RNAV STAR Procedural Adherence
How Procedures Have Changed

No Procedures
Flying was dangerous and not standardized

Instrument Approach Procedures
A method to consistently guarantee descent distance

STARS (conventional)

STARS (RNAV OPD)
Rules, procedures, and data for standard option and runway management (FAA 2014)
No Procedures

Flying was dangerous and not standardized
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

[Diagram of STARs route]
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

Expand Capability

Past
ARTCC radar tracks (CTAS data)

NOW
TRACON data (Sherlock2.0)

Longterm
Aircraft sensors (FOQA-type)

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 (fullwind 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

LATE ENTRY AND EARLY EXIT
7.13%
18,170

EARLY EXIT
19.70%
50,212

FULL LATERAL
18.99%
48,409

FULL LATERAL & VERTICAL
24.40%
62,194

No STAR
20.52%
52,291

SKIP
6.54%
16,681

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
- **FULL LATERAL**: 13.50%, 71,891
- **FULL LATERAL & VERTICAL**: 9.27%, 49,374
- **LATE ENTRY**: 14.17%, 75,455
- **EARLY EXIT**: 19.91%, 106,043
- **No STAR**: 26.09%, 138,973
- **LATE ENTRY AND EARLY EXIT**: 5.70%, 30,340

Total: 306,638
Denver

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

Magnitude of Excursion (ft) (bin)

Count of Waypoint

-3000 -2800 -2600 -2400 -2200 -2000 -1800 -1600 -1400 -1200 -1000 -800 -600 -400
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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