, and certification decisions should remain the responsibility of qualified personnel operating within established regulatory frameworks.

CURRENT FLIGHT INSPECTION AND PROCEDURE VALIDATION PROCESSES

Flight inspection and procedure validation are mature disciplines supported by well-established systems, methodologies, and regulatory frameworks. Modern Flight Inspection Systems (FIS) are capable of acquiring, synchronizing, and processing data from multiple sources with a high degree of accuracy, ensuring that measurement results meet defined uncertainty requirements and are suitable for operational and certification purposes.

These activities are inherently system-level in nature, involving the interaction of airborne equipment, ground-based navigation or surveillance systems, signal-in-space characteristics, and operational procedures. The processes used for evaluation are based on defined criteria and tolerances, and have proven effective in ensuring the safe and consistent performance of air navigation services and instrument flight procedures.

While the measurement and evaluation processes are well established, the overall environment has become increasingly complex. This includes the integration of multiple navigation and surveillance systems, the use of advanced signal processing techniques, and the continued evolution of performance-based navigation and GNSS-based operations. As a result, the volume and diversity of data available during flight inspection and validation activities have increased significantly.

The interpretation of this data, and the efficient use of it to support operational decision-making, remains dependent on the experience and judgment of the flight inspector or validation specialist. In many cases, this involves consideration of system behavior over time, comparison of multiple data sources, and identification

of conditions that may not be immediately apparent from individual measurements.

In this context, while existing systems and processes provide the necessary capability to perform flight inspection and validation effectively, there is an opportunity to enhance efficiency, consistency, and analytical support through the use of additional tools and methods.

OPPORTUNITIES FOR AI APPLICATION

Within the context of flight inspection and procedure validation, AI may provide value as an additional analytical capability in a number of areas. These opportunities are not associated with correcting deficiencies in existing systems or processes, but rather with improving efficiency, consistency, and the effective use of available data.

Analysis of Measured Data

One area of potential application is in the analysis and interpretation of measurement data. While modern Flight Inspection Systems provide accurate and well-correlated data, the volume and complexity of this information can be significant. AI-based tools may assist in identifying patterns, trends, or subtle conditions within these datasets that may not be immediately apparent, particularly when comparing multiple runs, systems, or time periods.

Correlation of Data

AI may also support the correlation of data across multiple sources and operational contexts. Flight inspection and validation activities often involve the interaction of airborne measurements, ground system behavior, environmental conditions, and procedural design. The ability to relate these factors may provide additional insight into system performance and behavior.

Mission Planning and Execution

Another area of potential benefit is mission planning and execution. The design of efficient flight inspection missions, including selection of flight schedules, sequencing of tests, and management of operational constraints, requires consideration of multiple variables. AI-based tools may assist in optimizing these factors to improve efficiency while maintaining required coverage and data quality.

Support for Engineering and Maintenance Activities

AI may also provide value in supporting engineering and maintenance activities. For example, analysis of inspection results in conjunction with historical data may assist in identifying conditions that could inform adjustment or maintenance of ground-based navigation or surveillance systems. In this context, AI may support the flight inspection team in providing timely and informed feedback to ground engineers.

Flight Inspection System Design and Development

In addition, AI may be applicable in the design and development of flight inspection systems themselves. The design of hardware and software components, as well as the validation of system performance, may benefit from analytical techniques capable of identifying relationships or behaviors within complex datasets.

Real-Time or Near-Real-Time Analysis

There is potential for AI to assist in real-time or near-real-time analysis during flight inspection or validation activities. While not replacing the role of the inspector, such capabilities may provide additional situational awareness or highlight conditions of interest during mission execution.

Training and Proficiency Development

AI may also provide value in training and proficiency development for flight inspection and procedure validation personnel. The ability to analyze large sets of historical inspection data and operational scenarios may support the development of training materials that better reflect real-world conditions. In this context, AI could assist in identifying representative cases, highlighting relevant system behaviors, and supporting more consistent training outcomes.

Simulation

Simulation is another area where AI may offer benefits in support of procedure validation. Simulation is commonly used to evaluate instrument flight procedures, including assessment of flyability, navigation system performance, and interaction with aircraft avionics. AI-based tools may enhance these simulations by enabling more realistic modeling of navigation system behavior, environmental conditions, and operational variability. This may improve the effectiveness of simulation as a tool for evaluating procedure performance prior to operational use.

Procedure Design Feedback

In addition, AI may support feedback into procedure design. The results of flight validation activities provide valuable information regarding how procedures perform in actual operational use. AI-based analysis of these results, particularly when considered across multiple procedures or environments, may assist in identifying trends or conditions that could inform future procedure design. This may contribute to improved consistency and effectiveness in the development of instrument flight procedures.

LIMITATIONS AND OPERATIONAL BOUNDARIES OF AI APPLICATION

General Characteristics and Limitations of AI

Artificial Intelligence (AI), as currently implemented, operates as a data-driven analytical tool. While it can be provided with detailed information describing physical systems, its outputs remain based on pattern recognition within input data rather than direct understanding of those systems. AI does not independently verify the correctness of its results against actual system behavior, nor does it confirm consistency with real-world conditions.

