Benefits of Including Heading and Airspeed in State Vector Report

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Overview

- Current heading and airspeed are valuable information to a variety of applications.
  - Along with ground vector, makes it possible to determine real-time wind encountered by aircraft.
  - Provides added situation awareness for tactical operations.
- Example applications that would use heading and airspeed information:
  - Paired approaches.
  - Precision FMS procedures.
  - Trajectory prediction following a turn.

Paired Approaches

- Paired approaches aim to have the trailing aircraft cross the threshold at a specified time after the lead aircraft.
  - Each aircraft slows to its desired final approach speed at a specified point.
  - Time spacing behind lead aircraft based on difference between final approach speeds of both aircraft and wind.
  - Wind affects the amount of time in which difference in final approach speeds acts to close or stretch the gap.
- Wind errors increase the uncertainty of the operation, requiring an increase in threshold crossing intervals in order to avoid unacceptably high number of missed approaches.
  - Results in lower airport capacity.

Paired Approaches (cont.)

- By sending air and ground vectors, updated winds are obtained at all altitudes along final approach course.
- Knowledge of current airspeed increases situation awareness for all aircraft in stream.
  - Pilots can compare actual airspeed of trailing and leading aircraft with expected speed.
  - Unexpected speed differences alert pilots to possibility of conflict.
  - May be valuable information in wind-shear event.

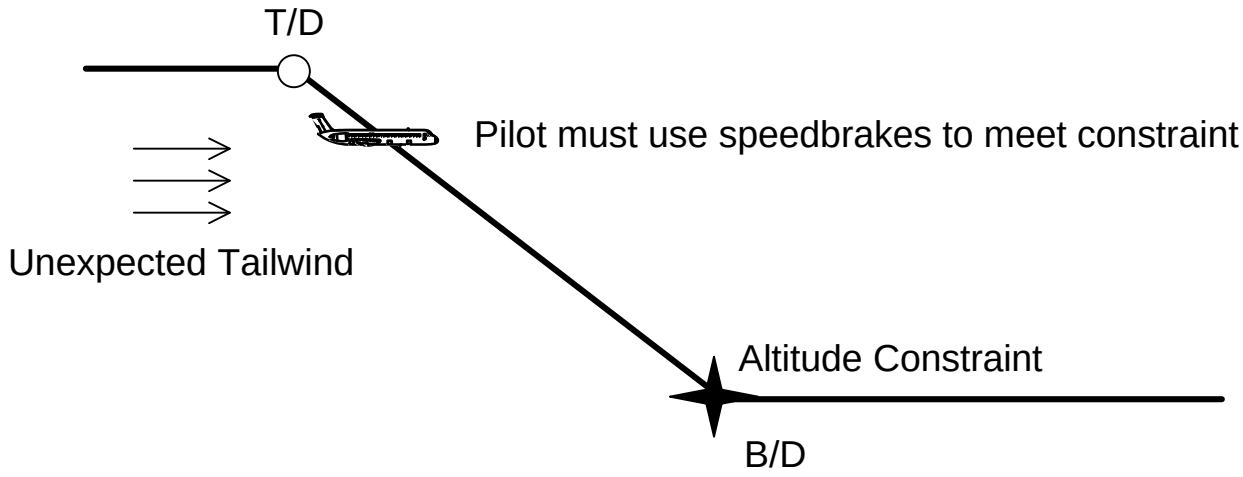
Precision FMS Procedures

- Current air traffic management procedures often impose waypoint speed and altitude restrictions on descending aircraft.
- FMS considers desired speed profile and waypoint restrictions when generating FMS descent path.
  - Current FMS generates idle descent path.
  - Path based primarily on airplane performance and wind.
- Wind information often sporadic and out-dated.
- Wind information from preceding aircraft (generated by combination of ground and air vectors) enables near real-time model, leading to more accurate path prediction and adherence.

Precision FMS Procedures (cont.)

- Inaccurate wind estimates lead to path that may not meet waypoint constraints without thrust or speedbrake inputs from pilot.
  - Results in higher crew workload and lower fuel efficiency.

Example: Descending Aircraft Encounters Unforecasted Tailwinds



Precision FMS Procedures (cont.)

- Future ATM procedures likely to require more precise FMS paths.
  - Time constraints applied at waypoints.
  - Vertical tunnels that require path adherence between waypoints (see presentation by Tony Warren).
  - Further increases need for accurate wind information.

Trajectory Prediction Following a Turn

- Conflict detection routine may need to extrapolate another aircraft's trajectory after it finishes a turn.
  - Example - Other aircraft operating in Heading/Track select mode enters a turn.
  - Current wind information (calculated by ground and air vectors) allows calculation of roll-out point and groundspeed after turn is completed.
    - Assumes commanded heading/track is also known.
  - Used to determine whether another aircraft's turn creates or resolves a conflict.

Air Vector Status in Current MASPS

- Proposing MASPS clarification to unambiguously include heading and airspeed in state vector report.
  - Table 3-5 of DO-242 includes true/indicated airspeed and true/magnetic heading as required parameters if the data are available.
  - Heading and airspeed are not mentioned in Section 2 description of state vector.
- If bandwidth is limiting, alternating between air and ground-referenced information could be a solution.