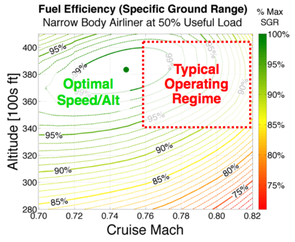
ASCENT Project 15: Cruise Altitude and Speed Optimization

Project Managers: Chris Dorbian, FAA
Aniel Jardines, FAA

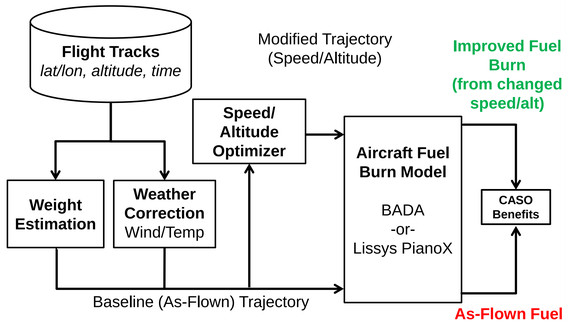
Principal Investigators: R. John Hansman, MIT

Cruise Altitude and Speed Optimization

- Flying closer to optimal altitudes and speeds in cruise can reduce system fuel consumption without major technology changes
- Analysis conducted of historical flights showed potential improvement in cruise fuel efficiency
- An EFB is being developed to assist in accessing those improvements



Analysis Method

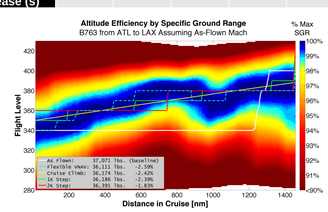


Analysis results

- Analysis of over 200,000 flights in 2012 showed potential fuel burn improvements
  - Altitude optimization: 1.69% (2000 ft step climbs)
  - Speed optimization: 1.93% (max range cruise)

Altitude and Speed Optimization Analysis for 2012

	Altitude Optimization				Speed Optimization	
	Cr. Climb	1K Step	2K Step	Flex	MRC	LRC
Sample Size	216,923	216,928	203,563	214,269	216,930	216,930
Mean (%)	1.87%	1.90%	1.69%	1.93%	1.93%	0.93%
Mean (lbs)	102 lbs	104 lbs	98 lbs	107 lbs	105 lbs	51 lbs
Median	0.87%	0.91%	0.76%	0.95%	1.24%	0.39%
3rd Quartile	2.30%	2.35%	2.13%	2.38%	2.83%	1.82%
Average Flight Time Increase (s)	13 s	13 s	14 s	9 s	152 s	-3 s



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Electronic Flight Bag App Development

The CASO decision support tool (DST) is a standalone prototype DST that predictively applies the CASO analysis to aid pilot decision-making in the cockpit. During cruise, the DST uses flight plans and weather forecasts to provide performance estimates and recommended trajectories for optimizing fuel burn in real time.

Motivation

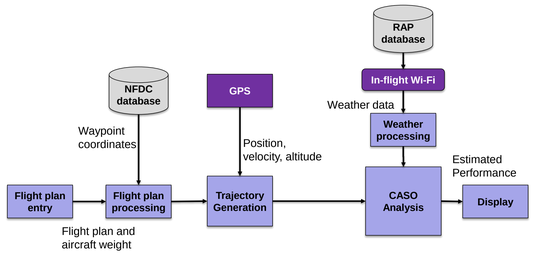
- Pilots, dispatchers, and air traffic controllers do not currently have access to all information and procedures required for improved cruise-phase efficiency
- Current flight plans are created around an hour before takeoff and usually not updated
- Currently available winds aloft information in the cockpit is limited, based on older forecasts, and not intuitively presented
- Limited support is currently available for enroute changes to the flight plan

Proposed DST Capabilities

- Real-time cruise altitude and speed optimization directly provided in the cockpit
- In-flight updates to weather and wind forecasts provide most current weather information
- Graphical display of fuel efficiency for various altitudes allows for informed planning in unexpected situations
  - (e.g. encountering unpredicted, severe turbulence)
- Flexible to flight plan amendments that occur in-flight
- The DST needs no access to aircraft systems
- Architecture also allows for possibility of integration with aircraft FMS and databus