As a result, outputs produced by AI systems may appear technically valid and internally consistent, but may not accurately reflect the performance or characteristics of the system being evaluated. Such outputs may contain errors or invalid conclusions that are not immediately apparent.

The accuracy of AI-generated results is dependent on the quality, completeness, and relevance of the input data, as well as the assumptions and limitations of the analytical methods used. These characteristics are inherent to the current state of AI technology and are not specific to any particular implementation.

Accordingly, outputs produced by AI systems must be treated as advisory in nature and subject to independent verification.

Examples of Observed AI Error Behavior in Practical Use

The following examples are provided to illustrate observed characteristics of AI systems when applied to technical tasks relevant to flight inspection and validation.

In one instance, an AI system generated a command sequence for a GNSS receiver that appeared technically plausible but did not exist. The generated command included parameters and usage consistent with expected syntax, but did not exist in the receiver documentation. The output was presented with a high degree of confidence, despite being incorrect. This demonstrates that AI systems may produce information that is syntactically and contextually consistent, but not technically valid. Further details are provided in Appendix A.

In another case, an AI system was used to perform a best-fit straight-line linear regression analysis as part of an ILS glidepath Reference Datum Height (RDH) study. The resulting output contained an arithmetic error, which was identified through comparison with independently verified data. This illustrates that even when performing basic analytical functions, AI-generated results may contain errors that are not immediately apparent. Further details are provided in Appendix B.

These examples are representative of behaviors that must be considered when applying AI within technical and safety-related domains.

Implications for Flight Inspection and Procedure Validation

Within the context of flight inspection and procedure validation, these characteristics have direct operational implications.

The evaluation of navigation systems and flight procedures requires a high degree of confidence in the accuracy, traceability, and consistency of analytical results. AI-generated outputs, while potentially useful, cannot be assumed to meet these requirements without independent verification.

Accordingly, AI is not suitable for roles that require authoritative determination of system performance or compliance with established standards. This includes, but is not limited to, certification decisions, acceptance of navigation facilities, and validation of instrument flight procedures.

The use of AI is therefore limited to supporting roles in which its outputs can be evaluated and verified by qualified personnel.

Operational and Functional Boundaries

It is emphasized that AI, within the context of flight inspection and procedure validation, is considered only as a supporting tool.

AI may be used to support analysis, improve consistency, and provide additional insight into complex data, provided that its outputs remain subject to verification by qualified personnel.

It is necessary to ensure that AI-based systems:

- Do not replace the role of the flight inspector or flight validation pilot;
- Do not make operational or certification decisions;
- Do not alter or override established inspection procedures or criteria.

The use of AI must not compromise:

- Measurement traceability;
- Transparency of analysis;
- The integrity of established inspection and validation processes.

All evaluation, interpretation, and certification decisions must remain the responsibility of qualified personnel operating within established regulatory frameworks.

These boundaries are essential to ensure that the use of AI enhances, rather than compromises, the safety and integrity of flight inspection and validation activities.

CONCLUSIONS

Artificial Intelligence (AI) represents a powerful analytical capability with growing application across engineering and operational disciplines, including flight inspection and procedure validation. Within these fields, AI offers opportunities to improve efficiency, support analysis, and enhance the use of increasingly complex and multi-source data.

Flight inspection and validation are mature disciplines supported by well-established methodologies, systems, and regulatory frameworks that have proven effective in ensuring the safe and consistent performance of air navigation services and instrument flight procedures.

AI may provide value as a supporting tool in areas such as data analysis, correlation of multi-source information, mission planning, system development, training, and procedure design feedback. When applied appropriately, these capabilities may assist flight inspection and validation personnel in gaining additional insight into system behavior and improving overall operational efficiency.

At the same time, the current characteristics of AI systems require careful consideration. As demonstrated, AI-generated outputs may appear technically valid while containing errors or invalid conclusions, and do not include independent verification against actual system behavior. These limitations are inherent to the present state of the technology and must be recognized in any operational application.

Accordingly, the use of AI within flight inspection and procedure validation must remain limited to supporting roles. All evaluation, interpretation, and certification decisions remain the responsibility of qualified personnel operating within established regulatory frameworks. The integrity of existing processes, including measurement traceability, transparency of analysis, and human-in-the-loop decision-making, must be preserved.

The appropriate use of AI is therefore not a question of replacement, but of careful integration. When applied with a clear understanding of its capabilities and limitations, AI may serve as a useful analytical tool that enhances, rather than alters or replaces, the established practices of flight inspection and procedure validation.

APPENDIX A

ChatGPT Hallucination of GNSS Receiver Command

ChatGPT ▼ Share ⋮

Is there a way to limit the maximum number of satellites used in the position solution for the Novatel OEM7 receiver?

