New Principles
Wake Vortex Safety

“NEW PRINCIPLES OF WAKE VORTEX SAFETY”

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Researchers in Russia are Ready to Work with Other Countries to Solve the Serious Challenges Posed by Wake Vortices
What Are The Desired Objectives for Vortex Forecasting Systems (VFS)?

- Minimize Risk from Wake Vortices
- Increase Airport Capacity
- Optimize Air Traffic Control Systems
- Reduce Pilot Workload
- Strengthen Public Confidence

Obstacles to Solving the WV Problem:
- Standards & Methods Have Not Been Agreed Upon
- WV Sensing Technology is Under Development and Unproven
- It Is Undesirable to Place New Burdens on Air Traffic Controllers
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Airborne Vortex Forecasting System (AVFS)

A VISUAL System for Pilots, to Warn of Impending Wake Vortex Threats

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The AVFS has Information on:

- **Lead Aircraft** (WV “generator”)
- **Protected Aircraft**
- **Weather Factors, Including Windspeed Profiles and Ambient Turbulence**
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What Does the AVFS Do With This Information?

- Models the Position and Intensity of Wake Vortices from the Generator
- Predicts the Trajectory of the Protected Aircraft
- Calculates When the Protected Aircraft is Facing a Hazard
- Alerts the Pilot, Who May Take Evasive Action

These Actions Are Done Through Simplistic Displays That Are Helpful & Non-Intrusive to the Pilot
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What The Pilot Sees:
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Where Can The Information Come From?

- Lead Aircraft (the WV “generator”)
  - ADS-B, TCAS, ACAS, GNSS, SSR Mode S, and other (satellite)
- Protected Aircraft
  - ADS-B, On-Board Systems
- Weather, Windspeed, and other Factors
  - Weather Radar, Meteorological (via ADS-B)

The Next Generation: Integrated Vortex Forecasting System (IVFS)

IVFS is Compatible with Main Principles of Communication Navigation & Surveillance-Air Traffic Management (CNS-ATM) Systems and Distributed Air-Ground Traffic Management (DAG-TM) Systems
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What Are the Elements of the AVFS Model?

- Unit tracking parameters of the generator and the protected aircraft
- Unit calculating the generator wake vortices
- Unit simulating the control plane
- Unit indicating a dangerous situation when the wake vortices are inside the APEA in the control plane
- Additional auxiliary units

What Are the Algorithms for the Model?

Parameters of the generator motion → Evaluation of the generator trajectory

Parameters of the protected aircraft → Calculation of the intersection point between the generator path and the control plane

Parameters of the generator motion → Evaluation of the age of the generator vortices at the control section

Atmosphere conditions: the wind velocity profile, ambient turbulence

Parameters of the protected aircraft motion and its geometrical and aerodynamic parameters → Evaluation of the position and intensity of the generator vortices at the control section

Evaluation of the danger area positions at the control section → Visualization of the danger areas for the pilot
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Potential Effectiveness Towards Objectives

<table>
<thead>
<tr>
<th>Desired Objectives</th>
<th>Traditional VFS</th>
<th>IVFS</th>
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<tbody>
<tr>
<td>Improve the Airport Capacity Under IFR</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Improve the Airport Capacity Under VFR</td>
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<tr>
<td>Increase Vortex Safety Under IFR</td>
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<tr>
<td>Increase Vortex Safety Under VFR</td>
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<tr>
<td>Alleviate the Pilot Work Under IFR</td>
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Conclusions

- **Wake Vortices Challenges Should be Solved Without Increasing Pilot Workload**
- **Wake Vortex Sensing Technology is Still In Its Infancy**
- **Modeling WVs and Displaying Information to Pilots Appears to be a Good Method**
- **Standards & Methods Need to Be Resolved**
- **The Use of AVFS and IVFS is a Good Potential Solution**