Understanding Current Safety Issues for Trajectory Based Operations

Michael Feary
NASA Ames Research Center

Michael Stewart
San Jose State University Research Foundation

2025-2035
Motivation for Research

Method 1
- ASRS Issues
- ATC Intervention
- Automation
- Procedure Design
- Charting

Method 2
- Standardization in Design
- Unchecked Complexity
- Summary & Next Steps

Functionality

Procedural Complexity

Time

2D
- Ground Based Lateral

3D
- RNAV Lateral
- RNAV Lateral & Vertical

4D
- Dynamic RNAV Paths RTA

We’re Here
Motivation For Research

Method 1

ASRS

Issues

ATC Intervention

Automation

Procedure Design

Charting

Method 2 Workshop

Standardization in Design

Unchecked Complexity

Summary & Next Steps

Method 1

Issues

Method 2

Issues

Next Steps
Method 1: ASRS Analysis

- Descend Via RNAV STARs
- \( \approx 400 \) ASRS reports reviewed
- Deviation trends were categorized

Chains of events were coded by Initial and causal factor
Issues from ASRS Analysis

More than 80% of Deviations in 4 Categories

1. ATC Interventions
2. Automation
3. Procedure Design
4. Charting
ASRS Issue #1
ATC Interventions

• Runway and Approach changes during the STAR triggered issues.

  “Several approach clearance changes...... expect Runway 35R RNAV RNPZ but mistakenly entered Runway 34R. After a TA alert.....”

• Altering charted restrictions
  – Changes physics of procedure

  “ATC specialists must not have any idea of the level of disruption the constantly changing speeds impose on the flight crew during arrival. In my opinion they truly need increased awareness of the destabilizing affect these speed changes have on a safe flight.”
ASRS Issue #2
Automation

- **FMS Entry errors**
  
  “late runway change as they approached HONIE on the WARRR RNAV STAR to ATL, the flight crew was unable to program it in a timely fashion and a modest track deviation Occurred”

- **Auto Flight Expectations**
  
  “We noticed we might be high by KIKKR and put full speed brakes out and kicked off the autopilot, the VNAV Path showed us on the descent path but we were high by up to about 1,000 foot”

- **Mismatched Capability**
  
  “We went 500 FT below the charted altitude crossing ARGAL…
  The altitude deviation occurred because the Captain put in a rate of descent that would allow us to cross the last fix [as required] versus the intermediate fixes.”
WHINY ONE ARRIVAL (RNAV)

ARRIVAL ROUTE DESCRIPTION

CRIED TRANSITION (CRIED.WHINY1)
PNUITS TRANSITION (PNUITS.WHINY1)
STUFT TRANSITION (STUFT.WHINY1)
YUYUN TRANSITION (YUYUN.WHINY1)

From KLNDR on track 309° to cross WHINY at or above 12000 and at 260K, then on track 316° to cross HOWDY between 11000 and 12000 and at 250K, then on track 279° to cross VANCO between 8000 and 9000 and at 250K, then on track 281° to cross BERMS between 7000 and 8000 and at 250K, then on track 281° to cross HLLZZ at 6000 and at 250K, then on track 281°. Expect RADAR vectors to final approach course.

NOTE: Chart not to scale.
Whiny 1 RNAV arrival into DFW. Star was loaded and confirmed by both pilots with emphasis on speed and altitudes especially being new stars. With autopilot engaged in LNAV and VNAV Path, aircraft remained on path and sped up in speed even with full speed brakes deployed. VANCO intersection to BERMS. ATC was notified and asked for relief. No scratchpad messages and light winds less than 10 knots. ATC coordinator contacted on arrival. Redesign intersection to provide more distance to allow greater flexibility. Crossing 2000 feet in 4.4 at 250 knots is very tight in normal conditions.

Fixes?

VANCO is gone
ASRS Issue #4: Charting

Missed Notes
Method 2: 2015 Workshop

1. To learn about design and issues
2. To provide a forum and start dialog

- Attended by
  - FAA Safety, Airline Reps, NASA personnel.

- Presentations:
  - Non-VNAV airline operational concerns
  - Weather effects
  - Design problems in Boston
  - Complexity
Standardization In Design

• No requirement to include stakeholders in design process
  – Might miss valuable feedback or knowledge
  – Might not have the authority to make needed changes (e.g., airspace)

• No method to catalog fixes
  – Actionable fixes not available to others

• Aero modeling is not comprehensive
  – Flyability limits are unknown
Deviations from 4 major categories

1. ATC Intervention
2. Automation
3. Procedure Design
4. Charting

- Are there other Categories? We need a larger pool of data. FOQA + ASAP = better picture
Design methods are not standardized leading to inconsistent results.

- Create a repository and forum for design problems, lessons learned, and best practices.

Increases in STAR implementation & functionality might be related to deviation occurrence rates.

- Need to know how often deviations occur- ATC data could possibly inform more accurately.
Unchecked Complexity Poses Future Risks
Motivation For Research

Method 1
ASRS

Method 2
Workshop
Standardization in Design

Unchecked Complexity

Summary & Next Steps

---

**Thank You**

Michael Stewart
650-604-3156
Michael.j.stewart@nasa.gov