Yes, the NovAtel OEM7 receiver allows you to limit the maximum number of satellites used in the position solution. This can be achieved using the `SATUSECONFIG` command, which provides control over satellite usage in position calculations. Hexagon DownL... +9

Using the `SATUSECONFIG` Command

The `SATUSECONFIG` command enables you to specify:

- **Maximum Number of Satellites:** Set the upper limit on the number of satellites the receiver uses in its position solution.
- **Satellite Selection Criteria:** Define criteria such as signal strength, elevation angle, or satellite health to determine which satellites are included.

For example, to limit the receiver to use a maximum of 8 satellites, you would issue the following command:

```
SATUSECONFIG MAXSAT 8
```

This command instructs the receiver to use no more than 8 satellites when computing its position.

Additional Considerations

- **Minimum Elevation Angle:** You can set a minimum elevation angle to exclude satellites that are low on the horizon, which often have poorer signal quality. This is done using the `SATELEVATIONMASK` command.
- **Signal Strength Threshold:** To exclude satellites with weak signals, you can define a minimum signal-to-noise ratio (SNR) threshold using the `SATSNRMASK` command.
- **Satellite Health:** The receiver automatically excludes unhealthy satellites based on broadcast ephemeris data. NovAtel Docume...

Reference

For detailed information on configuring satellite usage, refer to the [OEM7 Commands and Logs Reference Manual](#). NovAtel Docum... +6

If you need assistance with specific command syntax or further configuration, feel free to ask!

 Sources

Sorry but I don't see the SATUSECONFIG command in the OEM7 Commands and Logs Reference Manual. Can you please help?

Apologies for the earlier confusion regarding the SATUSECONFIG command. Upon reviewing the NovAtel OEM7 documentation, it appears that there isn't a command by that name available for configuring satellite usage.

To manage the number of satellites used in the position solution on a NovAtel OEM7 receiver, you can consider the following approaches:

1. Elevation Masking

Use the `SATELEVATIONMASK` command to set a minimum elevation angle. Satellites below this angle will be excluded from the position solution, effectively reducing the number of satellites considered.

2. Signal Strength Threshold

Employ the `SATSNRMASK` command to define a minimum signal-to-noise ratio (SNR) threshold. Satellites with SNR below this threshold will be disregarded in the position computation.

3. Satellite Exclusion

If you wish to exclude specific satellites, the `EXCLUDESAT` command allows you to specify particular satellites to be ignored by the receiver.

While these methods don't directly set a maximum number of satellites, they provide control over which satellites are used, indirectly influencing the total count.

For detailed information on these commands and their usage, please refer to the [OEM7 Commands and Logs Reference Manual](#).

If you need assistance with the syntax or implementation of these commands, feel free to

ask!


Is there a SATUSECONFIG command for the Novatel OEM6 receiver?

Apologies for any confusion in my earlier responses. After reviewing the available documentation, it appears that the `SATUSECONFIG` command is not present in the NovAtel OEM6 receiver firmware.

To manage the number of satellites used in the position solution on an OEM6 receiver, you can consider the following approaches:

1. Elevation Masking

Use the `SATELEVATIONMASK` command to set a minimum elevation angle. Satellites below this angle will be excluded from the position solution, effectively reducing the number of satellites considered.

2. Signal Strength Threshold

Employ the `SATSNRMASK` command to define a minimum signal-to-noise ratio (SNR) threshold. Satellites with SNR below this threshold will be disregarded in the position computation.

3. Satellite Exclusion

If you wish to exclude specific satellites, the `EXCLUDESAT` command allows you to specify particular satellites to be ignored by the receiver.

While these methods don't directly set a maximum number of satellites, they provide control over which satellites are used, indirectly influencing the total count.

For detailed information on these commands and their usage, please refer to the [OEM6](#)

[Family Firmware Reference Manual.](#) Hexagon Downl... +4

If you need assistance with the syntax or implementation of these commands, feel free to ask!



APPENDIX B

Google Gemini Mis-Calculation of Series Mean

There seems to be an error calculating the mean height, please check?

Correct, there was an error in the previous manual step calculation for the **mean height (\bar{Y})** and the resulting **ARDH**. Using the Python engine to verify the 11-sample standard (6,000 ft to 1,000 ft) with the **400 ft lateral offset**, here are the corrected results.

1. Corrected 11-Sample Data Set

Geometry: $X_{ant} = X + 1,000$, $L = 400$, $\theta = 3.0^\circ$ ($\tan \theta \approx 0.052408$).

Sample	X (Threshold)	D (Ground Distance)	Height (Y)
1	6,000	7,011.42	367.45
2	5,500	6,512.30	341.29
3	5,000	6,013.32	315.14
4	4,500	5,514.53	289.00
5	4,000	5,015.97	262.88
6	3,500	4,517.74	236.76
7	3,000	4,019.95	210.68
8	2,500	3,522.78	184.62
9	2,000	3,026.55	158.61
10	1,500	2,531.79	132.69
11	1,000	2,039.61	106.89

2. Corrected Statistical Values

- Mean Distance (\bar{X}): **3,500.00** ft
- Mean Height (\bar{Y}): **236.91** ft (Previously miscalculated)
- BFSL Slope ($\tan \theta_p$): **0.052142**