Air Traffic Controller Usage of Terminal-Area Speed Advisories

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Outline

- Background
- Speed Advisory Literature
- CMS Speed Advisories
- CMS Simulations
- Results
  - Speed Advisory Usage Data
- Closing Remarks

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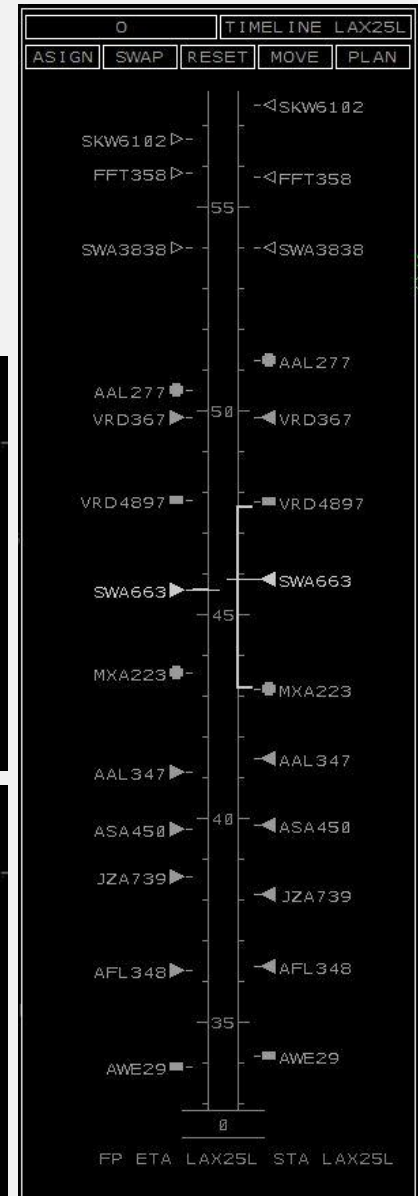# Background

- Problem
  - Uninterrupted Optimized Profile Descents (OPDs) limited to periods of low demand

- Approach
  - NASA's Super-Density Operations (SDO) research focus area
    - High runway throughput with fuel-efficient operations
      - Area Navigation (RNAV) OPD arrival routes to the runway
      - Runway scheduling
      - Controller-Managed Spacing (CMS) decision support tools

Background

- CMS tools
  - Timeline display
  - Slot markers
  - Speed advisories
    - Early/late indication
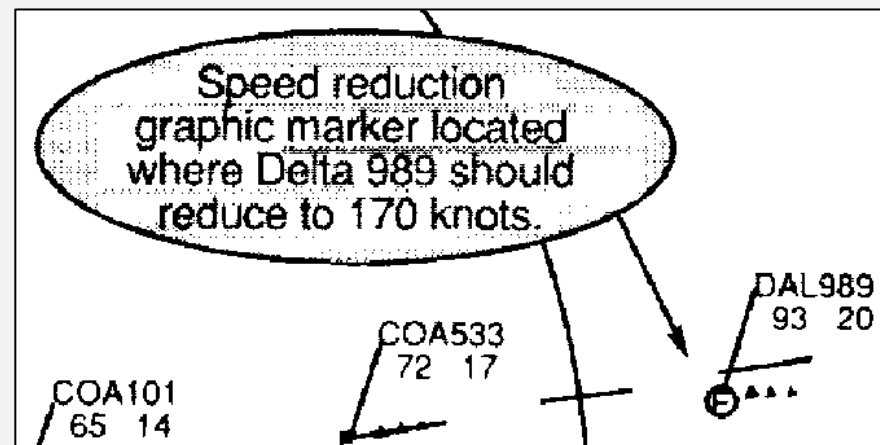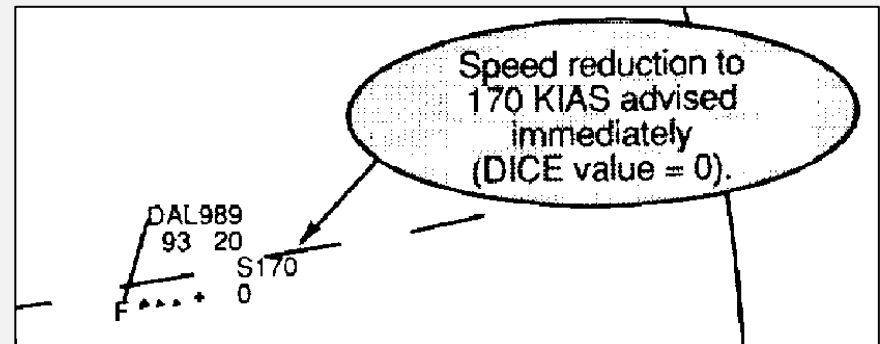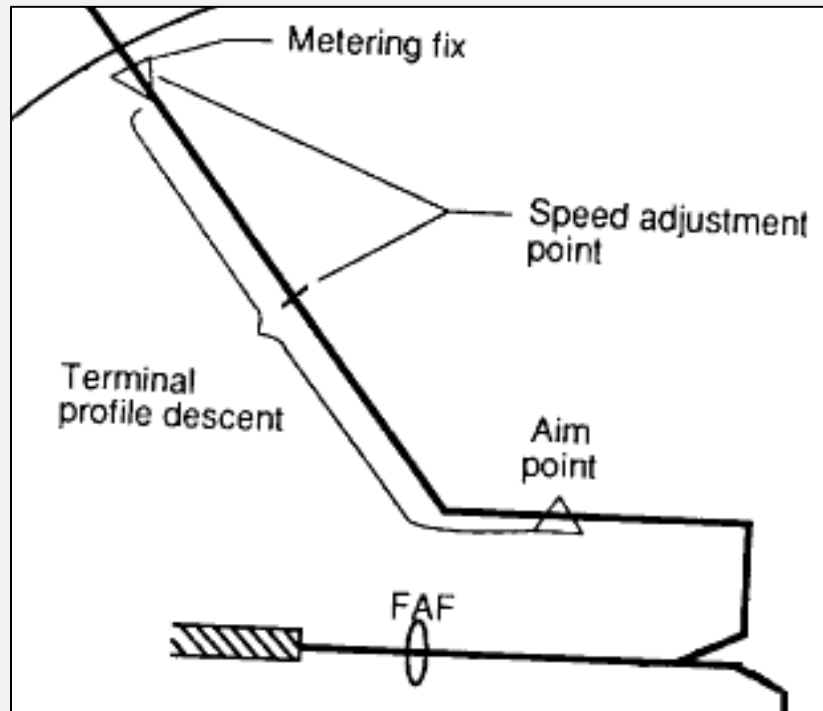
  - Shown to be effective

