INFLIGHT REPLANNING FOR DIVERSIONS

Michael Palmer
NASA Langley Research Center

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Current procedures for handling flight plan diversions can require too much of the crew's resources. This increases workload and may compromise safety and cause delays in modifying the flight plan. The goal of NASA Langley Research Center's Diverter research program is to develop guidelines for a prototype pilot decision aid for diversions that will reduce cognitive workload, improve safety, increase capacity and traffic flow, and increase aircraft efficiency. The Diverter program has been partitioned into five phases, the first three of which were performed under contract by Lockheed Aeronautical Systems Company, Marietta, GA. In the first two phases, which have been completed, the system requirements and desired functions were defined and a prototype decision-making aid was implemented and demonstrated on a workstation. In phase three, which is currently under way, the pilot/vehicle interface is being defined and the capability of the prototype is being improved. In the last two phases, which will be performed at NASA Langley Research Center, the interface will be implemented, tied into the prototype aiding software, and installed in an advanced simulation facility for testing. In addition, significant implementation issues may be addressed through flight testing on NASA research aircraft.

PROBLEM

Current procedures for handling diversions can require too much of the crew's resources. This increases workload, and may compromise safety and cause delays in modifying the flight plan.

DIVERTER PROGRAM GOAL

Develop guidelines for and implement a prototype pilot decision aid for diversions which will:

- Reduce cognitive workload
- Improve safety
- Increase capacity & traffic flow
- Increase aircraft efficiency (time & fuel)

DIVERTER ISSUES

- What aspects of diversion planning would benefit the most from intelligent aiding?
- Where should diversion information be displayed?
- How should the crew interact with the system?
- How should a diversion system interact with other aircraft systems?
- How should the system interact with existing ATC?

DIVERTER PROGRAM OBJECTIVES

● Phase 1 - Define requirements and desired functions

● Phase 2 - Develop prototype decision-making aid, and demonstrate "stand-alone" capability

○ Phase 3 - Define pilot/vehicle interface, and improve Diverter's functional capability

○ Phase 4 - Install and evaluate the aid in a realistic flight simulation environment

○ Phase 5 - Examine human-centered automation issues through simulation, and investigate implementation issues by flight testing on TSRV aircraft

PHASE 1 ACCOMPLISHMENTS

- Determined Diverter system requirements
  - Identified causes of diversions
  - Identified different types of diversions

- Determined desired system functions
  - Identified functions to be performed
  - Identified information required to make the necessary decisions for those functions
    - > Destination selection decision factors
    - > Route planning/replanning decision factors
    - > Other information sources

CAUSES FOR DIVERSIONS

- Destination traffic
- En route traffic
- Weather
- Runway or airfield closure
- Aircraft malfunction
- Passenger problem

TYPES OF DIVERSIONS

- Different departure route
- En route change to same destination
- Delaying vectors
- Holding
- Different arrival route
- Alternate destination

DIVERTER FUNCTIONS

- Perform situation assessment
  - Position, heading, airspeed, etc.
- Evaluate influences on rerouting
  - FAR's, weather, traffic, priorities, company rules, airspace restrictions, noise abatement, slot times
- Consider system status constraints
  - Aircraft systems, avionics, fuel, etc.
- Perform flight planning/replanning
  - Destination, route, fuel, time
- Perform manuever planning
  - Performance, terrain, traffic, weather

DESTINATION DECISION FACTORS

- Safety
- Airfield condition and facilities
- Passenger comfort
- Schedule constraints
- Economy

ROUTE DECISION FACTORS

- Available routes
- Obstacles & terrain
- Min & max altitudes
- Distance from destination
- Aircraft status
- Current weather conditions

PHASE 2 ACCOMPLISHMENTS

- Developed prototype decision-making aid
  - Selected subset of Diverter functions for implementation
  - Designed prototype decision aid using applicable AI technology
  - Implemented in Lisp on Symbolics
  - Incorporated engineering interface and explanation capability

- Demonstrated "stand-alone" capability
  - Demo 1: Included alternate airfield selection
  - Demo 2: Added route replanning & Adage display

PHASE 3 APPROACH

- Define pilot/vehicle interface
  - Identify pilot information needs, and display locations and hardware interactions
  - Define specs for all required display formats
    - > Appearance of information on display
    - > Exact source, content, and organization of required information

- Improve Diverter's functional capability
  - Integrate airfield selection/route replanning
  - Redesign database I/O procedures to read and write to independent data streams

PHASE 4 APPROACH

- Install Diverter in NASA Langley Advanced Concepts Simulator (ACS)
  - Adapt interface design as necessary
  - Tie in appropriate data streams

- Evaluate aiding capability during realistic flight scenarios

PHASE 5 APPROACH

- Examine human-centered automation issues through simulation
  - Evaluate existing interface, identify necessary changes, implement those changes
  - Examine sensitivity to decision factor weight changes, and to inaccurate or incomplete data

- Examine implementation issues through flight test on TSRV aircraft