RNAV STAR Procedural Adherence
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Next Steps
- Data Visualization
- Case Study Report
- A/B Testing

Method

Descriptive Data

Why we looked at OPD STARs

How Procedures Have Changed
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No Procedures
Flying was dangerous and not standardized

Instrument Approach Procedures
A method to consistently guarantee certain distance

STARS (conventional)

STARS (RNAV OPD)
RNAV (Required Navigation Performance) was introduced; new navigation and flight management tool introduced (FAA 2014)
No Procedures

Flying was dangerous and not standardized
Instrument Approach Procedures

A method to consistently guarantee terrain clearance

Two pages from Elrey Jeppesen’s “Little Black Book”: The Arps Ranch (far left) and Bitter Creek. At first, Jeppesen collected this navigational information to help his fellow pilots.
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)

Expand Capability

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

Environmental Variables
- Wind (burst wind 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)

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

Longterm Aircraft sensors (FOQA-type)
Descriptive Data

Assess Levels of Use

Identify Human Intervention
Assess Levels of Use
Memphis

- No STAR: 20.52% (52,291)
- Full Lateral: 18.99% (48,409)
- Full Lateral & Vertical: 24.40% (62,194)
- Early Exit: 19.70% (50,212)
- Late Entry: 11.86% (30,229)
- Skip: 6.54% (8,033)
- Late Entry and Early Exit: 7.13% (18,170)
- Skip and Late Entry: 0.37% (951)
- Skip, Late Entry, and Early Exit: 0.51% (1,307)
Houston

- **Skip and Late Entry**: 3.40% (18,107)
- **Skip and Early Exit**: 3.96% (21,082)
- **Skip, Late Entry, and Early Exit**: 0.78% (4,151)
- **Late Entry**: 14.17% (75,455)
- **Early Exit**: 19.91% (106,043)
- **Full Lateral**: 13.50% (71,891)
- **Full Lateral & Vertical**: 9.27% (49,374)
- **Late Entry and Early Exit**: 5.70% (30,340)
- **No STAR**: 26.09% (138,973)
Denver

- **No STAR**: 48.42% (282,908)
- **Early Exit**: 20.07% (117,244)
- **Late Entry**: 10.72% (62,648)
- **Skip, Late Entry, and Early Exit**: 4.57% (26,674)
- **Skip and Late Entry**: 0.92% (5,349)
- **Skip and Early Exit**: 15.45% (90,251)
- **Skip**: 3.14% (18,347)
- **Full Lateral**: 0.33% (1,944)
- **Full Lateral & Vertical**: 0.32% (1,888)
- **Late Entry**: 1.67% (9,775)
Identify Human Intervention
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
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