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Speed Advisory Literature

- ## 1989, 1993

  – Traffic Intelligence for the Management of Efficient Runway scheduling (TIMER)

Speed Advisory Literature

- ## 1989, 1991, 1992
  - – Final Approach Spacing Tool (FAST)

Speed Advisory Literature

- 1998
  - Terminal Routing Using Speed-control Techniques (TRUST)

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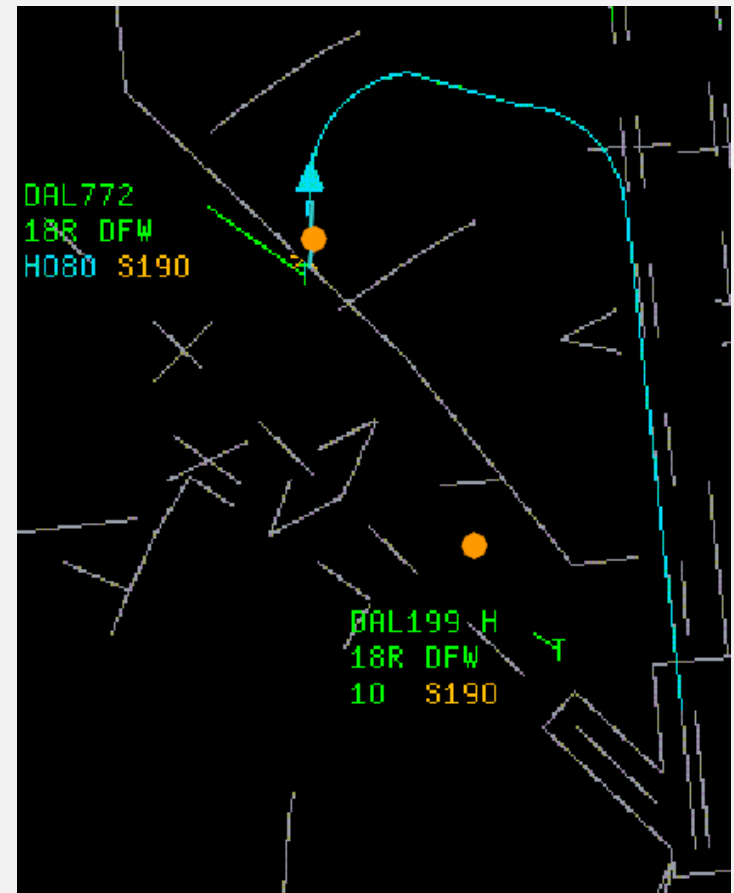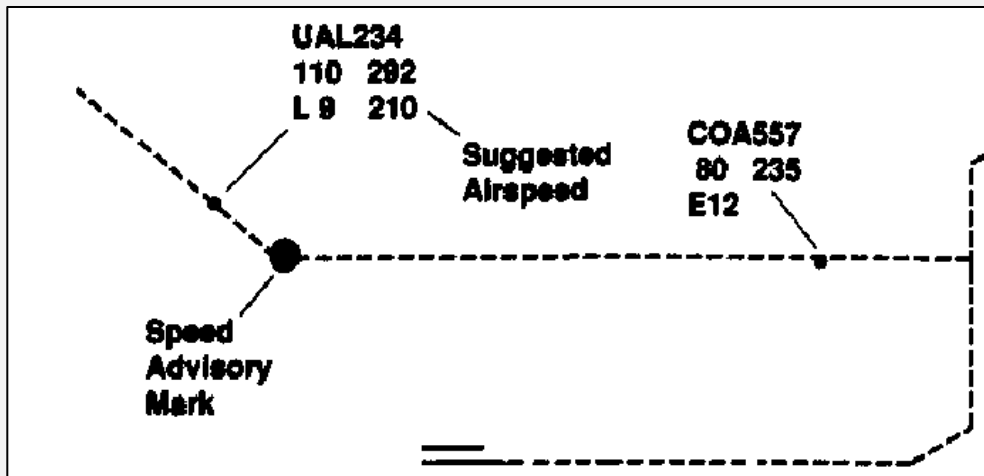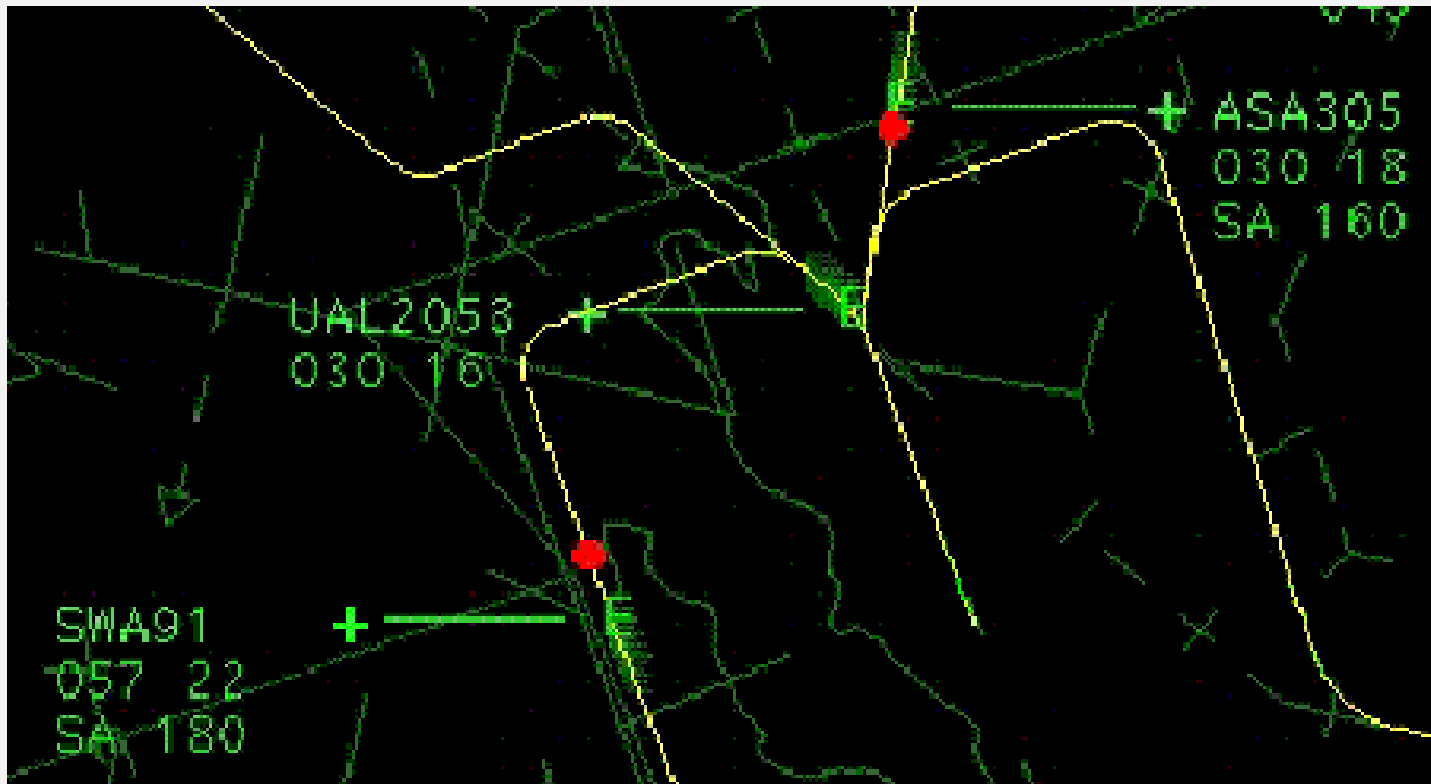
CMS Speed Advisories

