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Evaluating GA Pilots' Interpretation of New Automated Weather Products

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Assessing General Aviation Pilots’ Interpretation of Weather Products:

Traditional & New Automated Generation Products

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The Aviation Weather Problem

• The rate of weather-related accidents within general aviation (GA) operations has remained relatively stagnant (FAA, 2010).

• Between 2003 and 2007, a total of 1,532 GA accidents were identified as weather related (FAA, 2010).

(Fultz & Ashley, 2016).
Currently, there is wide variety of weather information available:

- **METAR**
- **Surface Analysis Charts**
- **G-AIRMET**
- **Area Forecast**
- **Radar**
Lack of Weather Knowledge

Pilots may have difficulty interpreting this information.

- Weather Products are difficult to interpret
- Poor Weather Products Usability
- Basic Weather Theory is challenging
Usability and Graphics May Improve Pilot Situational Awareness and Decision Making (Latorella & Chamberlain, 2002).
The Aviation Weather Center (AWC) has progressed in their presentation of Meteorological Products.
Background

Textual Based AIRMET

The textual based AIRMET products faced several limitations:

• Descriptions of spatial weather phenomena as textual instead of graphical

• Textual presentation may hinder the users’ understanding of the information
Background

G-AIRMET

The AWC then developed the graphical AIRMET (G-AIRMET).

• The G-AIRMET is an aviation weather tool providing short time-interval snapshots of weather

• New design facilitated the graphical display of pertinent aviation weather information

• Products are made with meteorologists in-the-loop
G-AIRMET SUITE

G-AIRMET ICE

G-AIRMET TANGO

G-AIRMET SIERRA
Background

Automated Products

The AWC has developed three new fully automated weather tools:

- Current and Forecast Icing Products (CIP/FIP)
- Graphical Turbulence Guidance (GTG)
- Ceiling and Visibility Analysis (CVA)

Automation = No meteorologist in the loop to generate weather product (FAA, 2016).
**Background**

**Automated Products**

Removing the human in the loop aspect can pose limitations

- May not accurately represent environment affected by weather
- Algorithms may cause errors
- No meteorologist to double check product data
Background

New Product Influence

Does the introduction of graphical and automated products improve pilots understanding of weather?

- Graphical information (in general) may cause pilots’ to take more risks
- Products could provide too much information
- If not followed with appropriate training, new products may pose challenges if not followed with appropriate training
The purpose of this research was to assess and compare pilots’ knowledge and interpretation of G-AIRMETs to the fully automated product suite (CVA, CIP, and GTG).

This comparison may help provide a better understanding of pilots’ performance with new fully automated weather products and give insight to possible training needs.
METHOD
Participants

Participants were recruited from Embry-Riddle Aeronautical University

Average Age:  $M = 20.70$,  $SD = 3.0$

<table>
<thead>
<tr>
<th>Pilot Certificate and/or Rating</th>
<th>Number of Pilots (Total = 131)</th>
<th>Flight Hours $M$ (SD)</th>
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<tbody>
<tr>
<td>Student</td>
<td>26</td>
<td>39.92 (33.62)</td>
</tr>
<tr>
<td>Private</td>
<td>46</td>
<td>99.35 (40.02)</td>
</tr>
<tr>
<td>Private with Instrument</td>
<td>33</td>
<td>173.79 (57.71)</td>
</tr>
<tr>
<td>Commercial with Instrument</td>
<td>26</td>
<td>261.52 (92.02)</td>
</tr>
</tbody>
</table>
**Method**

**Measures**

Two measures were used in this study, a Demographic questionnaire and the Aviation Weather Knowledge Questions.

- **Demographic**: Questions covered participant age, flight experience, flight training, and weather training.

- **Aviation Weather Knowledge Questions**: This study used 21 multiple-choice questions pertaining to G-AIRMETs, CVA, CIP/FIP, and GTG product interpretation (Blickensderfer et al., 2016).
5) **Taxonomy Code: 2005a, 2005b, 2005c**

Examine the four Graphical AIRMETS below, all of which are valid at 06Z. What potential hazards exist on a flight between points A and B below 10,000 feet?

- a) Moderate turbulence, moderate icing, IFR conditions.
- b) Moderate icing, IFR conditions.
- c) Moderate turbulence, IFR conditions.
- d) Moderate icing, moderate turbulence.
9) Taxonomy Code: 2008
Examine the Graphical Turbulence Guidance (GTG) product below. The product represents the expected conditions for what time?

- Aircraft: Light
- Plot: CAT
- Vertical level: 3,000 ft.
- Forecast time: 0400 UTC Sun 17 Apr 2016

GTG - Clear air turbulence at 5000 ft. MSL

a) 0300Z
b) 0400Z
c) 0700Z
d) The time period between 03-07Z

61) Taxonomy Code: 1201e, 2014
Examine the Ceiling and Visibility Analysis (CVA) product below valid for at 1605Z. What do we know about the ceiling and visibility conditions for the station with the red dot located to the immediate left of the letter “B” (Alliance Municipal Airport, NE)?

- Precautionary Use Statement: This product is for flight planning purposes only and should always be used in combination with radar and Medical (CAV) information from official sources such as METARs, TAFs, TAFs and area forecasts. CVA Ceiling and Visibility Analysis is intended to aid situational awareness with a quick glance visualization of current CAV conditions across an area or along a route of flight. CVA derives CAV for areas between METAR stations or may, as a function of distance from a METAR, provide extrapolated data.