Electronic Flight Bag App Development

DST Architecture



Inputs
- Weight: User entry
- Waypoints: User entry or flight plan upload
- Cost Index/Mach: User entry
- Weather: NCEP Rapid Refresh
  - Downloaded through in-flight Wi-Fi
- Position: GPS
- Aircraft performance model: BADA4
  - Architecture can accept other performance models

Outputs
- Recommended trajectory
- Estimated fuel and time performance
- Graphical depiction of fuel efficiency for various altitudes along track

Electronic Flight Bag App Development

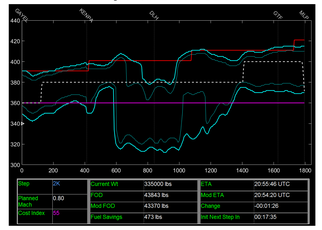
Example Cases

The altitude band of maximum efficiency varies with multiple factors, including aircraft weight and weather conditions along the flight path. The DST assists in-flight decision-making by calculating and clearly presenting altitude efficiencies projected through the entire flight.

Flight from SEA to EWR

The optimal altitude is not always the max reachable altitude. In most cases, the optimal is actually below.

Flight from EWR to SEA



Optimal altitudes may also occasionally be found by descending in some areas due to more favorable winds

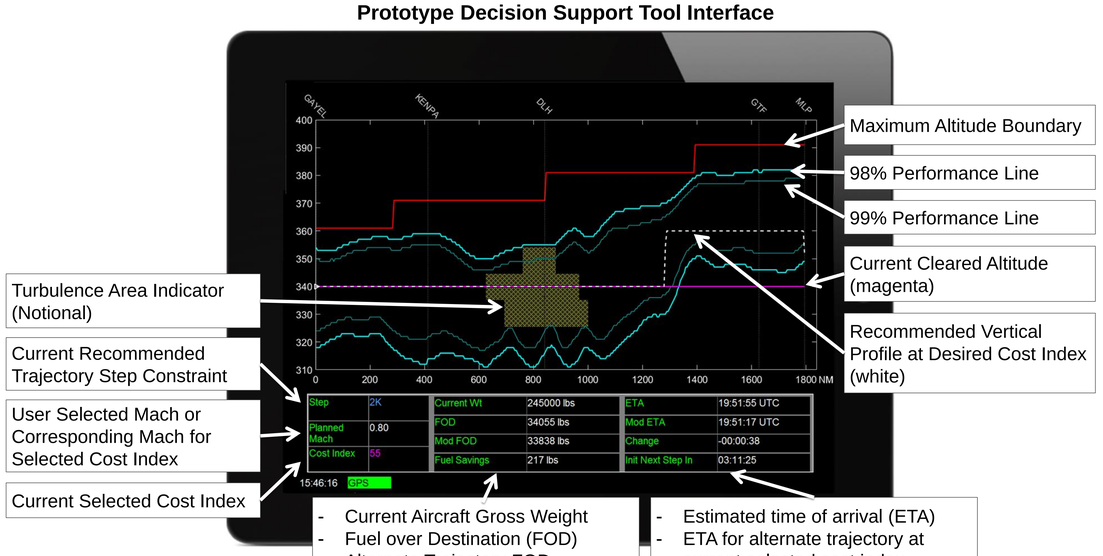
DST Evaluation

- An online scenario-based survey was developed to gain insight and input from pilots about the prototype DST
- Survey distributed to a group of airline pilots for beta testing
- Prototype DST is being prepared for flight testing

Ongoing Work

- Continue outreach with specific airlines about analysis results and DST development opportunities
- Expand outreach efforts to non-pilot stakeholders including dispatchers and ATC
- Refine DST user interface and explore additional features
- Prepare for demonstrating and testing the DST in flight

Prototype Decision Support Tool Interface



Contact Information

R. John Hansman rjhans@mit.edu
Clement Li clementl@mit.edu
Luke Jensen ljensen@mit.edu