- 2008 – present

CMS Speed Advisories

- Example scenario:

- a/c is early
  - 190 GAATE

- a/c is early
  - 190 GAATE
    - 180 GAATE

- a/c is early
  - 190 GAATE
    - 180 GAATE
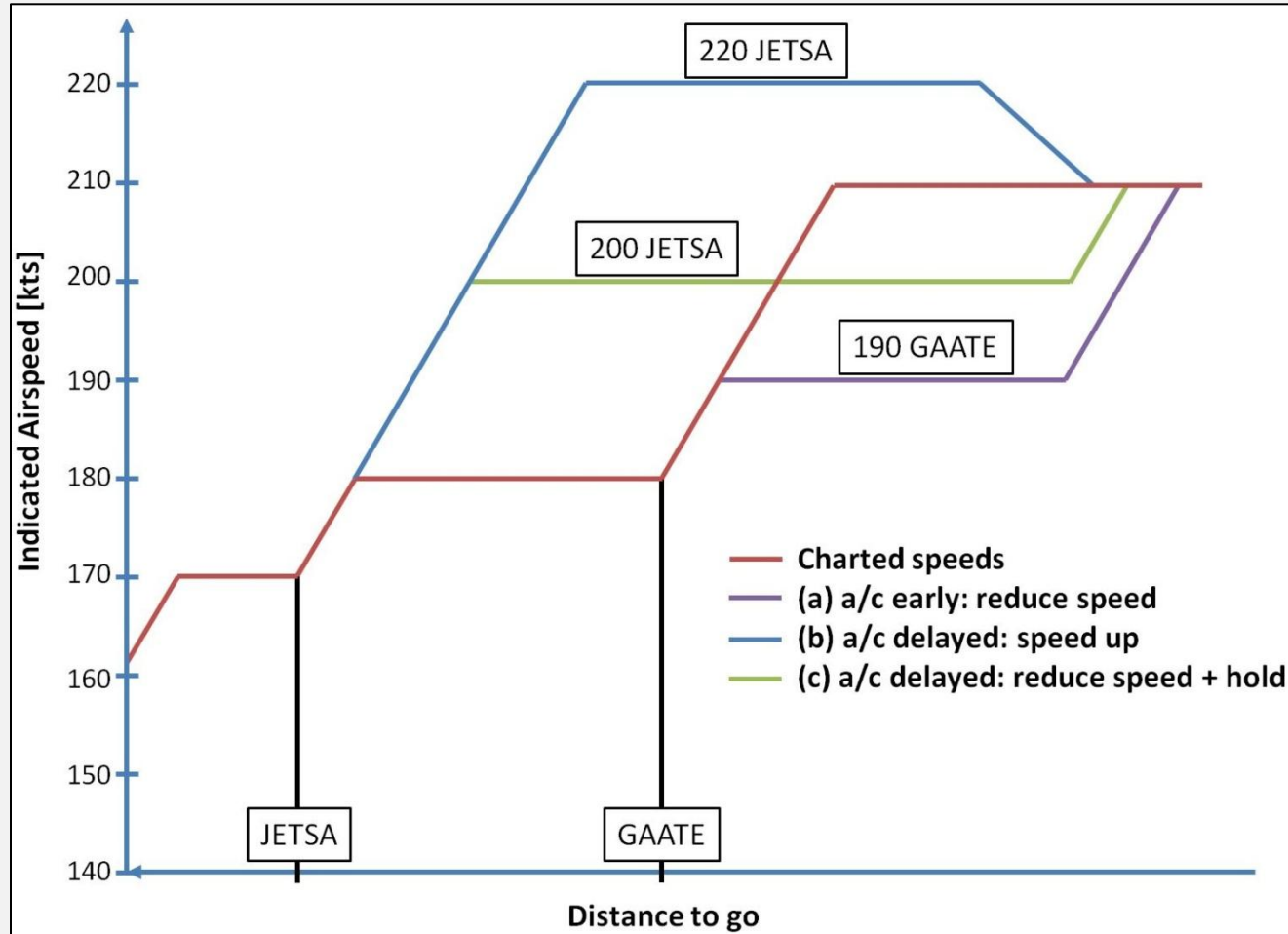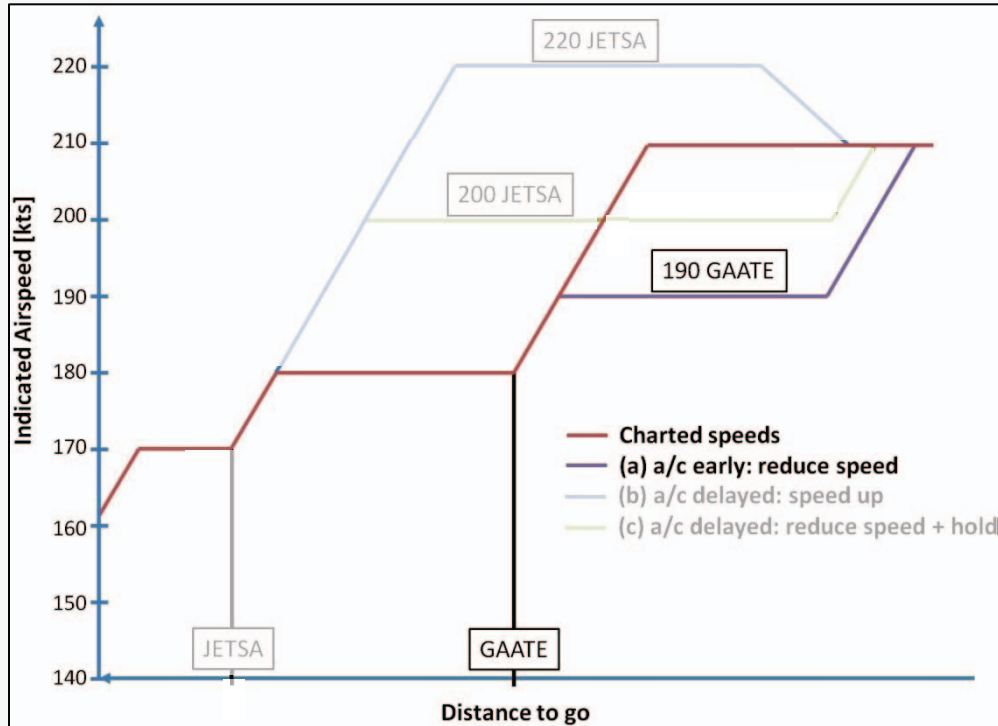   - ~~170 GAATE~~
      - 180 JETSA
        - E 0:54