- Ceiling and Visibility Display at 1605 UTC 17 Apr 2016

- Map:
  - Light
  - Dark
  - Simple

- Plot Options:
  - Fix CAT
  - Plottype

- Data Options:
  - Fix CAT
  - Plottype

- Overlays:
  - Fix CAT
  - Plottype

- Eddy Dissipation Rate (EDR)
- Terrain

- 03 hr forecast valid 0400 UTC Sun 17 Apr 2016

- Possible Terrain Obscuration

- D, E:
  - Either the ceiling is less than 1,000 feet or the visibility is less than 3 miles.
  - Either the ceiling is less than 1,500 feet or the visibility is less than 2 miles.

- C:
The ceiling is less than 1500 feet and the visibility is less than 3 miles.

- B:
The ceiling is less than 1500 feet and the visibility is less than 2 miles.

- A:
The ceiling is less than 1500 feet and the visibility is less than 2 miles.

<table>
<thead>
<tr>
<th>Difficulty Level</th>
<th>Point Biserial</th>
<th>Frequency of Each Distractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>.6</td>
<td>.322</td>
<td>60</td>
</tr>
<tr>
<td>A</td>
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<td>122</td>
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<tr>
<td>B</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>12</td>
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</table>
The Current Icing Product (CIP) example below provides what useful information for 1900Z on 4 May 2016?

**Probability of icing at 11000 ft. MSL**

Analysis valid 1900 UTC Wed 04 May 2016

1. The severity of icing at 11,000 feet MSL
2. The probability of encountering moderate or greater icing at 11,000 feet MSL
3. The maximum probability of icing regardless of altitude
4. The probability of encountering any intensity of icing at 11,000 feet MSL
Method
Measures

To assess the participant’s product interpretation scores, we calculated percent correct and developed composite scores for the following categories:

Traditional Generation Products
(13 questions)
- G AIRMET ICE (9 questions) *
- G AIRMET SIERRA (4 questions)*
- G AIRMET TANGO (6 questions)*

Automated Generation Products
(8 questions)
- CIP/FIP (4 questions)
- GTG (2 questions)
- CVA (2 questions)

* Groups share overlapping questions
Method

Procedure

Once participants arrived at the data collection site, each participant was briefed and received an informed consent form to sign and review.

Then they completed the following at their own pace:

- The computer-based online demographic survey.
- The computer based aviation-weather knowledge assessment.

After completing the demographic survey and the knowledge assessment, participants were debriefed and received their compensation. Subset of previous study (Blickensderfer et al., 2016).
RESULTS
We conducted four 4 X 2 Mixed ANOVAS. In each analysis we investigated the effect of experience on product interpretation score and the following factors:

1. Effect of Traditional and Automated on Product Interpretation Scores.
   - Traditional:
     - G-AIRMET ICE
     - G-AIRMET Sierra
     - G-AIRMET Tango
   - Automated:
     - CIP/FIP
     - CVA
     - GTG

   - CIP/FIP

   - GTG
   - G-AIRMET Tango

   - CVA
   - G-AIRMET Sierra
Results

Effect of Traditional and Automated on Product Interpretation Scores

4 x 2 Mixed ANOVA
• Product generation by experience on percentage correct

Pilots scored higher on automated weather products questions

Student pilots scored lower than Commercial Pilots
Results

Effect of Icing Product Generation on Product Interpretation scores

4 x 2 Mixed ANOVA

- Icing Product generation by experience on percentage correct

No significant main effect of icing product generation on icing interpretation scores

Commercial Pilots scored significantly higher than Private and Instrument pilots

Instrument pilots significantly scored Higher than Student pilots
Results

Effect of Visibility Product Generation on Product Interpretation scores

4 x 2 Mixed ANOVA
- Visibility Product generation by experience on percentage correct

Student Pilots scored significantly lower than Commercial Pilots

No significant main effect of visibility product generation on visibility interpretation scores

No other significant relationships occurred
**Results**

Effect of Turbulence Product Generation on Product Interpretation scores

4 x 2 Mixed ANOVA

- Turbulence Product generation by experience on percentage correct

Pilots scored significantly higher on automated GTG weather products interpretation scores.

No significant main effect of the pilot certificate on turbulence product interpretation scores.

No other significant relationships occurred.
The purpose of this study was to examine pilots’ abilities to interpret traditional human-in-loop graphical products and newer fully-automated aviation weather products.

- Pilots performed better on automated products than on questions using traditional products.
- For icing and visibility products, the results indicate similar interpretation scores for both traditional and automated generation products.
Discussion & Limitation

Discussion cont.

- Turbulence products results indicated that participants’ scored higher on the automated turbulence product interpretation questions.

- The significant differences found could be due to the same suite of contributing factors, training, pilot preference, and product usability.

- Usability of the weather products analyzed could also contribute to this significant difference in scores.
Discussion & Limitation

Limitations

• Participants were relatively low-hour pilots

• More generalizable sample could provide insight into how pilots are interpreting the automated products.

• Research is also needed to identify underlying reasons for the similarities and difference in interpretation scores.
Thank You
Questions?

References


