RNAV STAR Procedural Adherence

How Procedures Have Changed

Next Steps
Data Visualization
Scene Analysis
Procedure Analysis
Scenario Analysis
Training/Implementation

Method

Descriptive Data

Why we looked at OPD STARs

Data Source
RNAV STAR Procedural Adherence

How Procedures Have Changed

Data Source

Next Steps

Method

Descriptive Data

Why we looked at OPD STARs
How Procedures Have Changed

No Procedures
Flying was dangerous and not standardized

Instrument Approach Procedures
A method to consistently guarantee known distances

STARs (conventional)

STARs (RNAV OPD)
Robust technology settings, route standardization, and turn management (FAA 1994)
No Procedures

Flying was dangerous and not standardized
Instrument Approach Procedures

A method to consistently guarantee terrain clearance
STARs (conventional)

Standardized Routing & Terrain Clearance
STARs (RNAV OPD)

Noise reduction, fuel savings, route standardization, and flow management. (FAA, 2014)
Why we looked at OPD STARs

ASRS Reports from Pilots
1. Controller interventions
2. Autopilot and FMS errors
3. Procedure design

ASRS Reports from Controllers
1. Inter-controller communications
2. Pilot non-compliance
3. Misinterpreted instructions

Factors Influencing Adherence
- Weather
- Mixed Equipment Performance
- Traffic
Method
Overlay Flights on Routes

- Entry Waypoint
- Waypoint in route
- Exit Waypoint

- Identify route flown
- Determine adherence of lateral flight trajectory with waypoint restrictions
- Characterize lateral adherence (join late/skip/early exit)

Full Lateral Adherence of VKTRY2 into KDFW
Data Source

**Past**
ARTCC radar tracks (CTAS data)

**NOW**
TRACON data (Sherlock2.0)

**Longterm**
Aircraft sensors (FOQA-type)

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**Procedural Characteristics**
- Waypoint type, window size
- Speed Restrictions
- Altitude Restrictions
- Route name (e.g., Transition)
- Slope-degree angles
- Leg type (e.g., track to fix)

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**Environmental Variables**
- Wind (bulkwind component)
- Temperature (Rapid Refresh NOAA)

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**Aircraft Variables**
- Type and equipment suffix
- Groundspeed
- Altitude (several samples)
- Rate of descent
- Required slope to next restriction
- # of flights on the arrival

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Expand Capability
Procedural Characteristics
- Waypoint type, window size
- Speed Restrictions
- Altitude Restrictions
- Route name (e.g., transition)
- Slope-degree angles
- Leg type (e.g., track to fix)

Environmental Variables
- Wind (tailwind component)
- Temperature (Rapid Refresh NOAA)

Aircraft Variables
- Type and equipment suffix
- Groundspeed
- Altitude (several samples)
- Rate of descent
- Required slope to next restriction
- #of flights on the arrival

TRACON data (Sherlock2.0)

Longterm Aircraft sensors (FOQA-type)
Descriptive Data

Assess Levels of Use

Identify Human Intervention
Assess Levels of Use
Memphis

LATE ENTRY AND EARLY EXIT
7.13%
18,170

LATE ENTRY
11.86%
30,229

SKIP AND LATE ENTRY
3.15%
8,033

SKIP AND EARLY EXIT
0.37%
951

FULL LATERAL & VERTICAL
24.40%
62,194

FULL LATERAL
18.99%
48,409

EARLY EXIT
19.70%
50,212

No STAR
20.52%
52,291

SKIP
6.54%
16,681

SKIP, LATE ENTRY, AND EARLY EXIT
0.51%
1,307
Denver

- Early Exit: 20.07% (117,244)
- No STAR: 48.42% (282,908)
- LATE ENTRY AND EARLY EXIT: 10.72% (62,648)
- LATE ENTRY: 1.67% (9,775)
- FULL LATERAL: 0.33% (1,944)
- FULL LATERAL & VERTICAL: 0.32% (1,888)
- SKIP AND LATE ENTRY: 0.92% (5,349)
- SKIP AND EARLY EXIT: 15.45% (90,251)
- SKIP: 3.14% (18,347)
- SKIP, LATE ENTRY, AND EARLY EXIT: 4.57% (26,674)
Identify Human Intervention
WP Type

Excursion above restriction

Excursion below restriction

AT AT or Below AT or Above Window

Excursion Percentage

0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Next Steps

Data Visualization & synthesis

- Monitor trends
- Observe efficacy of mitigation strategies
- Observe factors that influence degradation
- Set acceptability metrics
- Decision support for designers
Monitor trends

Observe efficacy of mitigation strategies

Observe factors that influence degradation

Set acceptability metrics

Decision support for designers
RNAV STAR Procedural Adherence

Data Source

Next Steps
- Data Visualization
- Exploratory Data Analysis
- Model Selection
- Model Evaluation

Method

Descriptive Data

Why we looked at OPD STARs
- Initial Data Exploration
- Feature Selection
- Model Training
- Model Evaluation

How Procedures Have Changed