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CMS Simulations

- Data provided by three CMS simulations:

CMS Simulations

Simulation 1

- CMS3
- SCT/LAX
- 60-minute runs
- 2 independent runways
- 3 feeders
- 2 finals
- 10-knot wind forecast errors

Simulation 2

- CMS4
- Arrival schedule disruptions via off-nominal events
- 13/7 knot wind forecast errors
- 0, 1, or 2 wind shifts
- Speed advisory rejoin waypoint tied to 'sector exit' waypoints

Simulation 3

- CMS5
- D10/DFW
- 60-minute runs
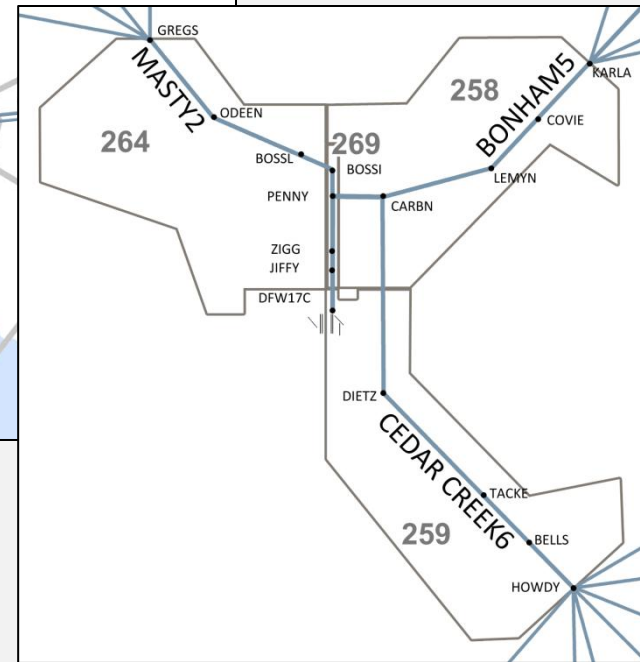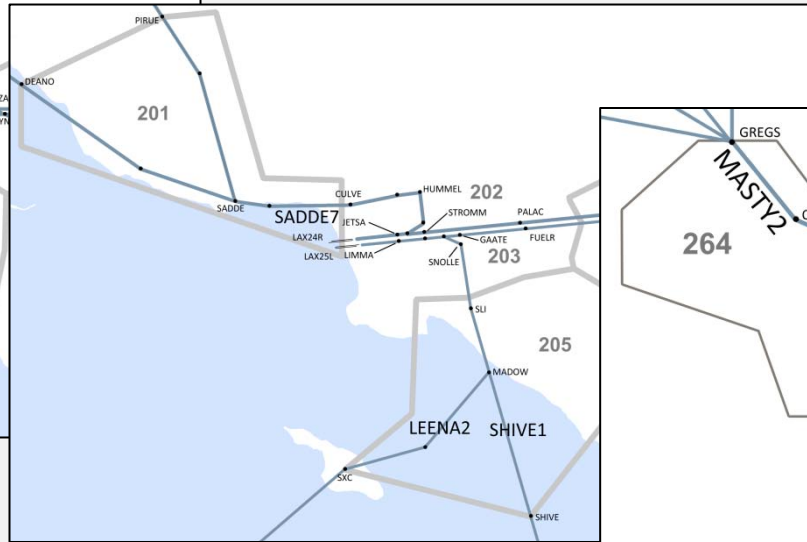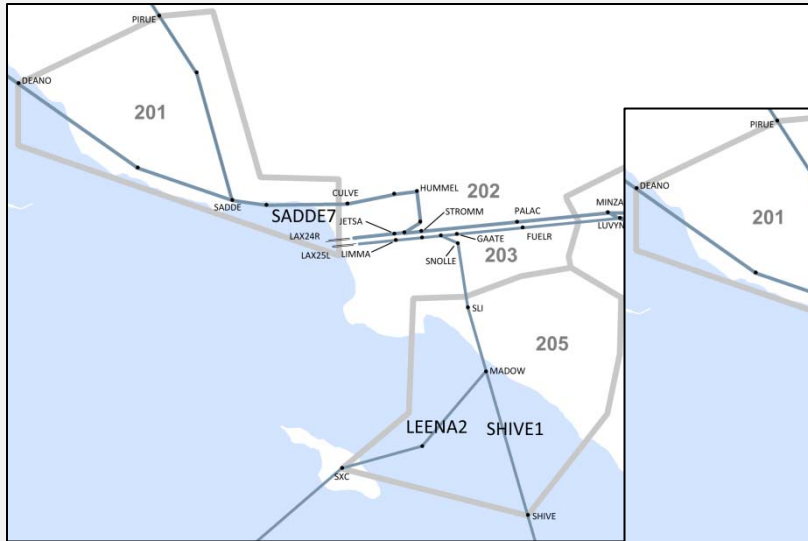- 1 runway
- 3 feeders
- 1 final
- No wind forecast error

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Results

- Speed advisory issued vs. speed advisory presented

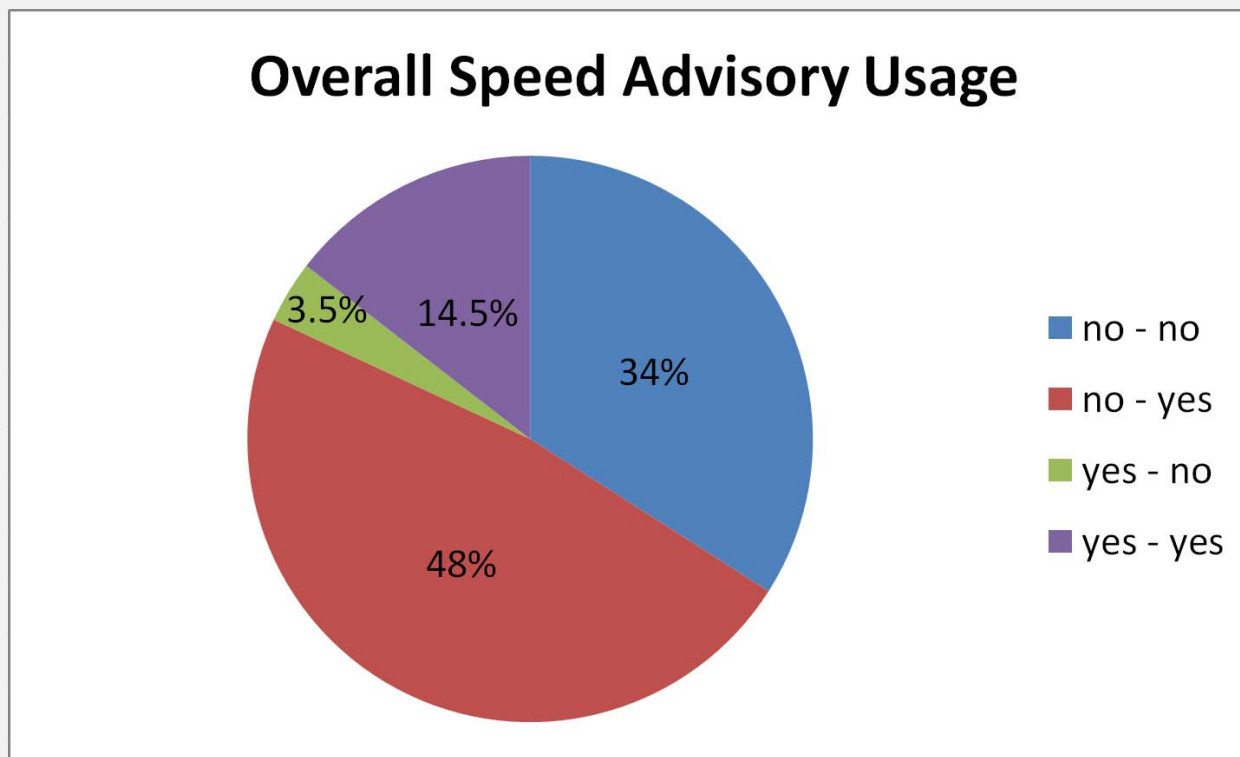 - Analyzed per speed advisory element…

    - until speed

    - rejoin waypoint

    …to produce four possible usage outcomes:

    - No-No
    - No-Yes
    - Yes-No
    - Yes-Yes

Speed Advisory Usage Data

Overall Speed Advisory Usage

- no - no — 34%
- no - yes — 48%
- yes - no — 3.5%
- yes - yes — 14.5%
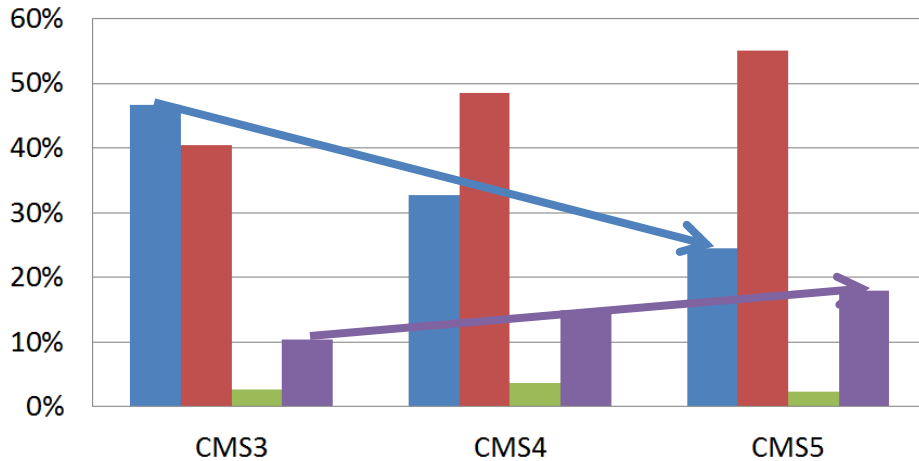
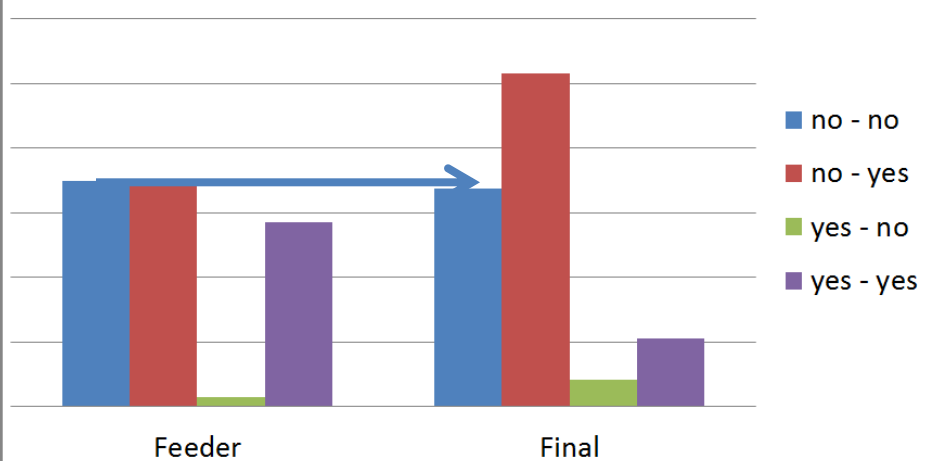- 85.5% of 7,733 speed advisories issued were modifications of the presented advisory

Speed Advisory Usage Data

- Acceptance improved over time
- Similar 'rejection rate' for feeders and finals
- Finals modified (the speed element) more often

Speed Advisory Usage Data

Speed Element Modification, by Simulation, by Position
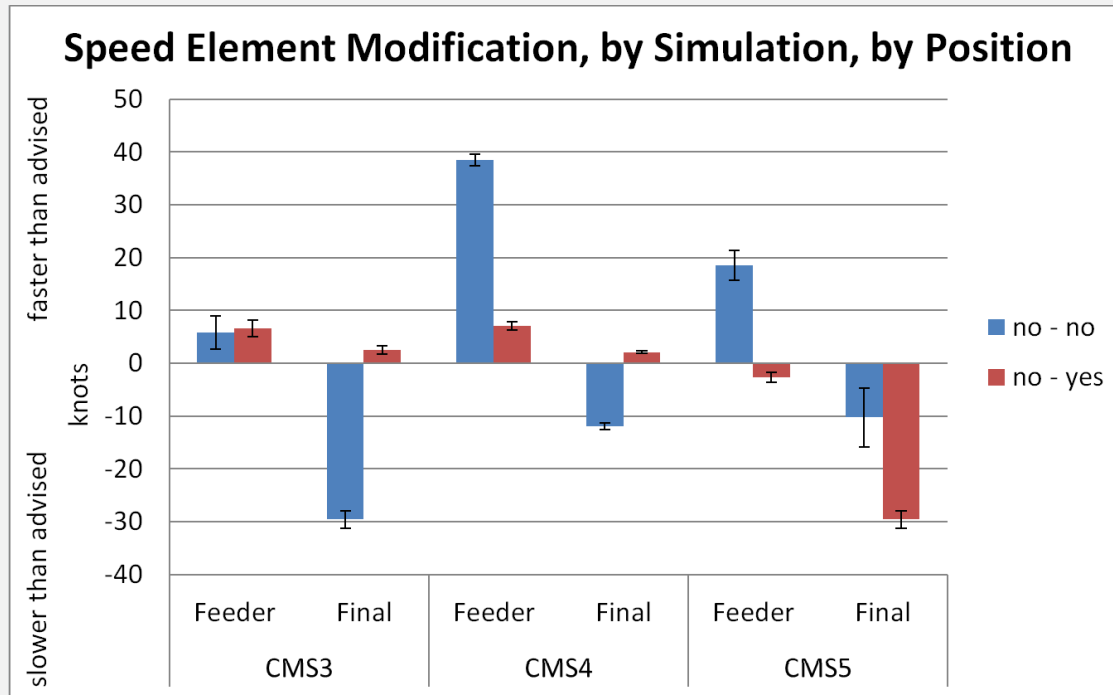
- Feeders mainly issued faster speeds, finals issued mainly slower speeds
  - Modifications to both elements showed a correlation to larger distribution of speed deltas

Speed Advisory Usage Data

Waypoint Element Modification, by Simulation, by Position
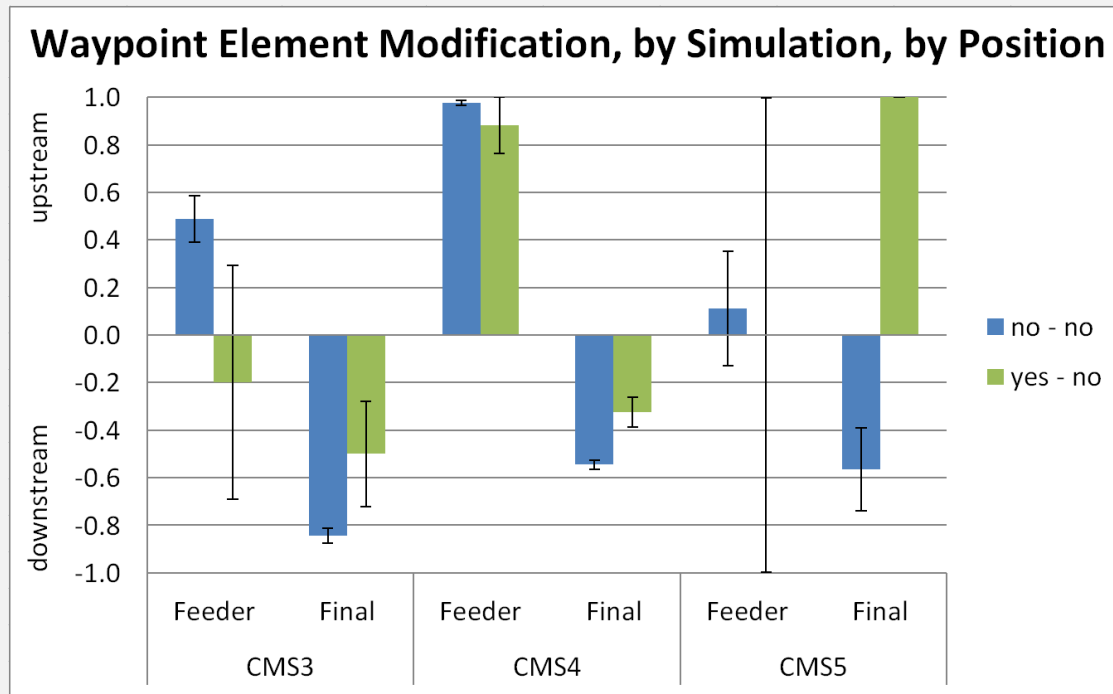
- When modifying both elements, feeders mainly issued upstream waypoints, finals issued mainly downstream waypoints

Speed Advisory Usage Data

Overall Speed Advisory Usage, by Logic Type, by Position

Chart legend:
- no - no (blue)
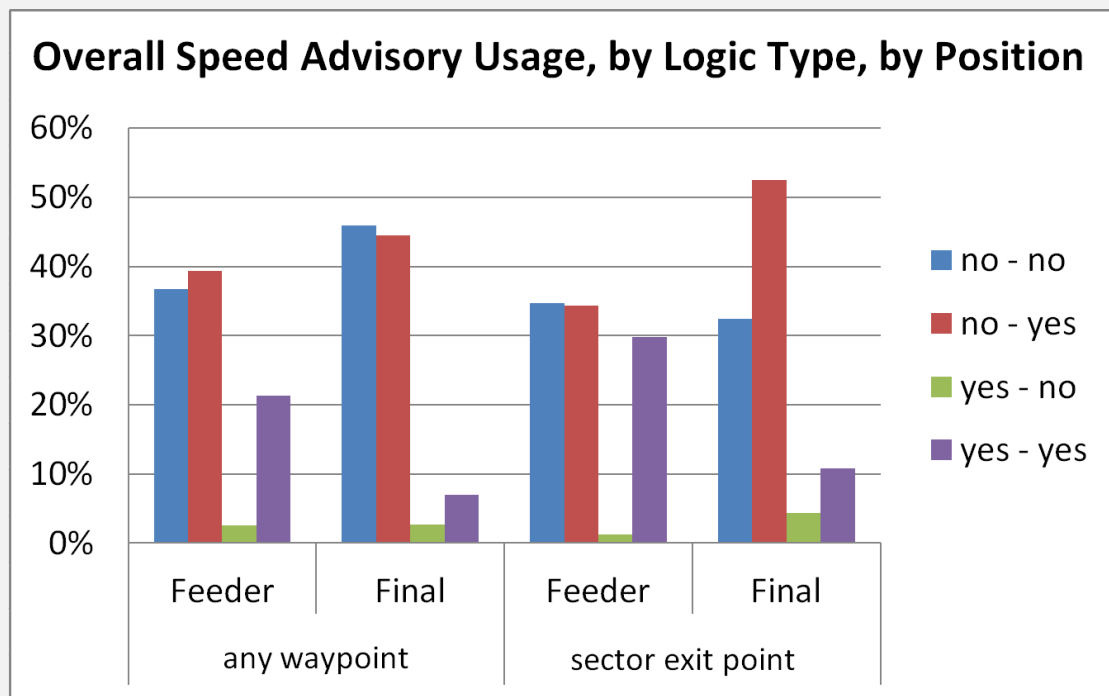- no - yes (red)
- yes - no (green)
- yes - yes (purple)

Categories: Feeder, Final (any waypoint); Feeder, Final (sector exit point). Y-axis: 0% to 60%.

- Reasonable expectations mostly met by the final controller's data

- Feeder controller modified fewer advisories

Speed Advisory Usage Data

Speed Advisory Usage, Counter-Intuitive Advisories
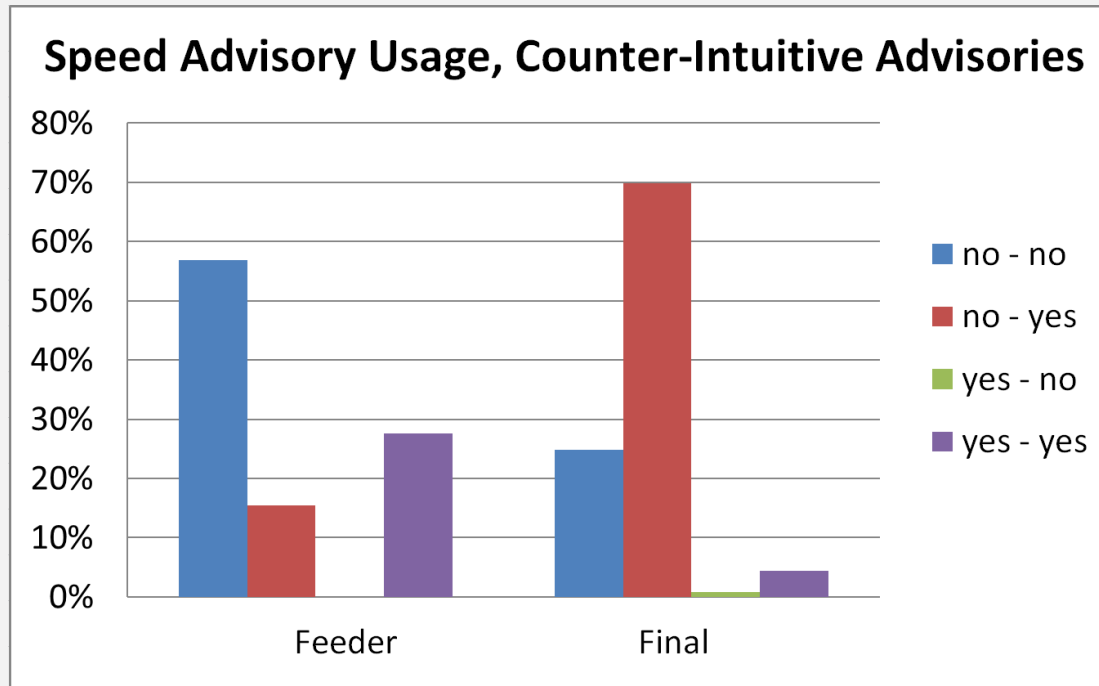
- Marginal/some acceptance:
  - Feeders rejected more than 50%, but accepted 25%
  - Finals rejected 25%, but modified 70%

Speed Advisory Usage Data

Overall Speed Advisory Usage, by Speed Granularity
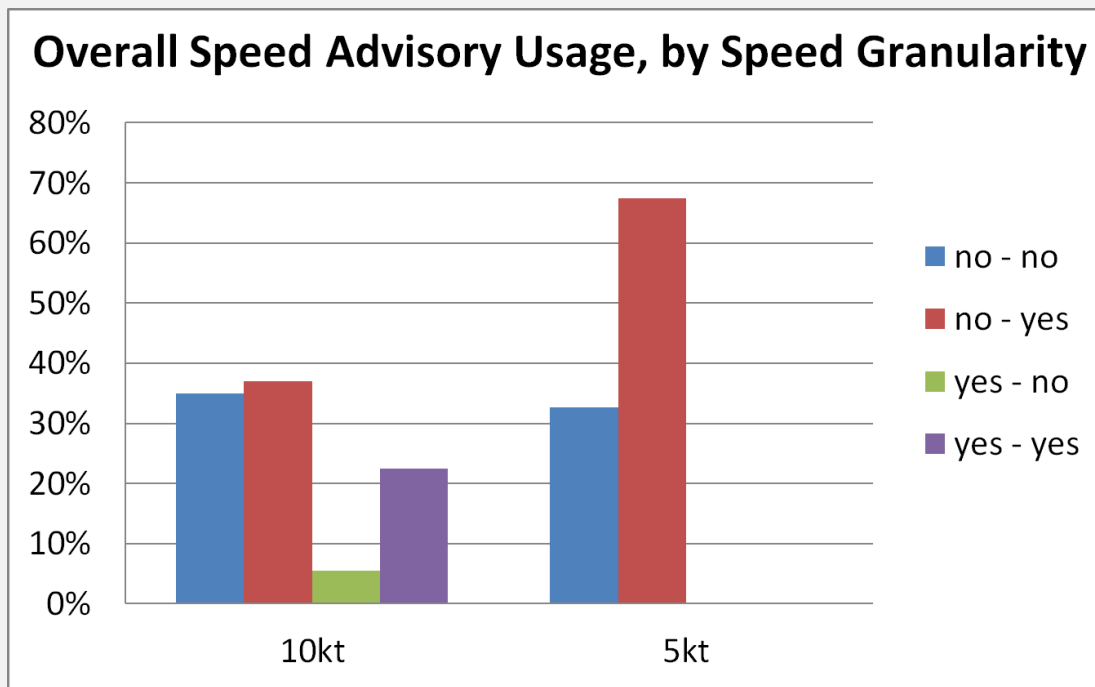
- Speeds with 5-knot increments not well received
  - Were never issued by the controllers

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Closing Remarks

- Simulation 2 + sector exit point logic = unexpected side effects:
  - Off-nominal events -> arrival flow disruptions -> schedule manipulations -> more aircraft with late ETAs (as compared to the other simulations)
  - Aircraft behind schedule + speed advisories tied to sector exit points + 7,000 ft charted altitude restrictions at sector exit points + 10,000/250 rule = speed advisories with 'capped' speeds
  - Possible '250 CULVE' speed advisory for an aircraft behind schedule and currently descending through 16,000 ft at 300 knots
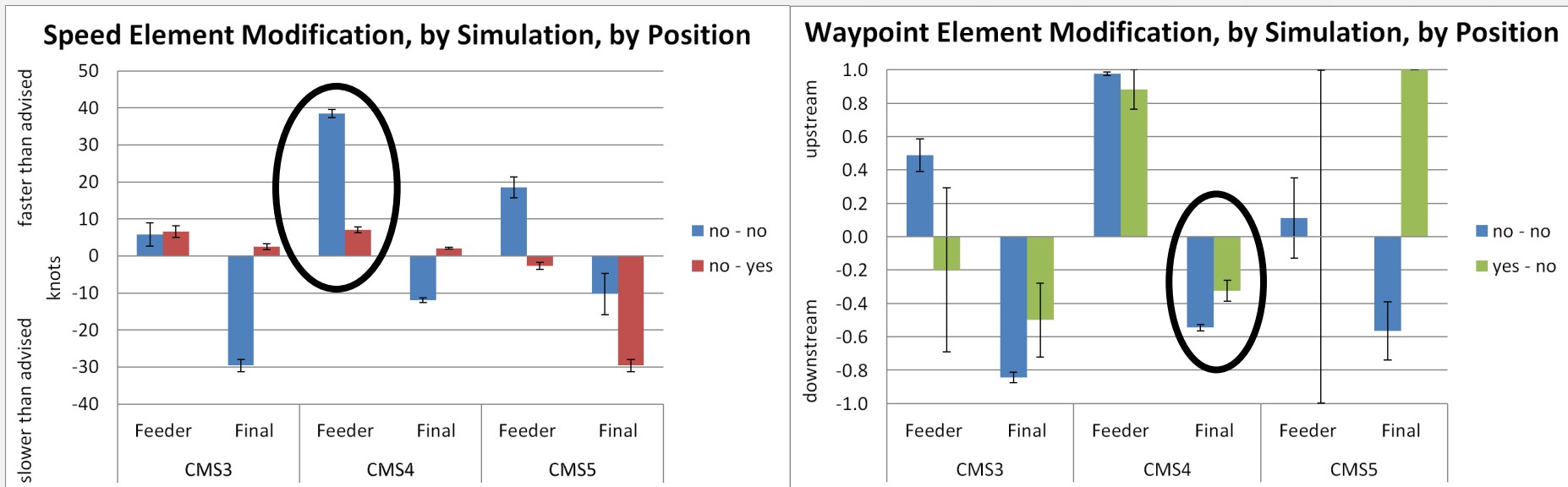
Closing Remarks

- Simulation 2 + sector exit point logic = unexpected side effects:
  - Aircraft still prior to the feeder's sector exit point + final controller taking an early handoff = speed advisories with minimal relevance

Closing Remarks

- ## Sector exit point logic also helps explain trends observed in the data:

– Feeders sometimes needed to issue something faster than 250 knots

– Finals sometimes needed to modify advisories that weren't meant for them

Closing Remarks

- Ideas going forward:
  - Perhaps more flexibility in the speed advisory logic to work in the context of the moment
    - Ownership awareness
    - 10,000/250 agility

- Work has already begun
  - Currently evaluating single-element speed advisories
    - No rejoin waypoint
    - Advised speeds based on current route segment

Questions?

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